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Energy
A Continuing Bibliography with Indexes

NASA SP-7043(17)
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National Aeronautics and Space Administration

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ACCESSION NUMBER RANGES

Accession numbers cited in this Supplement fall within the following ranges:

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STAR (N-10000 Series)	N78-10001—N78-15985

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NASA SP-7043(17)

ENERGY

A Continuing Bibliography

With Indexes

Issue 17

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced from January 1 through March 31, 1978 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA)*.

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INTRODUCTION

This issue of *Energy: A Continuing Bibliography with Indexes* (NASA SP-7043(17)) lists 1292 reports, journal articles, and other documents announced between January 1, 1978 and March 31, 1978 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. The first issue of this continuing bibliography was published in May 1974 and succeeding issues are published quarterly.

The coverage includes regional, national and international energy systems; research and development on fuels and other sources of energy; energy conversion, transport, transmission, distribution and storage, with special emphasis on use of hydrogen and of solar energy. Also included are methods of locating or using new energy resources. Of special interest is energy for heating, lighting, for powering aircraft, surface vehicles, or other machinery.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries* in that order. The citation, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR* including the original accession numbers from the respective announcement journals. This procedure, which saves time and money accounts for the slight variation in citation appearances.

Five indexes -- subject, personal author, corporate source, contract number, and report number -- are included. The indexes are of the cumulating type throughout the year, with the fourth quarterly publication containing abstracts for the fourth quarter and index references for the four quarterly publications.

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NASA SPONSORED DOCUMENT — AVAILABLE ON MICROFICHE

ACCESSION NUMBER — CORPORATE SOURCE — TITLE — PUBLICATION DATE — AUTHORS — AVAILABILITY SOURCE — CONTRACT OR GRANT — COSATE CODE — REPORT NUMBER

N78-10035*# Douglas Aircraft Co., Inc., Long Beach, Calif.
COST/BENEFIT TRADEOFFS FOR REDUCING THE ENERGY CONSUMPTION OF THE COMMERCIAL AIR TRANSPORTATION SYSTEM Summary Report, 5 Nov. 1974 - 30 Jun. 1976
E. F. Kraus and J. C. VanAbkoude Jun. 1976 77 p
(Contract NAS2-8618)
(NASA-CR-137925; MDC-J7340) Avail: NTIS
HC A05/MF A01 CSCL 05C

The fuel saving potential and cost effectiveness of numerous operational and technical options proposed for reducing the fuel consumption of the U.S. commercial airline fleet was examined and compared. The impact of the most promising fuel conserving options on fuel consumption, passenger demand, operating costs and airline profits when implemented in the U.S. domestic and international airline fleets was determined. A forecast estimate was made of the potential fuel savings achievable in the U.S. scheduled air transportation system. Specifically, the means for reducing the jet fuel consumption of the U.S. scheduled airlines in domestic and international passenger operations were investigated. A design analysis was made of two turboprop aircraft as possible fuel conserving derivatives of the DC-9-30. Author

TYPICAL CITATION AND ABSTRACT FROM *IAA*

NASA SPONSORED DOCUMENT — AVAILABLE ON MICROFICHE

ACCESSION NUMBER — AUTHORS — AUTHORS AFFILIATION — TITLE — CONFERENCE DATE — CONFERENCE

A78-11391 * # **Evaluation of initial collector field performance at the Langley Solar Building Test Facility.** R. J. Boyle, R. H. Knoll (NASA, Lewis Research Center, Cleveland, Ohio) and R. N. Jensen (NASA, Langley Research Center, Hampton, Va.). *International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Paper.* 20 p. 6 refs.

The thermal performance of the solar collector field for the NASA Langley Solar Building Test Facility is given for October 1976 through January 1977. An 1180 square meter solar collector field with seven collector designs helped to provide hot water for the building heating system and absorption air conditioner. The collectors were arranged in 12 rows with nominally 51 collectors per row. Heat transfer rates for each row are calculated and recorded along with sensor, insolation, and weather data every 5 minutes using a mini-computer. The agreement between the experimental and predicted collector efficiencies was generally within five percentage points. (Author)

A Listing of Energy Bibliographies Contained in this Publication:

IAA ENTRIES

A78-10056 * **Instrumental sensing of stationary source emissions.** W. F. Herget and W. D. Conner (U.S. Environmental Protection Agency, Research Triangle Park, N.C.). *Environmental Science and Technology,* vol. 11, Oct. 1977, p. 962-967. 5 refs. NASA-supported research.

A variety of programs have been conducted within EPA to evaluate the capability of various ground-based remote-sensing techniques for measuring the SO2 concentration, velocity, and opacity of effluents from coal-burning power plants. The results of the remote measurements were compared with the results of instack measurements made using EPA reference methods. Attention is given to infrared gas-filter correlation radiometry for SO2 concentration, Fourier-transform infrared spectroscopy for SO2 concentration, ultraviolet matched-filter correlation spectroscopy for SO2 concentration, infrared and ultraviolet television for velocity and SO2 concentration, infrared laser-Doppler velocimetry for plume velocity, and visible laser radar for plume opacity. G.R.

A78-10059 **NOx-O3 photochemistry in power plant plumes - Comparison of theory with observation.** W. H. White (Meteorology Research, Inc., Altadena, Calif.). *Environmental Science and Technology,* vol. 11, Oct. 1977, p. 995-1000. 20 refs. U.S. Environmental Protection Agency Contract No. 68-02-1919.

Measurements were made by an instrumented aircraft in the plume from a large, coal-fired power plant. In all traverses (out to 45 km downwind), ozone concentrations within the plume were depressed below background levels. The depth of this ozone dificit and the ratio of NO to NOx in the plume both decreased with increasing distance from the plant. A model is presented which accurately predicts the observed plume profiles of O3, NO, and NOx, from the background conditions, plume geometry, and basic photolytic cycle. Free-radical reactions within the plume did not significantly affect oxidant concentrations at the distances sampled. (Author)

A78-10062 **Comparison of levels of trace elements extracted from fly ash and levels found in effluent waters from a coal-fired power plant.** D. R. Dreesen, E. S. Gladney, J. W. Owens, B. L. Perkins, C. L. Wienke, and L. E. Wangen (California, University, Los Alamos, N. Mex.). *Environmental Science and Technology,* vol. 11, Oct. 1977, p. 1017-1019. 12 refs. Research supported by the U.S. Environmental Protection Agency; Contract No. W-7405-eng-36.

A78-10102 **Fusion research in the European Community (La recherche sur la fusion dans la Communauté Européenne).** D. Palumbo (Commission des Communautés Européennes, Brussels, Belgium). *(CEA, Compagnie Générale d'Electricité, DGRST, DRME, Electricité de France, and Thomson-CSF, Colloque National de Physique des Plasmas, Paris, France, Dec. 6-10, 1976.) Journal de Physique,* vol. 38, Aug. 1977, Supplement, p. C3-1 to C3-7. In French.

The argument for the development of fusion energy in the European Community is stated, and the structure and interrelations of some of the main commissions and other bodies formed for organizing fusion research in the European Community are described. The chief technological problems to be solved for achieving the goal of positive energy yield in controlled fusion are stated. Some of the principal types of devices currently being investigated are briefly characterized (toroidal pinch, screw pinch, reversed pinch, high-beta stellarator, low-beta stellarator, Ohmic heating, etc.). P.T.H.

A78-10131 **New energy sources - Are they a substitute or a supplement (Les énergies nouvelles - Energies de substitution ou énergies complémentaires).** I. Peychès. *Sciences et Techniques,* Sept.-Oct. 1977, p. 67-71. In French.

The future roles of several energy sources are considered. The discussed energy sources include nuclear energy, hydroelectricity, tidal power, and geothermal heat. In comparison with the use of constructed absorbers for solar energy, the use of large natural absorbers, such as the sea or areas of vegetation, is felt to be more advantageous. Wind power, which results from insolation, is also considered. The prospects of solar and nuclear energy in the near and distant future are compared. M.L.

A78-10152 **All-dielectric compound parabolic concentrator.** R. S. Scharlack (Mobil Tyco Solar Energy Corp., Waltham, Mass.). *Applied Optics,* vol. 16, Oct. 1977, p. 2601, 2602.

Good features of all-dielectric compound parabolic concentrators (CPC) are considered with attention directed to the increase in acceptance angle with increased nonnormal light incidence. This property makes all-dielectric CPC particularly attractive for stationary collectors. The effect is due to the apparent increase in index of refraction for light out of the normal plane. A procedure for calculating the effective increase in the index of refraction and determining the resulting concentration factor is presented. M.L.

A78-10170 **Lens-mirror combinations with maximal concentration.** M. Collares-Pereira, A. Rabl, and R. Winston (Chicago, University, Chicago, Ill.). *Applied Optics,* vol. 16, Oct. 1977, p. 2677-2683. 10 refs. ERDA-supported research.

By the addition of suitable reflectors the concentration of a lens can be increased to the thermodynamic limit, which is equivalent to an f-number of one half. Such lens-mirror combinations are useful whenever concentration rather than image formation is important, for example, in radiation detectors and solar energy collectors. The design of lens-mirror combinations with maximal concentration is described. To the approximation that the lens has sharp focal points at off-axis incidence, the solution for the reflector is readily found to be compound hyperbolic. With proper choice of the f-number of the lens the hyperbolic reflector reduces to a V-trough or cone, an arrangement which offers considerable advantages for fabrication. The 2-D case (line focus lens) suffers from aberrations due to focal length variation with nonplanar incidence. The optical performance of 2-D lens-mirror combinations at nonplanar incidence is analyzed and evaluated for its suitability in solar energy applications. A prototype Fresnel lens plus V-trough has been built, and test data are presented. (Author)

A78-10171 **Materials for luminescent greenhouse solar collectors.** J. A. Levitt and W. H. Weber (Ford Motor Co., Physics Dept., Dearborn, Mich.). *Applied Optics,* vol. 16, Oct. 1977, p. 2684-2689. 10 refs.

Luminescent greenhouse solar collectors are potentially useful for concentrating sunlight onto photovoltaic power cells. Measurements of the performance of small-scale collectors made of two commercially available materials (Owens-Illinois ED2 neodymium-doped laser glass and rhodamine 6G-doped plastic) are presented. The results are encouraging, but they indicate a need for further spectral sensitization and for reduced matrix loss coefficient. The measurements with monochromatic illumination agree with the predictions of a mathematical model developed to take account of reemission following the absorption of luminescence. Under solar illumination, the model predicts photon flux concentrations of about 15 for optimized full-scale collectors made of the materials studied and concentrations of 110 for reasonably improved glass. (Author)

A78-10243 **Cathode spots on metallic electrodes under the conditions of the channel of an MHD generator.** I. I. Beilis, V. I. Zalkind, and A. S. Tikhotskii (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *(Teplofizika Vysokikh Temperatur,* vol. 15, Jan.-Feb. 1977, p. 158-163.) *High Temperature,* vol. 15, no. 1, July 1977, p. 131-135. 16 refs. Translation.

Arc-discharge processes at MHD-channel electrodes are analyzed on the basis of experimental data. A theoretical description of such discharges is obtained, according to which spots burn by evaporation of a previously deposited impurity film, while the spot temperature is defined by the cathode's heat conductivity. V.P.

A78-10244 **Acceleration nozzles of MHD generators with deformation of supersonic flow.** N. M. Efremov, B. A. Tikhonov, and V. A. Khalkevich (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). *(Teplofizika Vysokikh Temperatur,* vol. 15, Jan.-Feb. 1977, p. 164-167.) *High Temperature,* vol. 15, no. 1, July 1977, p. 136-139. Translation.

A78-10245 **Effect of flow inhomogeneity on plasma instability near a channel wall.** V. P. Meitlis (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *(Teplofizika Vysokikh Temperatur,* vol. 15, Jan.-Feb. 1977, p. 168-171.) *High Temperature,* vol. 15, no. 1, July 1977, p. 139-142. 5 refs. Translation.

The stability of plasma flows along electrodeless MHD-channel walls is analyzed. The influence of nonuniform plasma motion on the development of oscillations is examined. The conditions for the onset of several types of instability are formulated. V.P.

A78-10246 **Processing the results of experiments on the U-25 unit by means of an information measuring system.** A. D. Iserov, V. I. Kalinin, L. L. Kirsanov, V. E. Lukash, G. P. Maliuzhonok, E. I. Novikov, A. V. Orlov, L. P. Poberezhskii, and V. Ia. Shemiakin (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *(Teplofizika Vysokikh Temperatur,* vol. 15, Jan.-Feb. 1977, p. 179-185.) *High Temperature,* vol. 15, no. 1, July 1977, p. 149-154. 7 refs. Translation.

Some aspects of the application of a data measuring system to the planning of experiments, using the power-generating MHD facility, U-25, are examined. Some problems involved in the processing of data obtained with this system are discussed. V.P.

A78-10300 **Scrubbers win the energy-SO2 controversy.** C. B. Earl (Davy Power-gas, Inc., Lakeland, Fla.). *Coal Mining and Processing,* vol. 14, Oct. 1977, p. 64, 65.

Considering the switch from oil to coal, alternatives for meeting source performance standards (SO2 emissions of 1.2 lb of SO2 per million Btu's fired in the boiler) are suggested: (1) the use of low sulfur coal, (2) physical or chemical cleaning of the coal before burning, and (3) the installation of Flue Gas Desulfurization (FGD) equipment (scrubbers). Although the installation of FGD systems is expensive, presents new operating problems, and is considered by some yet unproven, the systems require 3 to 5% of a generating plant's power output, and are felt to be the only methods which will achieve emission limitations within the required time period. Several FGD projects are currently being planned, including test equipment used for the development of larger, more efficient systems. S.C.S.

A78-10320 **Autothermal gasification of liquid hydrocarbons by partial oxidation.** H.-J. Henkel, H. Kostka, and A. Michel (Siemens AG, Forschungslaboratorien, Erlangen, West Germany). *(Energy Research and Development Administration, Meeting on Fuel Processing for Fuel Cell Power Generation, Palo Alto, Calif., Apr. 13, 1977.) Siemens Forschungs- und Entwicklungsberichte,* vol. 6, no. 5, 1977, p. 308-313.

It has been found by Henkel et al. (1973) that hydrocarbons can be gasified autothermally, practically without forming coke, with an air-fuel equivalence ratio of about 0.1, if suitable catalysts are used. The stability of autothermal reactors is considered. Coke formation in the reactor can be avoided by limiting the reactor inlet temperature. A description is presented of experiments concerned with the effect of catalysts on the reaction process. Attention is also given to aspects of coke formation, the operation of the autothermal reactors, and the gasification of diesel oil and light fuel oil. G.R.

A78-10375 # **Plasma flow computation method for MHD conversion channels.** I. Cserveny (Research and Design Institute for Thermaenergetic Equipment, Rumania). *Revue Roumaine des Sciences Techniques, Série Electrotechnique et Energétique,* vol. 22, July-Sept. 1977, p. 439-454.

A plasma flow computation method for MHD conversion channels is adapted for numerical computerized solution by means of the finite differences method. The real dependence of the plasma properties (the gas constant, isentropic exponent, electrical conductivity, heat conductivity, dynamic viscosity, and Hall parameter) on the absolute temperature, the pressure and the Mach number of the flow state is thus assessed. A generalized form of the Vulis equation is established and the possibility of smooth passage through the flow crisis is investigated. Conditions are formulated to avoid shock wave formation, through appropriate operation of the conversion channel, for any plasma properties. (Author)

A78-10411 **The potential of satellite solar power.** P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *IEEE, Proceedings,* vol. 65, Aug. 1977, p. 1162-1176. 33 refs.

The technology options for converting solar energy in space and transmitting power to earth are outlined. The design concepts of the SSPS based on thermal-electric and photovoltaic conversion are examined and salient characteristics are provided. Details of microwave power generation, beam transmission, and rectification and utility power pool interfaces are discussed. The requirements for a space transportation system, orbital assembly, maintenance and manufacturing in space are reviewed. The results of economic projections of SSPS operations are presented, utility economics outlined, and institutional impacts and legal status of the use of outer space considered. The environmental impacts of SSPS operations, such as stratospheric pollution by space vehicle exhaust products and of the microwave beam, including atmospheric attenuation and scattering, ionospheric propagation, and microwave biological effects are highlighted. (Author)

A78-10485 **Si/CdS heterojunction solar cells.** F. M. Livingstone, W. M. Tsang, A. J. Barlow, R. M. De La Rue, and W. Duncan (Glasgow, University, Glasgow, Scotland). *Journal of Physics D - Applied Physics,* vol. 10, Oct. 1, 1977, p. 1959-1963. 7 refs.

Heterojunction solar cells of the type Si-CdS have been fabricated which have efficiencies of 7% under AM1 conditions. The cells have been fabricated by depositing epitaxial CdS films on thermally cleaned silicon substrates under UHV. The efficiency of these cells has been studied over a wide range of Si resistivities and it has been found that the highest efficiency is obtained with near-intrinsic silicon. The series resistance associated with these cells results in a fill factor of 0.6. (Author)

A78-10502 **A history of flue gas desulfurization systems since 1850 - Research, development and demonstration.** *Air Pollution Control Association, Journal,* vol. 27, Oct. 1977, p. 948-961. 144 refs.

A78-10503 **Synthetic SO2 sorbents for fluidized-bed coal combustors.** R. B. Snyder, W. I. Wilson, I. Johnson, and A. A. Jonke (Argonne National Laboratory, Argonne, Ill.). *Air Pollution Control Association, Journal,* vol. 27, Oct. 1977, p. 975-981. 22 refs. ERDA-sponsored research.

Synthetic sorbents were investigated as an alternative to natural sorbents (limestone) for the removal of SO2 from the combustion gas in a fluidized-bed coal combustor. The sulfation rate of a synthetic sorbent, CaO in alpha-Al2O3, was determined as a function of gas composition, temperature, and calcium concentration in the sorbent. The reaction was found to be diffusion-controlled above 850 C and kinetically controlled at lower temperatures. The physical characteristics of the support material have a major effect on the sulfation kinetics. Porosity measurements indicated that supports containing large pores (greater than 0.2 micron) produced sorbents having high sulfation rates and that pores with diameters less than 0.2 micron did not contribute significantly to the capture of SO2. The sorbents SrO in alpha-Al2O3 and BaO in alpha-Al2O3 had lower SO2 capture rates that did CaO in alpha-Al2O3. The alkali metal oxide sorbents K2O and Na2O in alpha-Al2O3 captured SO2 much faster than did the alkaline earth metal oxides. (Author)

A78-10551 # **Silicon for solar photocells (Silicium pour photopiles solaires).** J.-J. Brissot (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France). *Acta Electronica,* vol. 20, no. 2, 1977, p. 101-116. 74 refs. In French.

The preparation of high-purity silicon for use in photovoltaic cells is reviewed, with attention given to the controlled growth of single crystals, the production of crystal ribbons, and the application of polycrystalline films to solar cells. Purification processes, including electrodeposition of epitaxial silicon formations from molten fluorides are considered; the costs and energy conversion efficiencies of various grades of purified silicon are compared. Crystal growth techniques, such as those involving the production of structures of controlled dimension from pulled single crystals are discussed, and dendritic growth techniques are described. Chemical vapor deposition processes for the creation of plates of polycrystalline silicon at relatively low cost are also treated. J.M.B.

A78-10552 # **Structures for photocells - Homojunctions, heterostructures or heterojunctions (Les structures des photopiles - Homojonctions, hétérostructures ou hétérojonctions).** E. Fabre (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France). *Acta Electronica,* vol. 20, no. 2, 1977, p. 117-131. 38 refs. In French.

This paper deals with a comparative analysis of the different possible structures for the solar cells, and it is shown that the determination of the best structure mostly depends upon the physical characteristics of the base material, and especially its band structure. The three main types of collecting junctions (homojunction N/P, Schottky or MIS barrier, heterojunction) are analyzed in the two particular cases of an indirect band gap semiconductor (silicon) and a direct band gap semiconductor (gallium arsenide). Finally, the copper sulfide material is also presented as an example of polycrystalline thin films. (Author)

A78-10553 # **Single crystal silicon photocells for terrestrial use - State of the art and perspectives on the future (Les photopiles au silicium monocristallin à usage terrestre - Etat de l'art et perspectives d'avenir).** J. Michel (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France). *Acta Electronica,* vol. 20, no. 2, 1977, p. 133-151. 23 refs. In French.

Methods of reducing the cost of single crystal silicon photocells with P/N junctions are discussed. Industrial processes employed in manufacturing the silicon cells, including the Czochralski method for pulling single crystal ingots and the preparation of junction structures, are reviewed. Means of decreasing the cost of manufacturing, such as minimizing the thickness of the silicon wafers, modifying the diffusion, metallization and antireflective coating processes, and improving the encapsulation process by increasing photocell density and silicon panel surface are mentioned. Improvement of the short circuit current is also considered. Costs of single crystal silicon photocells and photocells produced from polycrystalline silicon are compared. J.M.B.

A78-10555 # **Problems in adapting photocells to terrestrial applications (Problèmes d'adaptation des photopiles en vue d'applications terrestres).** G.-J. Naaijer (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France). *Acta Electronica,* vol. 20, no. 2, 1977, p. 165-185. In French.

The characteristics of a silicon photovoltaic cell are reviewed and a practical mathematical model for the device is established. A series of examples of low-power terrestrial utilizations are described. With a single cell the following devices can be operated: solar motors and swings; distress micro-transmitters; power supplies for pocket calculators or clocks with liquid crystal display, and discharge tube blinker lights. With a series of thirty-four cells a 12-V battery can be kept charged, thus prolonging its lifetime. Between these two extremes power supply of digital circuits, heliogyrators, electrolysis, refining, and cathodic protection against corrosion of metallic objects in contact with a net environment should be mentioned. Series/parallel association of cells with protection measures (by diodes), energy storage devices, adaptors/converters, adaptive associations, and simple solar tracking system without concentrators are discussed. (Author)

A78-10556 # **Terrestrial applications of the Radiotechnique-Compelec /RTC/ solar modules from 1961 to 1977 (Les applications terrestres des modules solaires RTC de 1961 à 1977).** B. Dalibot (La Radiotechnique Compelec, Paris, France). *Acta Electronica,* vol. 20, no. 2, 1977, p. 187-195. In French.

Terrestrial applications of several generations of silicon photovoltaic cells, from those having an energy conversion efficiency of 6 to 7 percent to those with an efficiency of 12.5 percent, are described. The use of the photocells for air and marine navigation beacons is discussed. In addition, the solar cells have been applied to VHF and UHF retransmitters, fire detection devices, water pumping stations, and a copper refining installation. J.M.B.

A78-10557 # **Relative cost-performance of various solar based power supply packages.** S. H. A. Begemann and P. Jansen (Philips' Gloeilampenfabrieken, Philips Research Laboratories, Eindhoven, Netherlands). *Acta Electronica,* vol. 20, no. 2, 1977, p. 197-204.

A computer simulation technique was used to compare several solar-based power supply systems for applications requiring daily availability of fixed, limited number of kilowatts. In addition to storage batteries, the power supply systems evaluated involved one or more of the following components: photovoltaic cells, wind generators or conventional electric generators. The simulations were conducted for climates having various levels of insolation and wind availability. The costs of the systems were compared; it was concluded that in areas with much sun and medium levels of wind, solar cell systems could become competitive with wind and conventional systems if photocell costs decrease somewhat. J.M.B.

A78-10558 # **The near-term prospectives for photovoltaic solar energy conversion.** M. Wolf (Pennsylvania, University, Philadelphia, Pa.). *(International Conference on Electronics +5, Paris,* *France, Mar. 28-Apr. 1, 1977.) Acta Electronica,* vol. 20, no. 2, 1977, p. 205-215. 33 refs.

Changes in the price/demand curve for photovoltaic energy conversion devices during the next five years, as well as technological advances affecting the cost of photocells, are discussed. Innovations such as the black or nonreflective silicon solar cell, or cells employing thin (50- to 100-micron) silicon layers and Ceria-doped glass covers are described; GaAs cells are also mentioned. A mathematical model for evaluating the economic viability of solar systems with varying cost per unit of array is given. In addition, a price/demand curve for solar arrays sold in the U.S., including historical data as well as predictions through 1982, is developed. The forecast involves annual doubling of production, with a 25% price reduction for each doubling, and an increase of cell efficiency to 12% by 1982. J.M.B.

A78-10605 # **Commercial application of laser fusion.** L. A. Booth (California, University, Los Alamos, N. Mex.). In: Technology of inertial confinement experiments; Proceedings of the Meeting, Dubna, USSR, July 19-23, 1976. Vienna, International Atomic Energy Agency, 1977, p. 59-80. 15 refs. Contract No. W-7405-eng-36.

The fundamentals of laser-induced fusion, some laser-fusion reactor concepts, and attendant means of utilizing the thermonuclear energy for commercial electric power generation are discussed. Theoretical fusion-pellet microexplosion energy release characteristics are described, and the effects of pellet design options on pellet-microexplosion characteristics are discussed. The results of analyses to assess the engineering feasibility of reactor cavities for which protection of cavity components is provided either by suitable ablative materials or by diversion of plasmas by magnetic fields are presented. Two conceptual laser-fusion electric generating stations, based on different laser-fusion reactor concepts, are described. (Author)

A78-10606 # **An overview of the planning considerations in the United States inertial confinement fusion program.** In: Technology of inertial confinement experiments; Proceedings of the Meeting, Dubna, USSR, July 19-23, 1976. Vienna, International Atomic Energy Agency, 1977, p. 81-106.

An overview of the United States research program in inertial confinement experiments is presented. The objective is to develop and demonstrate inertial confinement fusion as a proven energy technology. (Author)

A78-10614 **Economic and commercial assessment of solar energy conversion; Proceedings of the Conference, London, England, July 5, 1977.** London, International Solar Energy Society, 1977. 96 p. $8.20.

The economics and commercial prospects of solar energy systems, including space heating, domestic hot water heating and absorption cooling systems, as well as photovoltaic cells and hybrid wind/solar systems, are evaluated. The papers consider such topics as a discounted cashflow analysis of solar space heating, an examination of the long-range effects of inflation and interest rates on domestic solar energy systems, energy cost studies for a utility, the cost-effectiveness of photovoltaic and thermal conversion research programs, the use of heat pumps in domestic, industrial and commercial heating, a simple mathematical model for evaluating photovoltaic energy conversion efficiency, comparative rating of commercial solar water heating systems, a heat recovery system for a housing project, and a computer program for assessing the U.S. market for domestic and commercial solar energy systems. J.M.B.

A78-10615 **The economic evaluation of solar energy schemes.** P. F. Chapman (Open University, Milton Keynes, Bucks., England). In: Economic and commercial assessment of solar energy conversion; Proceedings of the Conference, London, England, July 5, 1977. London, International Solar Energy Society, 1977, p. 1-9.

Standard methods of discounted cashflow analysis, which take into account capital costs and savings in annual fuel consumption, are used in evaluating the cost-effectiveness of solar energy systems for heating buildings. Uncertainties affecting the evaluation, such as the cost of solar energy system components, the future of fuel prices, government tax credits, and future fuel price structures, which may involve seasonal tariffs to compensate for the cost of supplying peak demand, are also considered. Comparisons are made with the economics of natural gas, electricity and coal heating systems. In addition, the effects of insulation costs and interest rates for house mortgages on the selection of a heating system are mentioned. J.M.B.

A78-10616 **The value of solar heating.** A. H. Lancashire and K. R. Williams (Shell International Petroleum Co., Ltd., London, England). In: Economic and commercial assessment of solar energy conversion; Proceedings of the Conference, London, England, July 5, 1977. London, International Solar Energy Society, 1977, p. 10-19.

The long-range economics of solar energy systems for domestic heating is examined. In particular, a simple analytical technique is presented for investigating the payout or earning power of a fuel-saving investment over a number of years. The technique takes into account a general index of inflation, the time at which the investment is made (i.e., in the present or in subsequent years), the life of the project, interest rates, fuel price inflation and capital costs. Nomographs for finding capital cost, required solar panel area and savings of a solar domestic hot water system are also described. J.M.B.

A78-10617 **How much investment in conversion devices.** P. T. Landsberg (Southampton, University, Southampton, England). In: Economic and commercial assessment of solar energy conversion; Proceedings of the Conference, London, England, July 5, 1977. London, International Solar Energy Society, 1977, p. 20-27. 9 refs.

An economic analysis which takes into account the effects of inflation and interest rate variations is used in evaluating the feasibility of installing solar energy conversion systems. In addition, the analysis can be adapted to research and development programs and to the energy cost studies for a utility. Sample calculations are given for the minimum conversion efficiencies of economically viable domestic thermal collectors or solar cell panels; the cost-effectiveness of thermal conversion and photovoltaic conversion research programs is also discussed. J.M.B.

A78-10618 **The heat pump in relation to solar energy.** J. Keable (HELIX Multi Professional Services, London, England). In: Economic and commercial assessment of solar energy conversion; Proceedings of the Conference, London, England, July 5, 1977. London, International Solar Energy Society, 1977, p. 43-48.

The use of heat pumps powered by electricity, coal, oil or gas to provide domestic, industrial and commercial heating in a cool climate is discussed. In particular, it is suggested that heat pumps may be applied to space heating, hot water heating, and industrial drying processes, as well as to the recovery of heat losses from ventilation. A conventional gas-fired ducted domestic space heating system, a solar system employing flat-plate collectors, and an electrically powered compressor cycle heat pump designed for applications in the United Kingdom are compared. Due to its low expenditure of fuel, the heat pump system, though slightly more expensive to install than gas heat, is found to be the least costly alternative over a trial period of 15 years. The solar heating system, due to its high capital cost, is found to be uncompetitive. J.M.B.

A78-10619 **Cost factors in photovoltaic energy conversion with solar concentration.** J. E. Parrott (University of Wales Institute of Science and Technology, Cardiff, Wales). In: Economic and commercial assessment of solar energy conversion; Proceedings of the Conference, London, England, July 5, 1977. London, International Solar Energy Society, 1977, p. 49-53. 15 refs.

A simple mathematical model for evaluating the economics of photovoltaic energy conversion with solar concentration is developed, and the major components of a concentration system, including the concentrating lens or mirror, the tracking system, solar cells and the means of heat dissipation, are discussed. It is suggested that to be competitive, solar concentrators must have a lower cost per unit area than solar cells and must be very efficient at high levels of irradiance and under a variety of climate conditions. Three types of solar cell for use in concentration systems are considered: a conventional silicon cell with the p-n junction normal to incident radiation; a vertical junction cell, also of silicon; and a conventional cell with an Al(1-x)Ga(x)As window on a GaAs substrate containing the junction. Cost estimates are developed on the basis of these three designs. J.M.B.

A78-10620 Solar water heating - Some economic and commercial aspects. B. McNelis (General Technology Systems, Ltd., Hounslow, Middx., England). In: Economic and commercial assessment of solar energy conversion; Proceedings of the Conference, London, England, July 5, 1977. London, International Solar Energy Society, 1977, p. 54-63. 10 refs.

The relative cost-effectiveness of several solar water heating systems commercially available in the United Kingdom is analyzed; parameters considered in the analysis include panel area, energy and cash saved, percent reduction in energy use, and specific energy delivered. In addition, the advantages of arranging a mortgage running for the lifetime of the solar heating system, or of installing the solar heating system during initial construction of a building, are mentioned. The effects of the general inflation rate and of increases in fuel prices on the competitive standing of the solar heating systems are also assessed. J.M.B.

A78-10621 Economic considerations in the energy supply of Autarkic dwellings. J. G. F. Littler and R. B. Thomas (Cambridge University, Cambridge, England). In: Economic and commercial assessment of solar energy conversion; Proceedings of the Conference, London, England, July 5, 1977. London, International Solar Energy Society, 1977, p. 64-77. 9 refs. Research supported by the Science Research Council.

The design of a housing project for Cambridge, U.K., which would rely on solar and wind energy for space and hot water heating conditions. The impetus for the study is an economic one since proper selection of a site for certain freeze-susceptible crops, such as citrus, can result in huge savings of energy and resources. (Author)

A78-10622 Projected market penetration of solar heating and cooling in the United States. P. C. Spewak (Mitre Corp., McLean, Va.). In: Economic and commercial assessment of solar energy conversion; Proceedings of the Conference, London, England, July 5, 1977. London, International Solar Energy Society, 1977, p. 78-95. Contract No. E(49-18)-2322.

A computer program for assessing the potential U.S. market for solar hot water, space heating (air or liquid collectors) and absorption cooling systems, as well as heat pumps, is described. The computer model takes into account the kinds of buildings involved, capital costs for solar and conventional energy systems, the performance of the heating and cooling systems, climatological data for 16 regions of the contiguous states, and local tax structures. The costs of installing new solar systems and of retrofitting existing buildings with solar systems are compared; market penetration rates for the various combinations of solar hot water, space heating and cooling systems are developed. The computer program is also capable of modeling the purchase of solar energy systems before they become fully competitive. J.M.B.

A78-10623 Conference on Capturing the Sun Through Bioconversion, Washington, D.C., March 10-12, 1976, Proceedings. Conference sponsored by ERDA, EPA, U.S. Department of Agriculture, FEA, Council on Environmental Quality, NSF, U.S. Department of Commerce, DOD, DI, U.S. Department of State, et al. Washington, D.C., Bio-Energy Council, 1976. 872 p. $18.

Several subjects relevant to solar energy bioconversion are discussed. General surveys of the gas deficit, the ecology of bioconversion, and congressional perspective are presented. Biomass sources are considered with attention to urban and industry wastes, agricultural and forestry wastes, land and fresh water energy farming, and ocean farming. Bioconversion processes and products are examined in terms of gaseous fuels, liquid fuels, solid fuels, related products, and long-range concepts. Overall impacts are analyzed from the viewpoint of technology assessment, economic/social impacts, environmental impacts, and international aspects. M.L.

A78-10624 European Seminar on Biological Solar Energy Conversion Systems, Grenoble, France, May 9-12, 1977, Proceedings. Seminar sponsored by CNRS, COMES, CEA, DGRST, and INRA. London, International Solar Energy Society, 1977. 164 p. $11.00.

Agriculture and plant biochemistry topics relevant to biological solar energy conversion systems are discussed. Besides several studies of photosynthesis, research investigations on plant protein, nitrogenase, glycerol production, hydrogen production, methane fermentation, lignocellulose degradation, and electron transfer are reported. Other research deals with plant selection, silvicultural biomass plantations, the use of plant residues to produce energy, and algae characteristics. Also reported are the design of a solar greenhouse, an analysis of post-agricultural energy, a study of village and farm energy systems, and a study of an ocean food and energy farm project. M.L.

A78-10626 Present status and research needs in energy recovery from wastes; Proceedings of the Conference, Oxford, Ohio, September 19-24, 1976. Conference sponsored by ASME, ERDA, Engineering Foundation, and NSF. Edited by R. A. Matula. New York, American Society of Mechanical Engineers, 1977. 452 p. Members $17.50; nonmembers, $35.

The papers deal with such topics as the major basic and applied needs in both liquid and solid industrial and municipal waste processing, and research work on major problem areas associated with waste processing. Topics common to most of the papers are resource and energy recovery and the environmental aspects of large- and small-scale waste processing systems. V.P.

A78-10630 Quality and characteristics of steam produced from wastes. R. E. Sommerland (Foster Wheeler Energy Corp., Livingston, N.J.). In: Present status and research needs in energy recovery from wastes; Proceedings of the Conference, Oxford, Ohio, September 19-24, 1976. New York, American Society of Mechanical Engineers, 1977, p. 255-269.

Solid waste fuels, especially the lower grades, are troublesome, and require special considerations. In the present paper, the quality and characteristics of the energy output from steam systems fired in whole or in part with waste are assessed. The assessment is intended to be useful in evaluating various waste firing methods, combined firing systems for various energy systems, and also other thermal processes. V.P.

A78-10634 Densified refuse derived fuels - An alternative concept. C. C. Wiles (U.S. Environment Protection Agency, Washington, D.C.). In: Present status and research needs in energy recovery from wastes; Proceedings of the Conference, Oxford, Ohio, September 19-24, 1976. New York, American Society of Mechanical Engineers, 1977, p. 315-319.

Boiler facilities, say in the 25,000 to 200,000 lbs of steam/hr range, may not be large enough to carry the costs associated with converting to the use of fluff RDF (i.e., the air classified light fraction of shredded municipal solid waste). The present paper deals with an alternative concept to fluff RDF, which involves the use of densified forms of RDF (d-RDF) obtained by primary shredding, air classifying, secondary shredding of the light fraction, and densification, either by pelletizing, briquetting, or extrusion. The results of a research program indicate that d-RDF is a solid waste management concept capable of providing limited quantities of energy on a national basis. The economical, technical, and environmental aspects of producing and utilizing d-RDF in stoker-type boilers are evaluated. V.P.

A78-10635 **Prospects of energy recovery from the incineration of chemical plant wastes.** R. G. Novak and J. J. Cudahy (Hydroscience Associates, Inc., Knoxville, Tenn.). In: Present status and research needs in energy recovery from wastes; Proceedings of the Conference, Oxford, Ohio, September 19-24, 1976. New York, American Society of Mechanical Engineers, 1977, p. 365-370.

A78-10636 **Experience with burning industrial wastes in steam-generating and high-temperature heat recovery systems.** F. A. Govan and H. E. Beningson (Combustion Equipment Associates, Inc., Stamford, Conn.). In: Present status and research needs in energy recovery from wastes; Proceedings of the Conference, Oxford, Ohio, September 19-24, 1976. New York, American Society of Mechanical Engineers, 1977, p. 381-396.

A78-10637 **Overcoming obstacles to energy recovery from industrial wastes.** J. H. Kleinau (Copeland Systems, Inc., Oak Brook, Ill.). In: Present status and research needs in energy recovery from wastes; Proceedings of the Conference, Oxford, Ohio, September 19-24, 1976. New York, American Society of Mechanical Engineers, 1977, p. 397-413. 9 refs.

The present review of waste availability, logistics of incineration, and economics of energy recovery indicates that the obstacles to the utilization of the great quantities of waste available for energy generation are not necessarily technical in nature, but are more often problems of economics, engineering economics, or combinations thereof. Some specific comments on technological problems involved in the utilization of fluidized bed combustion are presented. V.P.

A78-10651 **Ocean energy resources; Proceedings of the Energy Technology Conference, Houston, Tex., September 18-23, 1977.** Conference sponsored by the American Society of Mechanical Engineers. Edited by N. T. Monney (U.S. Naval Academy, Annapolis, Md.). New York, American Society of Mechanical Engineers (Ocean Engineering Symposia Series. OED Volume 4), 1977. 108 p. $15.

The papers deal with the principal aspects of the formidable problem of both harnessing the solar energy stored in the oceans and tapping the geothermal energy at the bottom of ocean basins. The topics covered provide a broad overview of ocean energy resources, noting resource potential and the technical problems involved in harnessing each form of ocean energy. One paper uses a specific engineering problem to place in proper perspective the technical difficulties encountered in the actual development of a system that will operate effectively in an ocean environment. V.P.

A78-10652 **Power from the oceans' thermal gradients.** O. M. Griffin (U.S. Navy, Naval Research Laboratory, Washington, D.C.). In: Ocean energy resources; Proceedings of the Energy Technology Conference, Houston, Tex., September 18-23, 1977. New York, American Society of Mechanical Engineers, 1977, p. 1-20. 20 refs.

The concept of extracting useful power in tropical regions from the temperature differences between the oceans' warm surface water and cold deep currents dates from the late 19th century. Since that time several attempts have been made to design and operate such a power plant, and these early ventures, and more recent 20th century undertakings, have culminated in a U.S. government-sponsored R&D program aimed at operating a prototype plant driven by ocean thermal gradients during the 1980's. In this paper the history of the so-called ocean thermal energy conversion (OTEC) concept is outlined and its R&D funding history is traced through 1977. The present technological status of open and closed Rankine cycle plant concepts is discussed in terms of potential OTEC applications, and the state-of-the-art is reviewed in terms of baseline plant designs and other promising plant configurations. Several key areas remain to be addressed successfully before ocean thermal difference power plants become an economically and technically viable option; these include the development and successful operation of a new generation of efficient low temperature-difference heat exchangers; prevention of biofouling and corrosion problems; environmental and resource potential assessments; and platform, mooring, and stationkeeping design problems. (Author)

A78-10654 **Ocean energy from salinity gradients.** N. T. Monney (U.S. Naval Academy, Annapolis, Md.). In: Ocean energy resources; Proceedings of the Energy Technology Conference, Houston, Tex., September 18-23, 1977. New York, American Society of Mechanical Engineers, 1977, p. 33-42. 9 refs.

A major untapped source of energy exists where there is mixing between waters of different salinities. The problem is to convert this free energy of mixing between solutions of different salt concentrations into useful energy. The energy exists in the osmotic pressure difference between the two solutions. The osmotic pressure head between fresh water and seawater is approximately 240 m (787 ft). This is roughly the same height as the total number of dams constructed to produce electricity on the Columbia River (Wick, 1976). Thus the quantity of energy being extracted from the Columbia River as hydroelectric power is similar to that being lost in the free mixing of fresh water and seawater at the mouth of the river. Other highly saline bodies of water such as the Dead Sea, the Great Salt Lake, and salt marshes could be used to produce energy from salinity gradients. The average salinity of the oceans is about 3.5%, but the Dead Sea has a salinity of over 26%, which represents an osmotic pressure head of over 3000 m (9840 ft) at the mouth of the Jordan River. Each of these potential sources of energy is essentially a form of solar energy, as it depends on the sun for evaporation to produce the salinity gradients. (Author)

A78-10655 **Energy from ocean surface waves.** N. N. Panicker (Mobil Research and Development Corp., Dallas, Tex.). In: Ocean energy resources; Proceedings of the Energy Technology Conference, Houston, Tex., September 18-23, 1977. New York, American Society of Mechanical Engineers, 1977, p. 43-67. 42 refs. Contract No. WA-76-3104.

A quantitative estimation of the energy present in ocean waves, and a review of the techniques for utilizing wave energy are presented. Computations based on climatological data for the Northern Hemisphere show that wave energy is maximum at mid-latitudes and at longitudes towards the Eastern end of the Atlantic and Pacific Ocean basins. The total wave energy present in the world oceans at 12 noon GMT on October 2, 1975 is found to be 800 x 10 to the 15th power J. Wave energy is estimated to be renewed at the rate of 10 to the 12th to 10 to the 13th power watts, about the present level of world power consumption. The techniques for converting wave energy for use vary widely in scope. The proposed schemes include propulsion schemes, buoy power supply devices, offshore power plants and shore-based power stations. The technical and economic feasibility of utilizing wave energy is discussed. (Author)

A78-10656 **Ocean geothermal energy.** N. T. Monney (U.S. Naval Academy, Annapolis, Md.). In: Ocean energy resources; Proceedings of the Energy Technology Conference, Houston, Tex., September 18-23, 1977. New York, American Society of Mechanical Engineers, 1977, p. 69-81. 8 refs.

The paper deals with the problem of tapping the reservoir of geothermal energy, estimated at 259 billion cubic miles of stored primeval heat. Theoretically, this energy can be tapped by drilling deep into porous rock to provide a passage for a heat transfer fluid that will extract the heat. Realistically, the existing drilling capability is insufficient to reach the hot mass of material situated at an average depth of 22 miles below the crust of continents and at a depth of 2 miles below the crust at the bottom of ocean basins. Economic analysis of geothermal energy costs indicates that, considering logistics costs, drilling costs, platform costs, energy delivery costs, and increased power plant costs associated with operation in a hostile ocean environment, land-development of geopressured geothermal sources should be pursued before turning to ocean geopressured sources. If, however, the cost for cooling water, subsidence control, and brine disposal should become prohibitive for development of geothermal sources on land, the development of ocean geothermal sources may well become a more attractive proposition. V.P.

A78-10657 **The U.S. Navy's Ocean Food and Energy Farm Project.** H. A. Wilcox (U.S. Naval Ocean Systems Center, San Diego, Calif.). In: Ocean energy resources; Proceedings of the Energy Technology Conference, Houston, Tex., September 18-23, 1977. New York, American Society of Mechanical Engineers, 1977, p. 83-104. 33 refs.

The aim of the project discussed is to learn how to raise giant seaweeds and other organisms in the vast sunlit surface waters of the tropical and temperate oceans. Wave powered pumps would be used to upwell cool nutrient-rich waters to plants attached to horizontal lines positioned at depths of 15 to 30 m. Accomplishments include experience gained with three small farms, a variety of engineering studies, successful stimulation of seaweed growth by upwelled waters in both the Atlantic and Pacific, production of human foods by feeding seaweeds to sheep and shellfish, and production of methane fuel gas from digesters fed with seaweeds. Economic studies indicate that methane costs may range from about $2 to as much as $7 per GJ (per million Btu), depending on credit values assumed for foods and other products (1975 dollars). (Author)

A78-10675 **Annual review of energy. Volume 2.** Edited by J. M. Hollander, M. K. Simmons (California, University, Berkeley, Calif.), and D. O. Wood (MIT, Cambridge, Mass.). Palo Alto, Calif., Annual Reviews, Inc., 1977. 530 p. $17.

The global energy system is considered along with the history and the prospects of the international energy trade, the global energy resources, the policy alternatives of the major energy-importing nations, the role of multinational oil companies in world energy trade, global and international energy models, energy and food, and the impact of production and use of energy on the global climate. Attention is also given to the international safeguards problem, the coming age of conservation, energy and economic growth in Central America, perspectives on energy in the People's Republic of China, an energy perspective for the European Community, perspectives on energy in India, perspectives on energy in Japan, the objectives and the potential of the Organization of the Arab Petroleum Exporting Countries, perspectives on energy in Sweden, the Soviet version of the energy syndrome, and power and energy conversion factors. G.R.

A78-10676 **International Pulsed Power Conference, Texas Tech University, Lubbock, Tex., November 9-11, 1976, Proceedings.** Conference sponsored by the Institute of Electrical and Electronics Engineers, U.S. Air Force, U.S. Navy, and ERDA. New York, Institute of Electrical and Electronics Engineers, Inc., 1976. 357 p. $20.

Analyses, designs, and experimental results are reported for a variety of types of pulsed power systems and components. Major areas are switches, inertial energy storage, power conditioning, generators, pulsed beams, transformers, capacitive energy storage and magnetic insulation, and inductive energy storage. Topics covered include a controllable homopolar motor-generator energy storage system for application in a fusion power reactor, a radially converging electron beam accelerator, weight algorithms for adiabatic transformers for pulsed high power systems, and a modular power crowbar bank for the generation of a 50-MA 50-microsec current pulse for a toroidal plasma experiment. P.T.H.

A78-10680 **Controllable homopolar motor-generator energy storage for application in a fusion power reactor.** W. Y. Chen, W. E. Toffolo, and J. R. Purcell (General Atomic Co., San Diego, Calif.). In: International Pulsed Power Conference, Lubbock, Tex., November 9-11, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. IIB3-1 to IIB3-6. Research supported by the Electric Power Research Institute.

A scheme for a homopolar motor generator (HMG) with a controllable excitation field is proposed. Such a controlled field will enable the full volt-second capability of the induction coil to be utilized, so that in a Tokamak application one may achieve burn times twice as long compared to the case of a constant-excitation HMG. For a drum type HMG, it is shown that by placing iron yokes both interior to and around the rotor drums and by proper selection of machine geometry, it is possible to reduce the magnetic energy stored in the excitation coils without excessively increasing the weight and cost. A unit cost of $6.74/kJ was computed for a machine with total inertial energy of 1500 MJ and a magnetic energy of 96.2 MJ. P.T.H.

A78-10691 **Pulsed power systems for the LASL high energy gas laser facility.** K. Riepe and H. Jansen (California, University, Los Alamos, N. Mex.). In: International Pulsed Power Conference, Lubbock, Tex., November 9-11, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. IIC5-1 to IIC5-6. ERDA-sponsored research.

A CO2 laser fusion experiment is being designed with the goal of delivering 100 kJ to the target in a one nanosecond pulse. The laser will be pumped by an electron-beam-controlled discharge. The pumping power supply will be a number of parallel Marx generators, with an output voltage of 500 kV, and a total energy storage of about 5 MJ. The electron gun is a 'cold cathode' triode, also operating at about 500 kV. Preliminary design considerations for the pulsed power systems are presented. Some pulse forming network designs are discussed with calculated waveforms shown. (Author)

A78-10696 **Pulsed power for fusion.** T. H. Martin (Sandia Laboratories, Albuquerque, N. Mex.). In: International Pulsed Power Conference, Lubbock, Tex., November 9-11, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. ID1-1 to ID1-12. 14 refs. Contract No. AT(29-1)-789.

A review which traces the development of high power pulsed accelerators from the original inception for bremsstrahlung output, through the low impedance accelerators, to the double-sized accelerators for fusion is given. Proto II is presently being assembled at Sandia and preliminary testing on the Marx has been completed. Examples of various techniques involving Sandia accelerators are described. Requirements for accelerators capable of achieving fusion levels are developed and problem areas outlined. The diode insulator flashover problem limits the maximum current available from the accelerators. (Author)

A78-10698 **Pulse power systems employing inductive energy storage.** T. F. Trost, P. E. Garrison, and T. R. Burkes (Texas Tech University, Lubbock, Tex.). In: International Pulsed Power Conference, Lubbock, Tex., November 9-11, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. IID1-1 to IID1-6. 5 refs.

Basic circuits for utilizing inductive energy storage in high-power pulsers are compared in order to judge overall system performance. The comparisons are made from the standpoint of the power requirements and efficiencies for inductor charging and the switching times and efficiencies for discharging into the load. The response of several circuits are calculated, and the trade-offs in performance are discussed. (Author)

A78-10699 **Development of inductive storage for generation of high voltage pulses.** I. M. Vitkovitsky (U.S. Navy, Naval Research Laboratory, Washington, D.C.). In: International Pulsed Power Conference, Lubbock, Tex., November 9-11, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. IID2-1 to IID2-5. 12 refs.

The principles of high power generation are examined and an example of an inductive storage system used for charging a capacitive load is discussed. Initially the current is provided by a homopolar generator. In more advanced developments several current interruptors (circuit breakers and fuses) are staged in parallel. Current interrupting switches depend either on the mechanical disruption of conductors or on the increase of resistivity through heating or use of magnetic and/or electric fields. The design of various current interrupting devices is discussed. Advances concerning the components of inductive storage systems have made currently submegajoule output pulses at a power level near 100 GW possible. G.R.

A78-10701 **Terawatt pulse power systems utilizing inductive storage.** E. C. Cnare, M. Cowan, W. K. Tucker, W. B. Leisher, and D. L. Wesenberg (Sandia Laboratories, Albuquerque, N. Mex.). In: International Pulsed Power Conference, Lubbock, Tex., November 9-11, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. IID4-1 to IID4-6. 7 refs. ERDA-supported research.

This paper describes a system which employs a superconducting magnet, a generator coil, and nondestructive magnetic flux compression to produce pulsed power. Power in the terawatt range is predicted for full-scale systems suitable for both laser and e-beam applications of the future. Small-scale experiments are described which employed radially expanding aluminum tubes or plasma to produce peak powers of 0.5 gigawatt. (Author)

A78-10702 **Pulsed superconducting inductive storage system.** O. K. Mawardi and H. K. Chung (Case-Western-Reserve University, Cleveland, Ohio). In: International Pulsed Power Conference, Lubbock, Tex., November 9-11, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. IID5-1 to IID5-6. 10 refs. USAF-supported research.

A novel pulsed inductive storage system is described. A number of superconducting inductors are energized in series and subsequently discharged in parallel. The advantage of the scheme is that it spreads the energy stored over several inductors, reducing the current rating of the switches needed to provide the series-parallel interconnection. Furthermore, it improves appreciably the efficiency of energy transfer from the storage inductors to the load as compared to the efficiency of an inductive system using one storage inductor only. The feasibility of this inductive system is demonstrated on a system consisting of three storage inductors. (Author)

A78-10703 **Superconductive inductor storage and converters for pulsed power loads.** N. Mohan (Minnesota, University, Minneapolis, Minn.) and H. A. Peterson (Wisconsin, University, Madison, Wis.). In: International Pulsed Power Conference, Lubbock, Tex., November 9-11, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. IID6-1 to IID6-8.

Loads with pulse durations greater than several milliseconds are considered. The employed systems utilize a superconductive inductor as a means of energy storage. The charging characteristics of the inductive, pulsed power load are examined and a description is provided of different schemes for interfacing the pulsed load with the storage inductor, taking into account load and storage converters supplied by a common ac source. The storage converter can also be supplied by means of double conversion and operated in parallel or series with the utility converter. Advantages and drawbacks of the various systems are evaluated. All the schemes considered are equally effective in reducing real power fluctuations to a tolerable level. G.R.

A78-10705 **Explosive magnetic flux compression plate generators as fast high-energy power sources.** R. S. Caird, D. J. Erickson, W. B. Garn, and C. M. Fowler (California, University, Los Alamos, N. Mex.). In: International Pulsed Power Conference, Lubbock, Tex., November 9-11, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. IIID3-1 to IIID3-6. 6 refs. ERDA-USAF-Army-supported research.

A type of explosive driven generator, called a plate generator, is described. It is capable of delivering electrical energies in the MJ range at TW power levels. Plane wave detonated explosive systems accelerate two large-area metal plates to high opposing velocities. An initial magnetic field is compressed and the flux transferred to an external load. The characteristics of the plate generator are described and compared with those of other types of generators. Methods of load matching are discussed. The results of several high-power experiments are also given. (Author)

A78-10709 **The evolution of pulsed power.** G. K. Simcox, J. J. Moriarty, and T. J. Griffin (Raytheon Co., Bedford, Mass.). In: International Pulsed Power Conference, Lubbock, Tex., November 9-11, 1976, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. IIIE1-1 to IIIE1-6.

A review of pulse power developments is presented from the viewpoint of low duty-cycle, high power, high voltage generator technology. The effects of increasing duty-cycle upon dielectrics, switching, generator form and engineering problems are briefly discussed. Recognizing the importance of power conditioning and prime power management, the limitations and fundamental importance of pulsed power techniques are explored with reference to the Controlled Thermonuclear Reaction field. (Author)

A78-10722 **Ship Technology and Research /STAR/ Symposium, 2nd, San Francisco, Calif., May 25-27, 1977, Proceedings.** Symposium sponsored by the Society of Naval Architects and Marine Engineers. New York, Society of Naval Architects and Marine Engineers, 1977. 523 p. $45.

Consideration is given to marine transportation machinery and naval architecture, offshore fixed and mobile platforms, ocean thermal energy conversion and the marine transport of LNG. Particular papers are presented on the conceptual design of OTEC platforms, studies of biofouling of OTEC plants, and prospects of OTEC energy utilization. B.J.

A78-10723 **OTEC - A survey of the state of the art.** H. E. Sheets (Rhode Island, University, Kingston, R.I.). In: Ship Technology and Research (STAR) Symposium, 2nd, San Francisco, Calif., May 25-27, 1977, Proceedings. New York, Society of Naval Architects and Marine Engineers, 1977, p. 183-194. 9 refs.

Research on ocean thermal energy conversion is reviewed together with the availability of energy from this source. OTEC power plants can be built within existing technology, however, for optimum cost, certain component improvements will be necessary. Of particular interest are heat exchangers, as present practice would result in extremely large units and in high costs. The pumps and cold water pipe require some development due to the large amounts of water which must be transported. The platform structure and mooring arrangements need special attention and for the entire unit, corrosion and biofouling are critical factors for the intended long life and expected high reliability. The parasitic power of the auxiliary systems is critical to maintain the high efficiency of the power plant over its expected life. Energy use and transmission are dependent on the location of the OTEC plant. (Author)

A78-10724 **Conceptual design of OTEC platforms.** E. H. Harlow (Frederic R. Harris, Inc., New York, N.Y.), R. Cohen, and H. Skowbo (ERDA, Div. of Solar Energy, Washington, D.C.). In: Ship Technology and Research (STAR) Symposium, 2nd, San Francisco, Calif., May 25-27, 1977, Proceedings. New York, Society of Naval Architects and Marine Engineers, 1977, p. 195-201.

ERDA is developing a technology for converting ocean thermal energy into electrical energy. Such power plants in themselves will be enormous floating vessels. The configuration of these vessels is the subject of this paper, which summarizes the status of conceptual design for such plants that might be suitable for operation in various areas of the tropical and sub-tropical oceans. All designs have one common characteristic unusual for marine structures, namely a cold water pipe which will extend down into the cooler layers of the deep ocean several thousand feet below the surface, and circulate quantities of cool water through the condensers. The possible types of ocean thermal conversion platforms (OTEC) are reviewed and analyzed with respect to cost, mooring requirements, response to wave and current action, and viability as living quarters for crew. (Author)

A78-10729 **Energy development II.** New York, Institute of Electrical and Electronics Engineers, Inc., 1976. 196 p. $10.00.

Attention is given to solar-electrical systems, hydrogen transmission, Soviet MHD power plants, fuel cell power generation, wind-driven generators, geothermal power, energy from solid waste and coal liquefaction. Also considered are solar thermal electric power, the NASA-Lewis Center Wind Energy Project, ocean sited natural energy systems and different types of energy storage systems. B.J.

A78-10730 **Assessment of storage systems - The device utility interface.** T. R. Schneider and R. V. Snow (Public Service Electric and Gas Co., Newark, N.J.). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 24-32. 20 refs. Research sponsored by the Electric Power Research Institute and ERDA.

A brief description is given of the major approaches to energy storage and some of the device/utility interface parameters are considered. The systems examined are hydro pumped storage, compressed air storage for combustion turbines, thermal energy storage, electrochemical energy storage, flywheels and superconducting magnetic energy storage. Device/utility interface characteristics are discussed with reference to conventional and non-conventional rotating equipment and static conversion equipment. B.J.

A78-10731 **Solar-electrical systems - Theory and applications.** A. Braunstein (Tel Aviv University, Tel Aviv, Israel) and D. Biran (Ministry of Defence, Tel Aviv, Israel). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 33-39.

A general description is given of a solar-electrical energy system, and the solar array and its output as a function of different radiation intensities are discussed. The energy balance concept of a solar-electrical system is developed for constant and varying loads and criteria for the design of the energy systems are presented. The cost and reliability of solar-electrical systems are examined. B.J.

A78-10732 **Solar radiation and energy measurements.** D. Biran (Ministry of Defence, Tel Aviv, Israel) and A. Braunstein (Tel Aviv University, Tel Aviv, Israel). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 40-43.

The paper describes a simple and rather inexpensive solar radiation meter, which, using a solar cell, permits the recording of instantaneous radiation values or the measurement of integrated values during longer periods. The primary purpose of the meter is to gather climatological and meteorological data in optimizing the design and performance of a solar-electrical energy system. Various measurements made by means of the meter were studied for different meteorological conditions (clear and cloudy days) and compared with those obtained from a conventional meter (an Eppley pyranometer). B.J.

A78-10733 **Inverters for commercial fuel cell power generation.** G. A. Phillips, J. H. Vogt, and J. W. Walton (United Technologies Corp., South Windsor, Conn.). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 44-53. 11 refs.

This paper describes the results of work accomplished in developing low cost, high efficiency dc to ac power conversion equipment for fuel cell powerplants to be used in two different commercial applications. The first is for on-site power generation in the range of 10 to 500 kW and the second is for dispersed electric utility power generation in substations at a 26 MW power level. Performance data is presented on single-phase and three-phase prototype inverters in the first category. Work currently in progress on the 26 MW inverter is described including operational tests on a 500 kW unit delivering power into the lines of the Connecticut Light and Power Company. To accomplish the desired results, fast switching thyristors with low forward drop and high dv/dt are used. (Author)

A78-10734 **Some results of research carried out at the Soviet U-02 and U-25 open-cycle MHD facilities.** A. E. Sheindlin, E. M. Shelkov, S. I. Pishchikov, Iu. N. Sokolov, and V. A. Ovcharenko (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 63-69. 10 refs.

Experimental investigations of two Soviet MHD power plants - U-02 and U-25 are described. Layouts of the two facilities are presented and attention is given to such aspects of study as seed injection systems, combustor model tests, the high-temperature regenerative air-preheaters, and MHD generator design. B.J.

A78-10735 **Three ocean sited natural energy systems.** W. E. Heronemus, P.-A. Mangarella, and J. G. McGowan (Massachusetts, University, Amherst, Mass.). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 70-78. 17 refs.

A general description of the ocean current kinetic energy resource, the ocean thermal differences resource and of the energy resource in the winds over them, and the related energy transmission systems for exploitation of each of those natural energy flows, is given. Relative resource size, relative economics are compared. Comparative environmental, social geo-political, political characteristics of the oceanic power systems are mentioned. The possible uses of these ocean sited power plants to provide either raw energy or an energy product, or to provide electrical power on demand are treated. The conclusion suggests that the typical Power Engineer and the majority of the population might lead a fuller life the sooner we break free from consumption of owned fuel resources. (Author)

A78-10736 **Hydrogen transmission - The significance of efficiency.** C. A. Falcone (American Electric Power Service Corp., New York, N.Y.). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 79-82. 9 refs.

In a comparison of the efficiency of a conventional electric power system with a hydrogen-electric system, it is shown that energy conversion losses in the hydrogen system would result in much higher total energy consumption and would require greater power plant capacity for the same level of delivered energy. It is suggested that energy from a hydrogen-electric system would not only be more costly, but would result in a considerably greater environmental impact. B.J.

A78-10737 **Optimum peak-shaving mix for electric utilities.** R. A. Fernandes (Niagara Mohawk Power Corp., Syracuse, N.Y.). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 83-91. 32 refs.

Peak-Shaving Systems are classified into two categories: Constrained Continuous Output Peak-Shaving Systems and Unconstrained Continuous Output Peak-Shaving Systems. The importance of both classes of systems is discussed from a systems standpoint. Each of the peak-shaving systems are briefly analyzed in relation to static and dynamic requirements of the power system. The parametric curves derived display breakeven cost sensitivities of the most promising near-term peak-shaving technologies in the above categories - batteries in the first and hydrogen cycle peak-shaving in the second. Static and Dynamic effects on the power system due to peak-shaving are quantified on a $/kW basis. These results are considered as credits or debits in an overall economic evaluation and, when superimposed on direct breakeven costs allow selection of an optimum peak-shaving mix for electric utilities. (Author)

A78-10738 **Solar energy systems for electricity production.** L. O. Herwig (NSF, Washington, D.C.). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 92-95.

A brief description is given of three system concepts of electricity generation from solar energy: (1) solar thermal, (2) photovoltaic, and (3) ocean thermal. Progress in improving the performance and reducing the costs of solar thermal systems is reviewed in more detail, with emphasis on the collector subsystem, energy transport and thermal storage. B.J.

A78-10739 **A long-term solution to fossil fuel depletion.** D. L. Klass (Institute of Gas Technology, Chicago, Ill.). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 96-106. 25 refs.

It is argued that the only long-term practical alternative to sustaining a national economy on organic fuels is to convert a major source of continuously renewable nonfossil carbon to synfuels that are interchangeable with fossil fuels. The most promising source of this carbon is land- and water-based biomass produced from solar energy by photosynthesis. This paper presents an assessment of the biomass energy conversion concept, with emphasis on system design, economics and energetics. B.J.

A78-10740 **The prospect for geothermal power.** M. C. Smith (California, University, Los Alamos, N. Mex.). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 107-109.

Except for non-electrical applications, the earth's heat can, in general, be utilized only where the geothermal gradient is relatively high, so that higher than normal rock temperatures exist at economically drillable depths. This paper gives a brief description of a number of geothermal energy systems, including hydrothermal reservoirs, dry steam reservoirs, superheated water, geopressured reservoirs and dry hot rock. B.J.

A78-10741 **Solar-electric residential system tests.** D. B. Miller (Purdue University, West Lafayette, Ind.) and K. W. Böer (Delaware, University, Newark, Del.). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 116-124. 9 refs. Research supported by the American Public Power Association, Atlantic City Electric Co., Baltimore Gas and Electric Co., Delaware Power and Light Co., ESB, Inc., Ohio Edison Co., Pennsylvania Power and Light Co., Tampa Electric Co., and NSF.

The test system consisted of an array of CdS/Cu2S photovoltaic cells, augmented by a power amplifier, a parallel battery circuit, a normal residential lighting circuit, auxiliary rheostat loads, and a tie to the utility power line, located in the Solar One house. All circuits were carefully instrumented. Through a series of day-long tests, during partially cloudy and overcast days, 13 - 49% of the normal residential load came from the amplified solar source. A battery 'float' mode was shown to be useful for voltage regulation and maximum power tracking. The batteries were also 'deep-discharged' to show their energy storage capability. (Author)

A78-10742 * **Solar central electric power generation - A baseline design.** J. C. Powell (Honeywell, Inc., Minneapolis, Minn.). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 125-129. 10 refs. Research supported by Honeywell, Inc., Black and Veatch, Consulting Engineers, NASA, and NSF.

The paper presents the conceptual technical baseline design of a solar electric power plant using the central receiver concept, and derives credible cost estimates from the baseline design. The major components of the plant - heliostats, tower, receiver, tower piping, and thermal storage - are discussed in terms of technical and cost information. The assumed peak plant output is 215 MW(e), over 4000 daylight hours. The contribution of total capital investment to energy cost is estimated to be about 55 mills per kwh in mid-1974 dollars. B.J.

A78-10743 **Potential role of solar thermal electric power in the U.S.** D. Q. Hoover (Westinghouse Electric Corp., East Pittsburgh, Pa.) and A. D. Watt (Watt Engineering, Ltd., Boulder, Colo.). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 130-140. NSF-supported research.

The paper considers the potential for the production of electrical energy by means of conversion of the incoming electromagnetic energy to thermal energy and then its subsequent conversion via some type of heat engine to the generation of electrical energy. Insolation in the United States is discussed with emphasis on atmospheric effects, insolation observed at the earth surface and energy available to various collectors. Consideration is also given to collectors and their performance, the transport and storage of energy, heat engines, and system performance and costs. B.J.

A78-10744 **Capital and electrical production costs for geothermal power plants.** H. E. Klei (Connecticut, University, Storrs, Conn.) and F. Maslan (Futures Group, Inc., Glastonbury, Conn.). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 148-154. 14 refs. NSF Grant No. C-836.

In the present paper, the capital investment (composed of turbine and generator costs, exploration costs, well costs, and piping costs) for a geothermal production site are calculated. It is shown that the initial capital investment required for dry-steam geothermal plants changes little from $180-200/KW for plants above 100 MW. When the total investment in replacement wells over 20 years is added to the initial capital investment, the total reaches a minimum for plants between 50 and 100 MW. Since the amount of flashed steam/well obtained from hot-brine wells is close to that from dry-steam wells, and their initial capital investments are the same, the above conclusions hold also for hot-brine wells. Electrical production costs are minimum for plants around 100 MW; for a 110-MW plant, these costs are 6 to 8 mills/Kwh for both dry-steam and hot-brine systems. Hot-rock well systems are projected to have electrical costs between 4 and 8 mills/Kwh, but these costs are largely conjecture. V.P.

A78-10745 **National program for MHD power generation.** W. D. Jackson, R. V. Shanklin (ERDA, Washington, D.C.), and P. S. Zygielbaum (Electric Power Research Institute, Palo Alto, Calif.). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 158-165.

Development of MHD power generation systems in the U.S. is reviewed, with attention given to testing of MHD channels and electrodes, the use of high-temperature corrosion/erosion resistant materials for MHD components, and the Engineering Test Facility to be built under ERDA sponsorship in Montana. The current emphasis of the U.S. program is on the generation of electric power through utilization of domestic coal, including high-sulfur content coal; demonstrations of coal slag as a protective coating for MHD channel walls are reported. Problems related to the rate of thermal energy input recovery, turbine efficiency, recycling of the potassium seed, and emission control are also mentioned. A timetable for the development of commercial electric power generation by MHD open cycle coal-fired combined cycle plants is given. J.M.B.

A78-10746 **Energy from solid waste - Appraisal of alternatives.** R. G. Sheehan (City of Seattle, Seattle, Wash.). In: Energy development II. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 187-193. 15 refs.

The present paper provides the electric utility engineer with commercial solid waste/energy alternatives, helpful in the selection of cost-effective and environmentally acceptable disposal systems. A comparative analysis of electricity, steam, combustible gas (or solid waste), and methanol (and ammonia) generation showed that the most attractive solid-waste/energy system alternative is the use of air-classified solid waste fuel in existing pulverized-coal electric utility boilers, with the manufacture of methanol or ammonia from solid waste by way of partial oxidation pyrolysis, as the second most attractive solid-waste/energy system. Conventional incineration with unprocessed raw solid waste for the production of steam is a viable alternative in the case of year around steam requirements. The kiln-pyrolysis process for steam generation is seen to be a successful competitor to conventional incineration. V.P.

A78-10776 # **Doublet IIA experiments.** R. L. Freeman, S. J. Adcock, J. F. Baur, N. H. Brooks, J. C. DeBoo, R. K. Fisher, W. C. Guss, F. J. Helton, C. L. Hsieh, and T. H. Jensen (General Atomic Co., San Diego, Calif.). In: Plasma physics and controlled nuclear fusion research 1976; Proceedings of the Sixth International Conference, Berchtesgaden, West Germany, October 6-13, 1976. Volume 1. Vienna, International Atomic Energy Agency, 1977, p. 317-322. 5 refs. Contract No. E(04-3)-167. ERDA Project 38.

Detailed measurements of the temporal and spatial behavior of the plasma properties of doublet, elliptic, and circular cross-section discharges in Doublet IIA have been carried out. One major result of these studies is the observation of a significant increase in the electron density and the energy confinement time with increased elongation. A doublet discharge with an elongation of 2.9 had an energy confinement time x electron density product over seven times as large as the value reported previously for a circular discharge in Doublet IIA, and it is about three times the value of an elliptic discharge with an elongation of 1.5. The elliptic and circular discharges were produced passively by controlling the plasma-induced current in the field-shaping coils surrounding the plasma. The doublet discharges were produced by actively driving selected sets of the shaping coils, and these shaping fields were adjusted in time according to the changes in the plasma current density profile which accompany plasma heating. The measured electron temperature, ion temperature, and impurity level of doublet and elliptic discharges are also presented. (Author)

A78-10778 # **Shaping and compression experiments in a Tokamak.** G. Cima (EURATOM and U.K. Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, England; Milano, Università, Milan, Italy), D. C. Robinson, C. L. Thomas, and A. J. Wootton (EURATOM and U.K. Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, England). In: Plasma physics and controlled nuclear fusion research 1976; Proceedings of the Sixth International Conference, Berchtesgaden, West Germany, October 6-13, 1976. Volume 1. Vienna, International Atomic Energy Agency, 1977, p. 335-350. 18 refs.

Shaping and compression experiments on a plasma in a small multipole Tokamak, TOSCA, are described. Stable operation was obtained with plasmas of circular cross-section at currents of up to 25 kA, densities of about (1-3) times 10 to the 13th per cu cm and temperatures of up to 300 eV. Fluctuations, not MHD in origin, occur. Non-circular cross-sections have been produced by applying an approximately quadrupole field. A free-boundary equilibrium calculation has been used to deduce the detailed plasma shape by comparison with the experimental data. Elliptic plasmas, produced with a reduced aperture, are found to be positionally stable for b/a between 0.95 and 1.05. Growth times of axisymmetric modes are in good agreement with theoretical predictions. Full-aperture plasmas were stable for b/a less than about 1.5 if the primary windings were used as a passive feedback system. This value of ellipticity is in agreement with predictions of a stability calculation which takes account of all currents induced in the passive windings by the shaped plasma. Calculations also demonstrate plasma formation with a magnetic aperture. (Author)

A78-10796 # **Reconnection of field lines and disruptive instability in Tokamaks.** B. B. Kadomtsev (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). In: Plasma physics and controlled nuclear fusion research 1976; Proceedings of the Sixth International Conference, Berchtesgaden, West Germany, October 6-13, 1976. Volume 1. Vienna, International Atomic Energy Agency, 1977, p. 555-565. 8 refs.

The mechanism of magnetic-field-line reconnection is proposed as the most natural explanation of the disruptive instability in Tokamaks. Field-line reconnection adequately accounts for the internal disruptive instability when it is assumed that only the m = 1 mode develops; this paper extends that mechanism to the case where two or more modes are present. The concept of free reconnection is introduced in relation to the situation where a large number of allowed modes exist, and free reconnection in a Tokamak is shown to result in uniform current distribution over the column cross section as well as expulsion of part of the poloidal flux beyond the edge of the limiter. It is suggested that the disruptive instability in a Tokamak is an MHD activity that flares up for a short time and is permanently present in a diffusion column. The geometry of magnetic surfaces during reconnection is analyzed, and qualitative arguments are given which indicate that the disruptive instability begins to develop as a result of the intersection of the m = 2 mode with the inner m = 1 mode. F.G.M.

A78-10872 # **Reactor costs and maintenance, with reference to the Culham Mark II conceptual Tokamak reactor design.** R. Hancox and J. T. D. Mitchell (EURATOM and U.K. Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, England). In: Plasma physics and controlled nuclear fusion research 1976; Proceedings of the Sixth International Conference, Berchtesgaden, West Germany, October 6-13, 1976. Volume 3. Vienna, International Atomic Energy Agency, 1977, p. 193-202. 5 refs.

A cost estimate for the Culham conceptual Tokamak reactor (Mk I) is presented. The capital cost of a power station incorporating this reactor would be significantly higher than that of an equivalent fast breeder fission power station, mainly because of the low power density of the fusion reactor which affects both the reactor and building costs. To reduce the fusion station capital costs a new conceptual design is proposed (Mk II) which incorporates a shaped plasma cross-section to give a higher plasma pressure ratio. Since the higher power density implies more severe radiation damage of the blanket structure, the question of reactor maintenance assumes greater importance. With the proposed scheme for regular replacement of the blanket, a fusion power station availability around 0.9 should be achievable. (Author)

A78-10874 # **Mirror reactor studies.** R. W. Moir, W. L. Barr, D. J. Bender, R. J. Burleigh, G. A. Carlson, R. S. Devoto, J. N. Doggett, G. W. Hamilton, J. D. Lee (California, University, Livermore, Calif.), and J. H. Fink. In: Plasma physics and controlled nuclear fusion research 1976; Proceedings of the Sixth International Conference, Berchtesgaden, West Germany, October 6-13, 1976. Volume 3. Vienna, International Atomic Energy Agency, 1977, p. 223-235. 6 refs. Contract No. W-7405-eng-48.

The design of three types of mirror reactors is examined: (1) a fusion mirror reactor using 150-keV neutral-beam injectors based on the acceleration of negative ions; (2) a fusion-fission mirror reactor for the production of fissile fuel at minimum cost in blankets containing uranium or thorium; and (3) two classes of small mirror reactors represented by the fusion energy research facility (FERF)

for material and system testing and by the experimental power reactor (EPR) with a minimum size permitting the inclusion of a blanket and shield inside the coil windings. The fusion reactor is discussed in terms of blanket and blanket replacement, neutral beam injector, plasma direct energy converter, and a parametric analysis for mirror characterization. It is shown that the rapid particle loss from the ends gives a fusion mirror reactor with classical end losses a low Q value, small mirror reactors having room for a shield only can be used for material testing (FERF), and a fusion-fission EPR would produce considerable amounts of fissile fuel as well as net power.
S.D.

A78-10878 # **Neutral beam injector research and development work in the USA.** L. D. Stewart, G. C. Barber, W. K. Dagenhart, R. C. Davis, H. H. Haselton, J. Kim, N. S. Ponte, P. M. Ryan, D. E. Schechter (Oak Ridge National Laboratory, Oak Ridge, Tenn.), and L. R. Grisham (Oak Ridge National Laboratory, Oak Ridge, Tenn.; Princeton University, Princeton, N.J.). In: Plasma physics and controlled nuclear fusion research 1976; Proceedings of the Sixth International Conference, Berchtesgaden, West Germany, October 6-13, 1976. Volume 3. Vienna, International Atomic Energy Agency, 1977, p. 293-299. 20 refs. ERDA-sponsored research.

The paper reviews work on neutral beam injection research and development at Brookhaven National Laboratory, Lawrence Berkeley and Livermore Laboratories, and Oak Ridge National Laboratory in the U.S.A. Design objectives and characteristics of pertinent injectors are discussed. Positive-ion-based and negative-ion-based injector concepts are examined, with particular reference to the Tokamak Fusion Test Reactor. S.D.

A78-10879 # **Development of fast neutral beam injectors at Fontenay-aux-Roses.** A. Bariaud, R. Becherer, J. F. Bonnal, J. Druaux, M. Fumelli, R. Oberson, P. A. Raimbault, and F. P. G. Valckx (EURATOM and Commissariat à l'Energie Atomique Association sur la Fusion, Département de Physique du Plasma et de la Fusion Contrôlée, Fontenay-aux-Roses, Hauts-de-Seine, France). In: Plasma physics and controlled nuclear fusion research 1976; Proceedings of the Sixth International Conference, Berchtesgaden, West Germany, October 6-13, 1976. Volume 3. Vienna, International Atomic Energy Agency, 1977, p. 303-314. 18 refs.

The fast neutral beam injection system of TFR, based on ten Duopigatrons, is outlined and its evolution briefly described. For the development of high-power injectors, needed for JET and other European confinement experiments, a collaborative program is being carried out at Culham and at Fontenay. A survey is given of the results obtained at Fontenay on different injector components: the high-current Periplasmatron ion source; water-cooled extraction grids; and energy recovery systems for the residual charged beam fraction. (Author)

A78-10887 # **Formation of a high-current relativistic-electron-beam ring for plasma confinement.** A. Mohri, M. Masuzaki, K. Narihara, T. Tsuzuki, K. Yamanaka, and K. Ikuta (Nagoya University, Nagoya, Japan). In: Plasma physics and controlled nuclear fusion research 1976; Proceedings of the Sixth International Conference, Berchtesgaden, West Germany, October 6-13, 1976. Volume 3. Vienna, International Atomic Energy Agency, 1977, p. 395-402. 11 refs.

A78-10902 **Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record.** Conference sponsored by the Institute of Electrical and Electronics Engineers. New York, Institute of Electrical and Electronics Engineers, Inc., 1976. 1040 p. $40.

Attention is given to low cost silicon cells and arrays, noncrystalline silicon cells, low cost silicon material, space solar array technology, and space environmental effects. Consideration is also given to terrestrial applications of solar cells, chalcogenide semiconductor solar cells, MIS and Schottky barrier cells, and GaAs cells.
B.J.

A78-10904 * **Analysis of epitaxial drift field N on P silicon solar cells.** C. R. Baraona and H. W. Brandhorst, Jr. (NASA, Lewis Research Center, Cleveland, Ohio). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 9-14. 14 refs.

A78-10905 **The role of defects on the performance of epitaxial and diffused solar cells fabricated on EFG 'ribbon' silicon.** R. V. D'Aiello, P. H. Robinson, and H. Kressel (RCA Laboratories, Princeton, N.J.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 15-22. 6 refs. NSF Grant No. AER-74-15532.

This paper reports a comparative study of solar cells made using EFG ribbon silicon, with emphasis on the role of defects on cell performance. The work included epitaxial solar cell structures and cells made by direct diffusion, with the focus of interest on determining the effect of defects present in EFG ribbon, on each type of structure. The characterization included X-ray topography, SEM (EBIC mode) studies, lifetime measurements in addition to standard solar cell measurements. The effect of inclusions, grain and twin boundaries on fill-factor, short-circuit current density, and open-circuit voltage will be discussed. (Author)

A78-10906 * **A study of improvements in silicon solar cell efficiency due to various geometrical and doping modifications.** P. M. Dunbar and J. R. Hauser (North Carolina State University, Raleigh, N.C.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 23-29. 13 refs. NASA-supported research.

This paper presents the results of continued studies of silicon solar cell operation and limitations. The objective of this paper is to report on geometrical and doping changes in silicon solar cells which result in predictions of high efficiencies. Efficiencies as high as 20 per cent (uncorrected for metal coverage and ohmic sheet resistance) have been calculated for optimized cells. The conditions required to achieve these efficiency values are discussed. (Author)

A78-10907 **New developments in vertical-junction solar cells.** J. Lindmayer and C. Wrigley (Solarex Corp., Rockville, Md.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 30-32. Contract No. F33615-76-C-2058.

The non-reflective vertical junction structure has been developed in an effort to achieve solar cells with improved radiation resistance and high conversion efficiency. The cells are anisotropically etched structures having vertical channels as narrow as 7 microns wide etched over 100 microns into a (110) silicon surface. The structures are prepared using low-temperature oxidation techniques with photolithography to delineate the fine-line silicon etch pattern. The paper describes the performance of 2 cm x 2 cm vertical junction cells for the case of two channel geometries. B.J.

A78-10909 **Temperature dependence of the photovoltaic performance of Si cells under blue, white and near-bandgap irradiation.** E. Fischer-Colbrie, R. Wichner (California, University, Livermore, Calif.), and E. J. Charlson (Missouri-Columbia, University, Columbia, Mo.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 40-43. 5 refs. Contract No. W-7405-eng-48.

A78-10912 **Solar cells by ionized-cluster beam deposition and epitaxial techniques.** T. Takagi, I. Yamada, and A. Sasaki (Kyoto University, Kyoto, Japan). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 55-64. 7 refs. Research supported by the Mitsubishi Foundation for Natural Science Research.

It is shown that the ionized-cluster beam deposition and epitaxial techniques are useful for the fabrication of photo-cells. A thin layer of single silicon crystal and a very thin conductive metal film by this technique are used to obtain wide spectrum sensitivity of the cells. The p-n junction diode has been made by depositing an n-type silicon onto a p-type silicon substrate. The Schottky barrier diode has been made by depositing a gold film onto an n-type silicon substrate. These diodes show good performance and improve on photovoltaic characteristics in ultraviolet region. (Author)

A78-10914 **On the series resistance of solar cells.** S. Bobbio and F. P. Califano (Napoli, Università, Naples, Italy). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 71-73. Research supported by the Consiglio Nazionale delle Ricerche.

The paper deals with the influence of the finite conductivity of the upper contacts on the series resistance of solar cells. The influence of the series resistance on the solar cells efficiency at high illumination levels is also shown. (Author)

A78-10915 **Silicon solar cells on metallurgical silicon substrates.** T. L. Chu, S. S. Chu, K. Y. Duh, and H. I. Yoo (Southern Methodist University, Dallas, Tex.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 74-76. NSF Grant No. AER-73-07843; Contract No. E(04-3)-1285.

Metallurgical grade silicon is a promising substrate for the deposition of the active region of silicon solar cells. The substrate was prepared by the unidirectional solidification of chemically-treated metallurgical silicon, and the active region was deposited by the thermal reduction of trichlorosilane containing appropriate dopants. Large area (30 sq cm) solar cells with AM1 efficiencies of up to 6% have been produced. It is believed that the conversion efficiency can be improved by optimizing the structure properties of, and dopant profiles in, the solar cell. (Author)

A78-10916 **Fabrication and characterization of solar cells using dendritic silicon thin films grown on alumina ceramic.** S. Minagawa, T. Saitoh, T. Warabisako, N. Nakamura, H. Itoh, and T. Tokuyama (Hitachi, Ltd., Central Research Laboratory, Kokubunji, Tokyo, Japan). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 77-81. 7 refs. Research supported by the Ministry of International Trade and Industry of Japan.

A78-10918 **Low cost solar cells based on large area unconventional silicon.** H. Fischer and W. Pschunder (Telefunken AG, Heilbronn, West Germany). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 86-92. 8 refs. Research supported by the Bundesministerium für Forschung und Technologie.

Unconventional non-single crystalline silicon, characterized by controlled grain size and structure, has been used in low-cost solar cell manufacture. Large area (11 x 11 cm) solar cells have been produced for experimental purposes using materials of different grain sizes and modified solar cell fabrication procedures. The conversion efficiency of the solar cells has been optimized by altering the crystal forming process with respect to grain size, preferential orientation, and initial impurity concentration. Acceptable AMO efficiencies (8% for 11 x 11 cm cells and 12.5% for 2 x 2 cm cells) have been realized, and it is suggested that the material has potentially low-cost applications to the automated production of solar cells. S.C.S.

A78-10920 **Efficiency calculations for thin film polycrystalline semiconductor Schottky barrier solar cells.** C. Lanza and H. J. Hovel (IBM Thomas J. Watson Research Center, Yorktown Heights, N.Y.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 96-99. 12 refs.

A78-10921 **Vacuum deposited polycrystalline silicon solar cells.** C. Feldman, H. K. Charles, Jr., F. G. Satkiewicz, and N. A. Blum (Johns Hopkins University, Laurel, Md.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 100-105. 9 refs. Contract No. N00017-72-C-4401.

Experimental solar cells were fabricated from vacuum deposited polycrystalline silicon films using conventional integrated circuit processing techniques. Solar cell efficiencies of approximately 2% (AM2) were obtained from small devices with no attempt to optimize the electrode configuration and without an anti-reflection coating. Directions for improvement in processing and structure are indicated which could lead to the development of low cost, large area, photovoltaic devices suitable for terrestrial conversion of solar energy. (Author)

A78-10922 * **Silicon solar cells from transition metal doped Czochralski and web crystals.** J. R. Davis, P. Rai-Choudhury, P. D. Blais, R. H. Hopkins (Westinghouse Research Laboratories, Pittsburgh, Pa.), and J. R. McCormick (Dow Corning Corp., Hemlock, Mich.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 106-111. Contract No. NAS7-100.

The influence of metallic impurities on solar cell characteristics has been examined to establish the cost sensitive purity versus performance trade-offs. Solar cells were fabricated on 2 to 4 ohm-cm p-type substrates obtained by Czochralski and dendritic web growth processes. Controlled amounts of metallic impurities were introduced into the melt during growth and included Fe, Cr, Mn, Ni, Cu, Ti, V, Zr, Mg, Zn, and Al. Impurity concentrations in the crystals were determined using emission and mass spectrographic techniques and in some cases by neutron activation analysis. The solar cells were characterized by means of a computer program to curve-fit measured voltage-current data. The principal effect of the added impurities is a degradation of lifetime and diffusion length. (Author)

A78-10925 * **Production of solar-grade silicon from purified metallurgical silicon.** L. P. Hunt, V. D. Dosaj, J. R. McCormick, and L. D. Crossman (Dow Corning Corp., Hemlock, Mich.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 125-129. 22 refs. NSF-ERDA-NASA-supported research.

The long-term goal of this work is to produce silicon of solar-grade quality at 3 x 10 to the 6th kg/y for less than $10/kg by, or before 1986. The approach is to improve and expand upon the technology used today to commercially produce metallurgical-grade silicon (MG-Si). This is currently being accomplished by using purer raw materials in the arc furnace process for producing MG-Si, by upgrading the furnace itself, and by unidirectionally solidifying the molten silicon exiting the furnace. Solar cells fabricated from partially purified MG-Si have shown average AM0 efficiencies in the range of 9-11%. Since further MG-Si purification yet remains possible, fabrication of cells of considerably higher conversion efficiency is deemed feasible. (Author)

A78-10926 * **Dip-coated sheet silicon solar cells.** J. D. Heaps, R. B. Maciolek, J. D. Zook, and M. W. Scott (Honeywell Corporate Research Center, Bloomington, Minn.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 147-150. 7 refs. Contract No. JPL-954356.

A cost-effective method is being developed for producing solar cell quality sheet silicon by dip coating inexpensive ceramic substrates with a thin layer of large grain silicon. Mullite (Aluminum Silicate) ceramic substrates coated with a thin layer of graphite have been dipped into molten silicon to produce 20-150 micron thick layers having grain sizes as large as .4 cm x 4 cm. With these silicon layers photovoltaic diodes have been fabricated with measured and inherent conversion efficiencies of 4% and 7%, respectively. (Author)

A78-10927 **The tubular silicon solar cell - A new concept for photovoltaic power generation.** A. I. Mlavsky, H. B. Serreze, R. W. Stormont, and A. S. Taylor (Mobil Tyco Solar Energy Corp., Waltham, Mass.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 160-167. 13 refs.

The application of tubular solar cells, mounted in a collector, to a simple photovoltaic-solar thermal energy system has been suggested. The EFG (edge-defined, film-fed growth) technique has been used to grow experimental cells having a 3/8 inch diameter at rates of up to 2.5 inches per minute to lengths of five feet. It was found that tubular growth is particularly adaptable to the EFG technique, eliminating problems previously associated with EFG ribbon growth such as the presence of SiC particles. The tubular cells are found to have a better crystal structure than silicon ribbons and very low leakage current. Although cell conversion efficiencies exceeded 7%, improvement in tubular chemical quality will be necessary to achieve the required 10% efficiency. It is also suggested that improved cell making processes will be needed to achieve low-cost manufacturing. S.C.S.

A78-10928 * **Experiments to evaluate high-temperature rolling as a low-cost process for silicon solar cells.** G. T. Noel, S. Kulkarni, M. Wolf, D. P. Pope, and C. D. Graham, Jr. (Pennsylvania, University, Philadelphia, Pa.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 168-172. 5 refs. Contract No. JPL-954506.

Mechanical rolling (a process used in industry for producing large quantities of metallic sheet and strip) has been suggested for the rapid low-cost manufacture of silicon sheet to be used for photovoltaic power generation equipment, such as solar arrays. The advantages of rolling include: high rates of production, wide sheets as products, good control of dimension, and (in the case of solar grade silicon) minimal development of impurities. Experiments have been performed using high-temperature, high-speed compression of polycrystalline silicon cylinders. Metallography and X-ray diffraction techniques have been used to examine the samples both before and after compression, and a model process has been designed to evaluate the technical practicality and economic feasibility of the method. S.C.S.

A78-10929 **Ribbon-to-ribbon crystal growth.** I. A. Lesk, A. Baghdadi, R. W. Gurtler, R. J. Ellis, J. A. Wise, and M. G. Coleman (Motorola, Inc., Phoenix, Ariz.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 173-181.

A new ribbon growth technique utilizes scanned laser beams to create a localized molten region in a preformed polycrystalline silicon ribbon; translating the melt converts the starting material to single crystal (or large grain) ribbon. Solar cells with useful efficiency have been fabricated on grown ribbon. Theoretical analysis, coupled with experimental results, indicate that this technique should be capable of providing silicon substrates for manufacture of solar cells to meet the long range ERDA objectives. (Author)

A78-10930 **An analysis of factors influencing the efficiency of EFG silicon ribbon solar cells.** K. V. Ravi, F. V. Wald, R. Gonsiorawski, H. Rao, L. C. Garone, J. C. T. Ho, and R. O. Bell (Mobil Tyco Solar Energy Corp., Waltham, Mass.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 182-190. 12 refs.

The performance characteristics of EFG silicon ribbon solar cells have been analyzed with a view towards determining the material and process related parameters that influence cell conversion efficiencies. Solar cell conversion efficiencies in excess of 10% have been realized. The performance and yield limiting factors in these materials have been identified, with lifetime reducing impurities being implicated as the principal problem in current generation EFG ribbons. (Author)

A78-10932 * **ATS-6 solar cell flight experiment through 2 years in orbit.** L. J. Goldhammer (Hughes Aircraft Co., El Segundo, Calif.) and L. W. Slifer, Jr. (NASA, Goddard Space Flight Center, Greenbelt, Md.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 199-207. 14 refs. Contracts No. NAS5-11677; No. NAS5-22873.

ATS-6 solar cell flight experiment data through 2 years of synchronous orbit operation are presented. Comparisons are made of the performances of the 13 different types of solar cell/cover configurations, including new cover processes and materials, and the Comsat violet cell. These performances are also compared: (1) to the performances of the LES-6 solar cell experiment, the ATS-6 main solar arrays, and the Hughes Aircraft Company solar arrays, and (2) to laboratory spectrum electron irradiations. It was found that the cells of the ATS-6 experiment generally performed as expected through 6 to 9 months in orbit, but that at 2 years they were more severely degraded than expected. (Author)

A78-10936 **Qualification of European high efficiency solar cells for future ESA satellites.** K. Bogus, J. C. Larue, and K. K. Reinhartz (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 229-237. 5 refs.

From a comparative assessment of various types of high-efficiency solar cells it was found that 10 ohm cm cells made from crucible grown silicon are most appropriate for application on future ESA telecommunication satellites. Detailed qualification tests were performed on 500 AEG production-type cells according to the ESA standard specification for solar cells. All tests were passed successfully. At end-of-mission (10 to the 15th power e/sq cm, 1 MeV) the maximum power is 52 mW which is an increase of 15% compared to conventional cells presently used. (Author)

A78-10937 **Comparative testing of high efficiency silicon solar cells.** A. Meulenberg, D. J. Curtin, and R. W. Cool (COMSAT Laboratories, Clarksburg, Md.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 238-246. 14 refs. Research sponsored by the International Telecommunications Satellite Organization.

Violet and nonreflective-type high efficiency silicon solar cells from five sources were tested both with and without coverslides. The cells were measured for antireflective coating thickness and index of refraction, thermal emittance, absorptance, and degradation under ultraviolet light, electron irradiation and post-electron photon exposure. The degradation results indicated that after a dose of 10 to the 15th power electrons/sq cm, the better high efficiency cells have residual power outputs equal to or better than conventional cells prior to irradiation. Ultraviolet test results of the new antireflective coatings (i.e., Ta/x/O/y/ or TiO/x/) on high efficiency cells extrapolated from 800 hours indicate degradation of 2 to 3 percent after one year's exposure to one sun UV irradiation. (Author)

A78-10938 **Electron and proton degradation of commercially available solar cell/coverslide components.** J. R. Barton (Boeing Aerospace Co., Kent, Wash.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 247-254.

In the experiments described, a variety of solar cell and slidecover configurations were tested with the aim of obtaining comparable sets of 1-MeV electron and proton degradation characteristics. The overall results indicate that proper calculation of solar cell performance should consider initial performance, relative degradation from charged particle bombardment, and the change in temperature coefficients caused by the particles. The temperature coefficients of the basic cell parameters (maximum power output; voltage at maximum power; short-circuit current; and open-circuit voltage) undergo significant changes under the action of charged particles. Protective covers with conductive coatings have a lower glassing factor, but are as resistive to bombardment as conventional fused silica covers. The glassing factor varies as a function of the coating process and the material of the anti-reflective coating. V.P.

A78-10940 **Photon degradation of electron and proton irradiated silicon solar cells.** J. Bernard, S. Mottet (ONERA, Département d'Etudes et de Recherches en Technologie Spatiale, Toulouse, France), and R. L. Crabb (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 262-269. 5 refs.

Thin silicon solar cells prepared from 11 types of p-Si were exposed in the laboratory to 1 MeV electrons and to 2.5 and 10 MeV protons, up to fluences of 10 to the 15th power e/sq cm and 5 to the 11th power p/sq cm, respectively. The cells were periodically photon irradiated for 48 hr, the electrical performance and base-region minority-carrier diffusion length being determined at each stage. The data obtained were used to derive a generalized expression relating the solar cell minority-carrier diffusion length to the irradiation fluence. Photon degradation of electron-bombarded cells was found to be independent of dislocation density, type of dopant atom, and impurity concentrations (O, C, B, Al, and P). No degradation was observed in the case of proton bombardment. V.P.

A78-10943 **Solar cell processing with spin-on diffusion sources.** T. C. Chandler, Jr., R. B. Hilborn, Jr., and J. W. Faust, Jr. (South Carolina, University, Columbia, S.C.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 282-285. 6 refs.

In the study described, the problem of the poor quality of solar cells prepared from spin-on diffusion sources was attacked by studying the diffused layers by means of metallurgical techniques. It was found that device performance was degraded by nonuniform diffusion over the surface of the wafer and that nonuniform diffusion was caused by variations in the thickness of the spin-on silica layer. Cells which were diffused, using a uniform film of spin-on doping source exhibited better current-voltage characteristics, lower series resistance, and higher values of fill factor. It is shown that this better performance can be ensured by taking steps to maintain the uniformity of the film coverage, to eliminate cracks and bubbles, and to maintain the proper temperature of both the spin-on source and wafer during the spinning operation, and also to maintain the appropriate speed and duration of spin. The respective conditions are specified. V.P.

A78-10944 * **High performance, inexpensive solar cell process capable of a high degree of automation.** P. Shah and C. R. Fuller (Texas Instruments Semiconductor Research and Engineering Laboratories, Dallas, Tex.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 286-292. 13 refs. Contracts No. F33615-75-C-2066; No. JPL-954405.

This paper proposes a process for inexpensive high performance solar cell fabrication that can be automated for further cost reduction and higher throughputs. The unique feature of the process is the use of oxides as doping sources for simultaneous n(+) junction formation and back p(+) layer, as a mask for metallization and as an in situ AR coating for spectrum matching. Cost analysis is performed to show that significant cost reductions over the conventional process is possible using the proposed scheme and the cost intensive steps are identified which can be further reduced to make the process compatible with the needed price goals of 50 cents/watt. The process was demonstrated by fabricating n(+)-p cells using Arsenic doped oxides. Simple n(+)-p structure cells showed corrected efficiencies of 14.5% (AMO) and 12% with doped oxide as an in situ antireflection coating. (Author)

A78-10945 **Merits of ion-implantation processes in conjunction with appropriate annealing procedure for fabrication of silicon solar cells.** R. Varma and S. Zwerdling (Argonne National Laboratory, Argonne, Ill.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 293-298. 6 refs.

A78-10946 * **Silicon solar cells by ion implantation and pulsed energy processing.** A. R. Kirkpatrick, J. A. Minnucci, T. S. Shaughnessy, and A. C. Greenwald (Simulation Physics, Inc., Bedford, Mass.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 299-302. Contracts No. F33615-75-C-2006; No. JPL-954289; No. NAS7-100.

A new method for fabrication of silicon solar cells is being developed around ion implantation in conjunction with pulsed electron beam techniques to replace conventional furnace processing. Solar cells can be fabricated totally in a vacuum environment at room temperature. Cells with 10% AM0 efficiency have been demonstrated. High efficiency cells and effective automated processing capabilities are anticipated. (Author)

A78-10947 * **Application of thick-film technology to solar cell fabrication.** M. B. Field (Owens-Illinois, Inc., Toledo, Ohio) and L. R. Scudder (NASA, Lewis Research Center, Cleveland, Ohio). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 303-308. Contract No. NAS3-19441.

Several uses of thick-film technology in solar cell fabrication are discussed. Wrap-around contacts are obtained by first printing and firing a dielectric over the edge and subsequently applying a low-firing temperature conductor. Interconnection of cells into arrays can be achieved by printing and co-firing thick-film pastes, soldering, or with heat-curing conductive epoxies on low-cost substrates. Despite ongoing research, printed (thick) film vitreous *protective coatings do not yet offer sufficient optical uniformity and transparency for use on silicon.* Ohmic contacts on n- and p-type silicon are considered. M.L.

A78-10948 * **Integral glass sheet encapsulation for terrestrial panel applications.** J. A. Minnucci, A. R. Kirkpatrick, and W. S. Kreisman (Simulation Physics, Inc., Bedford, Mass.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 309-312. Contracts No. JPL-954521; No. NAS7-100.

Concepts for integral glass sheet encapsulation of terrestrial solar cell modules using techniques based upon electrostatic bonding are being developed. It is possible for the glass to provide hermetic encapsulation, the structural support, and a vehicle for integral interconnection of the solar cells. Anticipated capabilities, present status, and cost projections for large scale terrestrial utilization are discussed. (Author)

A78-10949 **Processing ramifications of textured surfaces.** M. G. Coleman, W. L. Bailey, and R. A. Pryor (Motorola, Inc., Phoenix, Ariz.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 313-316.

The paper is concerned with the complications that result from the presence of textured surfaces on silicon wafers. Direct process interactions are discussed with attention to handling, cleaning and wet chemistry, vacuum evaporation, photolithography, and ion implantation. Indirect process interactions can affect measurements and antireflection material selection. Textured surfaces are used to enhance light penetration into the surface of a solar cell. M.L.

A78-10951 * **Material and design considerations of encapsulants for photovoltaic arrays in terrestrial applications.** W. Carroll, E. Cuddihy, and M. Salama (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 332-339. 7 refs. Contract No. NAS7-100.

Procedures for analyzing cyclic mechanical stresses in encapsulated photovoltaic arrays designed for terrestrial application are discussed. The concept of 'thermal stiffness', the product of alpha and Young's modulus, is presented, and its usefulness for minimizing mechanical stresses is demonstrated. The concept of the proportional-limit' helps indicate the upper limit of design stress for plastics. System design is considered with attention to cell dimensions, cell to substrate adhesive, single encapsulant system, double layer encapsulant, and stresses in the interconnects. The permeability of polymeric materials to gases is examined. M.L.

A78-10953 **High efficiency solar cells.** C. Y. Wrigley (Solarex Corp., Rockville, Md.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 343-346. 5 refs.

This paper discusses some practical considerations relating to the impact of cell fabrication technologies and the changes which can be wrought by optimization of fabrication parameters to improve resulting solar cell efficiencies. Although there is a wide range of available approaches for generating new fabrication technologies, some crucial points must be considered, and tried, in their implementation. After such implementation, there remains a good deal to be gained by modification to improve cell efficiencies. Practical, viable process technologies will encompass adaptability to numerous cell types but improvements such as presented here can increase cell efficiencies and yield further gains. Some specific improvements applied are discussed in detail. (Author)

A78-10954 **Total energy use in the production of silicon solar cells from raw materials to finished product.** L. P. Hunt (Dow Corning Corp., Hemlock, Mich.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 347-352. 20 refs.

The total energy required to produce silicon solar cells from the raw material SiO2 is estimated. Metallurgical-grade silicon, semiconductor-grade trichlorosilane, polycrystalline semiconductor-grade silicon, and silicon solar cells are considered in terms of the process energy required to produce them and in relation to the total energy expended in their manufacture. The energy payback times using present technology is 24 years for space cells and 12 years for terrestrial cells. Improvements are described which could reduce the energy payback time to as little as four months for terrestrial cells. M.L.

A78-10955 * **SAMIS - A simulation of the solar array manufacturing industry.** R. G. Chamberlain (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 353-359. ERDA-supported research; Contract No. NAS7-100.

SAMIS is a continuing activity of the Project Analysis and Integration Task of the Low-cost Silicon Solar Array Project (LSSA). It provides a standardized procedure for producing reliable estimates of the cost of manufacturing solar arrays or their components. These estimates are based on descriptions of the manufacturing processes which are being studied and developed by LSSA subcontractors and will be used to assess the commercial viability of those processes and to set research priorities. (Author)

A78-10956 **Fired through printed contacts on antireflection coated silicon terrestrial solar cells.** A. D. Haigh (Ferranti, Ltd., Manchester, England). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 360, 361.

A78-10957 **Improved mesh interconnector technology for the Meteosat solar array.** G. J. La Roche (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 362-367.

The use of silvermesh as a solar cell interconnector material is described. Although applied successfully on rigid or flexible solar arrays, silvermesh can not survive periodic gap variations of about 10% of the gap width. In combination with an adhesive free gap technique and careful handling procedures, the silvermesh interconnector design was improved to successfully pass the qualification test program for the Meteosat solar array. A theoretical analysis of design characteristics is presented. M.L.

A78-10958 **Advanced interconnect for use with ultrasonic seam welding on solar cells.** G. J. Pack and R. W. Opjorden (Hughes Aircraft Co., Space and Communications Group, El Segundo, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 368-374.

A weldable stress-free interconnect for solar cells is required for the space environment. This requirement results from increased mission life and artificial environments ruling out the use of solder. Because of this constraint, Hughes addressed the specific problems of developing (1) an ultrasonic seam welding capability, and (2) a stress-free interconnect suitable for the space environment, both of which would be compatible with automated mass-production. The final result of this effort will be an automated welding machine that employs a stress-free, in-plane interconnect with the redundancy of a seam weld. Elimination of out-of-plane stress relief in the interconnect and the use of seam welding for redundancy (rather than three or four spot welds) is considered essential to the reliable mass production, bonding, and encapsulation of large solar arrays for both space and terrestrial photovoltaic power systems. (Author)

A78-10959 **A novel solar cell interconnection design.** R. A. Pryor, M. G. Coleman, and M. C. Keeling (Motorola, Inc., Phoenix, Ariz.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 375-378.

A novel interconnection design for solar cells within modules is developed. The design places thin buss plates beneath the solar cells. These buss plates can be designed for series, parallel-series, or parallel interconnection with equivalent ease. Such designs can incorporate multiple contacts to each solar cell and can reduce series resistance losses. Furthermore, this interconnection system is easily adapted to any size or shape of solar cell. (Author)

A78-10965 **Development of a multi-kW roll-out solar generator.** H. Bebermeier, U. Hoffmann, and J. Rath (Telefunken AG, Wedel, West Germany). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 418-429. 6 refs. Research sponsored by the Bundesministerium für Forschung und Technologie.

Since 1974 AEG-Telefunken is engaged in the development of a flexible multi-kW double roll-out solar generator DORA. The goal of this program is the development of a modular and light weight system which can be adapted to different power requirements. The paper describes the DORA concept, its main components and performance, and discusses the design flexibility and growth capability of the system. The tests, performed so far with DORA, are summarized. Finally, future applications of DORA are discussed, showing that DORA is capable of satisfying the demand for lighweight generators with a range of application from communication satellites to high power space stations. (Author)

A78-10966 **Comparison of foldout and rollout solar generators in the multi-kW-range.** W. Alsbach and H. Lösch (Deutsche Forschung- und Versuchsanstalt für Luft- und Raumfahrt, Cologne, West Germany). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 430-434.

The design features of a double roll-out (DORA) and an ultralight fold-out (ULP) solar generator are compared with respect to system aspects for different applications. Both are well suited for missions with a power range from 1.5 to 10 kW. The DORA has better power-to-weight ratio in the upper power range but it has no transfer capability. Though the ULP has some interface constraints because of its size in stowed configuration, it seems better suited for conventionally launched spacecraft up to approximately 5 kW. The DORA shows advantages for shuttle application and free flyer configurations. P.T.H.

A78-10967 **Development status of the ultralightweight solar array ULP.** H. v. Bassewitz (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany) and J. Lydorf (Telefunken AG, Wedel, West Germany). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 435-442.

The ultralightweight solar array (ULP) is an advanced hybrid array for spacecraft with a power requirement of 1 to 10 kW. It consists of a number of identical interhinged panels with a rigid carbon fiber frame and a flexible carbon fiber reinforced solar cell blanket. The frame supports a prestressed flexible substrate on which the solar cells are bonded. The array power is produced by a 100-ohm cm, n-on-p, silicon solar cell of 200 micron thickness and 2 x 4 cm in dimensions with a 100 micron thick cerium-stabilized microsheet cover slide. The blanket is undergoing thermal cycling qualification tests. The modules have been exposed to 1500 cycles between 80 and -180 C without any visual changes. Sinusoidal and random vibration tests have shown that the ULP is able to withstand a much lower frequency range than required for the Atlas-Centaur launch vehicle. P.T.H.

A78-10970 **Concentrator solar arrays for space power.** W. Luft (TRW Defense and Space Systems Group, Redondo Beach, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 456-461. 5 refs. Contract No. F33615-73-C-4085.

Investigations related to an evaluation of the performance of concentrator solar arrays using GaAs and Si solar cells are discussed. A modular concentrator concept in which many modules are connected into a large array is considered. On the basis of the results of the investigations, it appears that a concentrator-augmented solar array employing AlGaAs/GaAs solar cells provides more power per kilogram than nonconcentrator silicon arrays and that this power can be provided at 10 to 30 percent of the recurrent cost for nonconcentrator Si arrays. G.R.

A78-10971 **The relationships between preparation parameters, operating characteristics and physical processes in Cu2S-CdS thin film solar cells.** G. Storti (Delaware, University, Newark, Del.) and J. Culik (Delaware, University, Newark, Del.; Carnegie-Mellon University, Pittsburgh, Pa.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 462-465. 9 refs. NSF Grant No. AER-72-03478; Contract No. E(49-18)-2538.

A78-10972 **An automatable integrated thin film solar cell array.** W. J. Biter and F. A. Shirland (Westinghouse Research Laboratories, Pittsburgh, Pa.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 466-470.

A description is presented of a new integrated array of thin film solar cells which can be produced by means of continuous automatic fabrication techniques and which offers major advantages in cost and operational reliability. In the first step of the fabrication procedure negative electrodes are formed on an insulating substrate. The negative electrodes define the individual cells. In the second step a continuous layer of CdS is deposited on the substrate, and the upper surface of this layer is converted to Cu2S. Afterwards a shorting bar pattern and the positive grid electrode are deposited on the Cu2S barrier layer. G.R.

A78-10973 **Variation of short-circuit current spectral response with Cu/2-x/S composition in thin film Cu/2-x/S/CdS photovoltaic cells.** N. C. Wyeth and A. W. Catalano (Delaware, University, Newark, Del.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 471-474. 9 refs. Research supported by SES, Inc.

A78-10974 **Model of the CdS/Cu2S heterojunction.** K. W. Böer (Delaware, University; SES, Inc., Newark, Del.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 475-482. 21 refs. Research sponsored by SES, Inc.

The model considered by Shiozawa et al. (1969) does not provide a quantitative description of the current-voltage characteristics of CdS/Cu2S solar cells. A consistent physical model which permits a quantitative description of the current-voltage relations of the considered solar cell is, therefore, developed. Aspects of carrier generation are discussed along with the relations involved in the recombination and diffusion in Cu2S. The conditions in the junction region in CdS are investigated and experimental evidence is presented. G.R.

A78-10975 **The influence of the horizontal and vertical structure of the p-n junction in Cu2S-CdS solar cells.** G. H. Hewig and W. H. Bloss (Stuttgart, Universität, Stuttgart, West Germany). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record.
New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 483-487. 7 refs. Bundesministerium für Forschung und Technologie Contract No. ET-4045.

A78-10977 **Characteristics of chalcocite /Cu/x/S/ films produced by different methods and some properties of solar cells made from such films.** J. J. Loferski, J. Shewchun, E. A. DeMeo, R. Arnott, E. E. Crisman, R. Beaulieu, H. L. Hwang, and C. C. Wu (Brown University, Providence, R.I.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 496-501. 5 refs. NSF-supported research.

A78-10978 **Post-fabrication treatments, surface properties, and front contact of Cu/x/S-CdS solar cells.** F. Pfisterer, H.-W. Schock, and W. H. Bloss (Stuttgart, Universität, Stuttgart, West Germany). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record.
New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 502-507. 23 refs. Bundesministerium für Forschung und Technologie Contract No. ET-45.

During the production of Cu/x/S-CdS solar cells a heat treatment procedure in air at 180 C is used to restore the cell efficiency which has been reduced as a consequence of the copper treatment process. A theoretical model has been developed by Pfisterer et al. (1975) concerning the physical mechanisms which are responsible for the observed cell behavior. An investigation is conducted regarding the validity of the model. It is shown that a certain amount of oxygen is necessary to obtain optimum solar cell efficiencies, but that an excessive exposure to oxygen causes cell degradation. G.R.

A78-10979 **Influence of Cd and Zn doping on the electrical and optical properties of bulk Cu2S.** F. Guastavino, S. Duchemin, G. M. Moussalli, J. Bougnot, and M. Savelli (Montpellier II, Université, Montpellier, France). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 508-514. 6 refs.

A78-10980 **The formation of Cu2S thin films for CdS solar cells by sulfurization of copper with thiourea.** F. Arjona, F. Rueda, E. Garcia-Camarero, M. León, and L. Arizmendi (Madrid, Universidad Autónoma, Madrid, Spain). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 515-518. 11 refs.

A78-10981 **CdS sprayed thin films - Electrical and optical properties.** J. Bougnot, M. Perotin, J. Marucchi, M. Savelli (Montpellier II, Université, Montpellier, France), and M. Sirkis (Montpellier II, Université, Montpellier, France; Arizona State University, Tempe, Ariz.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record.
New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 519-525. 5 refs.

The investigation involved the deposition of thin films on small plates of Pyrex by means of a spraying procedure. The liquids used in the spraying procedure were obtained by mixing aqueous solutions of cadmium chloride and thiourea. The parameters studied were the ratio Cd(double plus)/S(--) in the spraying solution and the substrate temperature. The employed method led to reproducible results. The electrical and optical properties of the thin films obtained by spraying were found to be similar to those of films prepared by evaporation. G.R.

A78-10982 **Studies related to Zn/x/Cd/1-x/S-Cu2S solar cells.** L. C. Burton, B. Baron, W. Devaney, T. L. Hench, S. Lorenz, and J. D. Meakin (Delaware, University, Newark, Del.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, *Institute of Electrical and Electronics Engineers, Inc., 1976, p.* 526-528. 15 refs. NSF Grant No. AER-72-03478; Contract No. E(49-18)-2538.

Zn(x)Cd(1-x)S films suitable for use in solar cells have been deposited and characterized. Zn(x)Cd(1-x)S-Cu2S heterojunctions with reproducible open circuit voltages of .67-.68 volts have been fabricated. Barrier height measurements indicate that the increased open circuit voltage is due to an improved match between the mixed sulfide and Cu2S electron affinities. (Author)

A78-10983 **Recent results on II-VI heterojunctions for photovoltaic solar energy conversion.** A. L. Fahrenbruch, F. Buch, K. W. Mitchell, and H. Bube (Stanford University, Stanford, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 529-533. 16 refs. NSF-ERDA-supported research.

Several of the II-VI heterojunctions of greatest interest, including the n-CdS/p-CdTe, n-CdSe/p-ZnTe, n-ZnSe/p-CdTe, and n-ITO/p-CdTe junctions, were fabricated by vacuum evaporation, solution spraying, and close-spaced vapor transport. The basic heterojunction properties have been characterized by a variety of measurement techniques. Several n-CdS/p-CdTe cells with solar efficiencies up to 7.9 percent were made and new optimal absorption data for CdTe was obtained by a collection-efficiency analysis capable of discriminating between bulk and interfacial components of recombination loss. (Author)

A78-10984 **Thin film heterojunction and homojunction solar cells utilizing I-III-VI2 ternary compound semiconductors.** L. L. Kazmerski, G. A. Sanborn, A. J. Merrill, M. S. Ayyagari, S. D. Mittleman, G. K. Morgan (Maine, University, Orono, Me.), and F. R. White. In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record.
New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 534-539. 21 refs. NSF-ERDA-supported research.

A78-10985 **InP/CdS solar cells.** J. L. Shay, M. Bettini, S. Wagner (Bell Telephone Laboratories, Inc., Holmdel, N.J.), K. J. Bachmann, and E. Buehler (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record.
New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 540-543. 10 refs.

Single crystal InP/CdS solar cells having efficiencies of 15% under air mass = 2 illumination and polycrystalline thin film cells having efficiencies of 5.7% air mass = 2 under illumination are described. Basic studies of the interface reveal that the thin film efficiency is presently limited at least in part by the quality of the InP within the grains, and not exclusively by interface phenomena intrinsic to a polycrystalline cell. (Author)

A78-10986 **CdS - sputtered Cu2S solar cells.** N. K. Annamalai (West Virginia University, Morgantown, W. Va.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 547, 548. NSF Grant No. ENG-76-09256.

The preliminary results of the photovoltaic effects of a sputtered Cu2S layer on CdS are presented. A Cu2S layer on evaporated CdS layer was formed by sputtering a Cu2S straight target in an argon atmosphere; others have deposited Cu in a H2S and argon atmosphere. Stoichiometry of the film can be varied by a co-sputtering Cu and Cu2S. The effects on the output of the cell due to heat treatment in air and vacuum are discussed. (Author)

A78-10987 **Indium phosphide films deposited by cylindrical magnetron reactive sputtering.** J. A. Thornton (Telic Corp., Santa Monica, Calif.) and A. D. Jonath (Lockheed Research Laboratories, Palo Alto, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 549-553. 14 refs. Research sponsored by the Armco Steel Corp.

The deposition of indium phosphide coatings on glass substrates through d.c. reactive sputtering of indium in an argon-phosphine atmosphere using a cylindrical magnetron is described. The microstructures and resistivities of the 10-micron thick coatings were found to depend on the temperature of the substrate and the injection rate of the phosphine. The conductivities obtained were n-type. Optical transmission and X-ray diffraction analyses confirmed that the InP films deposited were of high quality. The use of cylindrical magnetron reactive sputtering to manufacture low-cost terrestrial CdS/InP solar cells is discussed. J.M.B.

A78-10988 **What is simulated AM0 - A comparison of CNR and violet cell measurements across USA and Europe.** J. F. Allison (COMSAT Laboratories, Clarksburg, Md.) and R. L. Crabb (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 554-559. 9 refs. Research sponsored by the Communications Satellite Corp.

The outputs of conventional, violet and nonreflective solar cells subjected to various types of simulated air mass = 0 (AM0) conditions are studied. Discrepancies of up to 13 mA in short circuit current and up to 5 mW in peak power are noted in 2 by 2 cm cells; measurements of spectral response indicate variations of more than 20% at certain wavelengths. The AM0 spectral irradiance of a carefully adjusted solar simulator, which produces higher short circuit currents and peak power levels than the commonly used simulators, is also reported. It is suggested that accurate spectral calibration of solar simulator outputs and accurate standard solar cells are needed. J.M.B.

A78-10990 **Albedo contribution to satellite solar array performance.** J. M. Voss (Boeing Aerospace Co., Seattle, Wash.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 569-572.

The contribution of earth albedo to the power capability of a satellite solar array is assessed for the case of two typical satellites in near-earth polar orbits. In-orbit data is presented, showing the amount of albedo contribution to satellite power generation in different orbits. The albedo contribution for a cylindrical solar array is presented in a normalized form in order to make it useful as a means of estimating the minimum and maximum expected increase in solar array power. This information is useful in arriving at a realistic assessment of satellite power capability and of shunt dissipation requirements. (Author)

A78-10994 **Potential of GaAs solar cells for Air Force space power systems.** C. Stuerke (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 591-594. 6 refs.

Characteristics of the GaAlAs/GaAs heterofaced solar cells under development by the Air Force Aero-Propulsion Laboratory are discussed. An array of 4 by 4 cm GaAs cells was found to have an efficiency of 14% when tested under simulated air mass = 0 conditions; efficiencies up to 18% are held to be attainable. The cost of 1 by 1 cm cells is estimated to be between $3.00 and $5.80. Furthermore, the GaAs cells are capable of greater power density than silicon cells, and are less affected by high-temperature operation. However, their sensitivity to 1-MeV electrons may present problems during operation in a natural radiation environment. J.M.B.

A78-10995 **Improved Helios cell output.** P. A. Payne and R. L. Oliver (Spectrolab, Inc., Sylmar, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 595-599. Research supported by Hughes Aircraft Co.

Work on the Helios cell in the past year improved the average output of filtered 2 x 2 cm N/P cells from 68mW (AM0) to 78mW (AM0). Aside from increasing control of the difficult P+ process variables, a sculpture etch to reduce front surface reflection was introduced, the number of gridlines to reduce series resistance was increased, and the back contact was made reflective (to reduce the absorptivity resulting from the sculptured surface). Cells as high as 81mW have been fabricated. (Author)

A78-10996 **Textured surface cell performance characteristics.** J. Scott-Monck and P. Stella (Spectrolab, Inc., Sylmar, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 600-602. 8 refs.

Selective etching (texturizing) silicon solar cells is discussed. The texturized cells have higher outputs than conventional silicon cells due to significant reductions in reflection losses obtained across the spectral response region. The performance of texturized cells ranging in thickness from approximately 75 to 300 microns with base resistivities of both nominal two and ten ohm-cm was evaluated. Short circuit current, maximum power density, relative spectral response and power-to-weight ratios are reported for the devices. It is suggested that texturized silicon cells employing advanced junction design and improved antireflection coatings could have power outputs 27 to 35% greater than conventional silicon solar cells. J.M.B.

A78-10997 **Black and thin silicon solar cells.** J. Michel (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 603-605. 9 refs.

Methods for reducing the cost of solar electricity obtained from P/N junction single crystal silicon photocells are discussed. In particular, the use of a cheap etching bath (KOH) for texturizing black solar cells, and the possibility of producing efficient cells with silicon layers in the 70 to 300 micron range are considered. A computer program capable of analyzing energy conversion efficiency as a function of silicon layer thickness for a black cell and a normal cell without antireflective coating is also described. An economic evaluation indicates that if kerf losses involved in cutting thin silicon wafers can be kept low, the cost of black cells with thin silicon layers may be 4 percent less than that of comparable photocells currently employed in terrestrial applications. J.M.B.

A78-10998 **The current status of the U.S. photovoltaic conversion program.** L. M. Magid (ERDA, Div. of Solar Energy, Washington, D.C.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 607-612.

Research and development programs in terrestrial photovoltaic conversion, sponsored by the Division of Solar Energy of ERDA, are discussed. By 1986, ERDA planning calls for a factor of thirty reduction in solar array prices (to $300 per peak kWe) and demonstration of advanced solar arrays with prices about one hundred times lower than present levels. Research in advanced arrays, which emphasizes thin-film silicon, cadmium sulfide/copper sulfide, and gallium arsenide photovoltaic materials, is reviewed; the testing and evaluation of optical concentrators and the power conditioning and storage elements of photocells are also considered. Regional residential photovoltaic systems developed for demonstration purposes, as well as load center tests involving generation of up to 10 MW of electrical energy by fiscal year 1984, are mentioned. J.M.B.

A78-10999 **Status of the ERDA photovoltaic material and device studies.** D. M. Warschauer (ERDA, Div. of Solar Energy, Washington, D.C.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 613, 614.

Research sponsored by ERDA in the area of photovoltaic energy conversion systems is discussed, with attention given to solar cell materials (silicon, cadmium sulfide, copper oxide, and cadmium telluride), heterostructure configurations, polycrystalline silicon films or gallium arsenide films on low-cost substrates, and high-efficiency monocrystalline thin films of indium phosphide. An investigation of photocell loss mechanisms which involves a combination of material and diode studies, computer calculations and an adaptation of the transient capacitive method of analysis is also considered. The possible institution of periodic colloquia on photovoltaic conversion held under the auspices of ERDA is mentioned. J.M.B.

A78-11000 **The solar energy researcn programme of the Commission of the European Communities.** A. Strub (Commission of the European Communities, Brussels, Belgium) and R. Van Overstraeten (Leuven, Katholieke Universiteit, Heverlee, Belgium). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 615-617.

A78-11001 **French activities in the field of photovoltaic power conversion for terrestrial use.** M. Rodot (CNRS, Paris, France) and W. Palz (Centre National d'Etudes Spatiales, Paris, France). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 618-622.

After a brief survey of past developments on solar cells in France, the present organization of solar cell research and development is reviewed. The main programs launched in 1976 are listed; they aim at (1) improving the technology of present silicon cells, (2) studying new materials and new structures that might be used in future cells, (3) performing system studies and building demonstration prototypes. (Author)

A78-11002 **Status of the West German terrestrial photovoltaic program.** H. R. Lösch (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Cologne, West Germany). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 623, 624. 12 refs.

A78-11003 **Terrestrial solar cell R & D in the UK.** F. C. Treble (Royal Aircraft Establishment, Space Dept., Farnborough, Hants., England). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 625, 626.

A78-11004 **Photovoltaic system in 'Sunshine Project' - R & D underway in Japan.** T. Koyanagi (Ministry of International Trade and Industry, Electrotechnical Laboratory, Tokyo, Japan). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 627-633.

Japanese research in photovoltaic conversion systems, aimed at reducing costs by a factor of 100, is discussed; topics considered include silicon ribbon crystals, silicon thin-film cells, solar cells using II-IV compound semiconductors, array encapsulation procedures, and devices combining photovoltaic and thermoelectric effects. In particular, the growth rate of laterally pulled silicon ribbons, ion plating or eutectic silicon film growth, vertical multijunction cell structures, screen printing and firing of silver pastes to form low-cost electrodes, photovoltaic systems with solar concentrators, the degradation of conversion efficiency during cell operation, and thin-film solar cells having a glass substrate/transparent electrode/chemically deposited CdS film/vacuum evaporated CdTe film/Au electrode structure are considered. J.M.B.

A78-11005 **German activities in the field of terrestrial application of solar cell arrays.** R. Buhs and H. Gochermann (Telefunken AG, Wedel, West Germany). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 634-640. 12 refs. Research supported by the Bundesministerium für Forschung und Technologie.

German programs in the solar energy field, including the production of solar generators using large (10 by 10 cm) solar cells of inexpensive non-single crystalline silicon, are discussed. Two techniques for protecting cells from environmental effects, one involving encapsulation between sheets of glass held by a polyvinylbutyral seal, the other requiring encapsulation in glass fiber reinforced acrylic resin, are considered; power outputs of plastic- and glass-embedded arrays are compared. The application of silver foils to connect solar cells in an array is also mentioned. The non-single crystalline silicon solar generators subjected to encapsulation and silver foil interconnection of the cells were found to have efficiencies of 8% or greater. J.M.B.

A78-11006 **Major terrestrial applications for photovoltaic solar energy conversion in the 1980-2000 period.** S. L. Leonard (Aerospace Corp., El Segundo, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 641-652. 5 refs. NSF Grant No. GI-44099; Contract No. E(04-3)-1101. ERDA Project 8.

Technical and economic analyses have been made of a number of on-site residential applications and central station applications for photovoltaic solar energy conversion in the Southwestern United States in the 1985-2000 period. The methodology employed computer simulation of the performance of the photovoltaic systems, both with and without electric storage, and included a reliability analysis procedure for determining the amount of backup conventional generation capacity which would be sufficient to maintain reliability of service during non-insolation periods. It was determined that, for reasonable fuel-price projections, photovoltaic systems would be cost effective in either type of application when array prices are in the $100-300 per peak kW range (1976 dollars). (Author)

A78-11007 **Nominal cost and performance objectives for photovoltaic panels in nonconcentrating central station applications.** E. A. DeMeo, D. F. Spencer, and P. B. Bos (Electric Power Research Institute, Palo Alto, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 653-657. 10 refs.

A procedure is described for estimating capital costs of nonconcentrating, flat plate photovoltaic central stations. Results obtained allow the estimation of a nominal set of cost and performance objectives for photovoltaic panels used in such stations. Comparisons with today's perception of electric utility generation alternatives indicate that acceptable plant economics will probably require photovoltaic panel efficiencies in excess of 10% and panel costs near $10-$20 per sq cm. It is also shown that support and wiring costs will probably be comparable to panel costs if economic viability is achieved, and that both of these costs are therefore equally important leverage items in reducing plant costs. However, panel efficiency is shown to be the major leverage item in reducing costs. Finally, it is pointed out that a principal factor affecting plant economics is total array cost per unit area per unit of powerplant efficiency, and this - in conjunction with the above objectives - leads to some important considerations regarding the use of optical concentration. (Author)

A78-11008 **Solar photovoltaic conversion electric utility point of view and development role.** G. W. Braun (Southern California Edison Co., Los Angeles, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 658-660.

The role of individual electric utilities, as well as the collectively sponsored Electric Power Research Institute, in promoting research in photovoltaic energy conversion is discussed. Economic evaluations, which indicate that the value of solar photovoltaic power may be in the range $500 to $1000 (1980 dollars) per kilowatt, are mentioned; the use of solar power in meeting peak demand is considered. The advantages of central generation of solar energy, including the opportunity to develop energy storage facilities, and the optimal use of sunfall by location of the generators in areas where solar radiation is highest, are reviewed. It is suggested that, due to the high cost of installing special metering and the problems associated with financing and constraints on building design, solar energy systems for individual homes may not be as economical as large-scale utility-managed solar generation. J.M.B.

A78-11009 **Status of the ERDA photovoltaic systems definition project.** D. G. Schueler and B. W. Marshall (Sandia Laboratories, Albuquerque, N. Mex.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 661-666. 11 refs. ERDA-supported research.

The photovoltaic systems engineering and analysis program and the photovoltaic concentrator development program sponsored by ERDA are discussed. Conceptual design studies of residential, intermediate, and central station photovoltaic power systems, as well as economic assessments of the photovoltaic systems, are reviewed. In particular, competing designs for a central photovoltaic power station for Phoenix, Arizona are described; the various types of cells and concentrators proposed, and the cost of components and structures are compared. An analysis of the economic viability of photovoltaic and combined photovoltaic/thermal power generation is also reported. Investigations of passive reflectors, compound parabolic concentrators, parabolic trough collectors, and refractive systems (such as Fresnel lenses) for photovoltaic concentrator systems are mentioned. J.M.B.

A78-11010 **Computer simulation of photovoltaic systems.** M. W. Edenburn, G. R. Case, and L. H. Goldstein (Sandia Laboratories, Albuquerque, N. Mex.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 667-672. 11 refs. ERDA-supported research.

A computer program for simulating the steady-state performance of photovoltaic power generators is described; the program incorporates thermal models for a concentrating or nonconcentrating array, and is also capable of taking into account power generation cycles, loads and demands, and solar and weather data for eight locations in the U.S. The nonconcentrating array may be tilted and tracked in the simulation scheme. The solar cell, battery, inverter and d.c. regulator models are considered, and a simulator which imposes on the cells an effective load causing them to operate at their maximum power point is mentioned. The computer program may accomodate alternative electrical subroutine models and thermal models for other concentrator concepts as they are developed. J.M.B.

A78-11011 **Performance and cost assessment of photovoltaic system concepts.** A. Kirpich and E. Buerger (General Electric Co., Space Div., Valley Forge, Pa.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 673-680. Contract No. E(29-1)-3686.

The design and economic evaluation of photovoltaic systems for residential and central power plants are considered. A residential photovoltaic scheme relying on shingle-mounted solar cells is described; problems associated with the scheme, including the need for energy storage and the feedback of excess power to the local utility, are discussed. Three concepts for a central power plant are also mentioned: an azimuth tracking design; an arrangement of low-ratio concentrators in East-West rows, which are seasonally adjusted; and an arrangement of East-West rows of tilted flat panels. Energy outputs as a function of solar cell area, panel area, and land area are compared for the three concepts. The permissible solar cell costs for both the residential and large-scale photovoltaic systems are contrasted through the use of a nomogram. J.M.B.

A78-11012 **Technical and economic results of solar photovoltaic power systems analyses.** P. F. Pittman, E. F. Federmann, R. R. Ferber, and C. R. Chowaniec (Westinghouse Electric Corp., Pittsburgh, Pa.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 681-690. Contract No. E(11-1)-2744.

Conceptual designs were developed for residential, intermediate, and central station solar photovoltaic power systems. Included were system configurations and subsystem designs used for cost/performance tradeoff comparisons. System costs were determined using the ERDA goals for solar cell cost of $500/kW in 1985 and $100/kW in 2000. Based upon the assumptions made, the results show that residential systems should begin to become viable in selected locations in 1985, while the intermediate and central station systems appear to become attractive closer to the year 2000. (Author)

A78-11013 **Photovoltaic system design and analysis application to a shopping center.** F. T. C. Bartels (Spectrolab, Inc., Sylmar, Calif.) and C. C. Kelber (Facilities Systems Engineering Corp., Los Angeles, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 691-697. Contract No. E(11-1)-2748.

In the present paper, the solar photovoltaic system designs developed for three applications - a single-family residence, a shopping center, and a central power station - are discussed. The results of an operational and economic analysis are examined, with emphasis on the shopping center application. Some economic and technical considerations are presented, concerning an array module design based on silicon photovoltaic cells of 15% efficiency. V.P.

A78-11014 * **Status of the ERDA/NASA Photovoltaic Tests and Applications Project.** J. N. Deyo, H. W. Brandhorst, Jr., and A. F. Forestieri (NASA, Lewis Research Center, Cleveland, Ohio). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 698-704.

A78-11015 **The conceptual design and analysis of a photovoltaic powered experimental residence.** N. F. Shepard, Jr. and R. Landes (General Electric Co., Space Div., Philadelphia, Pa.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 705-714.

The paper deals with the results of a six-month definition study conducted to analyze the performance, plan the testing program, and specify the test equipment requirements for an experimental photovoltaic powered residence. In a residence of the type proposed, the solar cell modules are mounted above the south-facing roof in such a way that the natural convective cooling from the rear side can be used to reduce the cell operating temperature. Other functional elements are a photovoltaic system components room, and a room housing the data-acquisition and control systems required to monitor the experiment. A display panel is also provided as a visual aid to graphically represent the operation and performance of the system tested. Following a 12-month operational evaluation period, a lead-acid battery was added to the photovoltaic system. The results of a performance sensitivity analysis for four selected site locations are evaluated. V.P.

A78-11016 **DOD/ERDA terrestrial photovoltaic systems demonstration program.** D. D. Faehn (U.S. Army, Mobility Equipment Research and Development Command, Fort Belvoir, Va.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 715-720.

The program discussed in the present paper was initiated to study the feasibility of using photovoltaic energy sources for military systems. Three of the six planned demonstration sources have been operated successfully, since September 1976, at a facility which constitutes the first (centralized) demonstration phase of the program. Encouraging results have been obtained with a battery charger, a water purification plant, and a telephone communication station. V.P.

A78-11017 **Insolation and wind - A natural combination for self-sufficient power systems.** S. M. Lee (U.S. Naval Weapons Center, China Lake, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 721-724.

Many military installations with small to medium power requirements are situated at remote isolated locations characterized by a high insolation level and a good wind potential. In many cases, there is a negative seasonal correlation between wind and solar energy. Some aspects of using these sources to provide an effective self-sufficient energy system for remote installations are examined in the present paper. V.P.

A78-11018 **Military applications of solar cell power.** J. W. Bond, Jr. (U.S. Army, Mobility Equipment Research and Development Command, Fort Belvoir, Va.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 725-732.

In the present paper, the potential military applications of solar cell power are reviewed, and the advantages of solar cell power for tactical, ancillary, mobile, and remote applications are pointed out. The various types of solar cell power systems that may be used for military applications are discussed and compared. V.P.

A78-11019 * **The Redox Flow System for solar photovoltaic energy storage.** P. O'Donnell, R. F. Gahn, and W. Pfeiffer (NASA, Lewis Research Center, Cleveland, Ohio). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 733-736.

The interfacing of a Solar Photovoltaic System and a Redox Flow System for storage was workable. The Redox Flow System, which utilizes the oxidation-reduction capability of two redox couples, in this case iron and titanium, for its storage capacity, gave a relatively constant output regardless of solar activity so that a load could be run continually day and night utilizing the sun's energy. One portion of the system was connected to a bank of solar cells to electrochemically charge the solutions, while a separate part of the system was used to electrochemically discharge the stored energy. (Author)

A78-11020 **Silicon solar cell development for concentrated-sunlight, high-temperature applications.** J. G. Fossum and E. L. Burgess (Sandia Laboratories, Albuquerque, N. Mex.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 737-743. 12 refs. ERDA-supported research.

The development of silicon solar cells for use in concentrated-sunlight, high-temperature environments, based on theory and experiment, is presented. The theoretical work is aided by exact numerical simulations of the cells. Suggested cell designs are then fabricated using standard integrated circuit processing techniques. The designs are verified through computer-controlled testing of the cells at solar illuminations up to 90 suns (9 W/sq cm) and temperatures up to 100 C. The development of a 5-cm-diameter silicon wafer cell for a 50-sun, approximately 100 C application is emphasized. (Author)

A78-11021 **The testing of specially designed silicon solar cells under high sunlight illumination.** T. T. Rule, S. Y. Harmon, C. E. Backus, and D. L. Jacobson (Arizona State University, Tempe, Ariz.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 744-750. 8 refs. ERDA-supported research.

Several conventionally processed silicon cells with fine grid patterns to reduce the series resistance, which becomes more important for increased intensities, were tested for concentration ratios from 1 to 60 suns. One edge illuminated cell was tested up to 80 suns. All of the cells showed an increase in efficiency by a factor of 1.1 to 1.2 at about 10 suns and then a gradual decrease back down to their one sun efficiency values at about 40-50 suns. The efficiencies decreased approximately linearly with temperature for all intensities levels in the temperature range of 40 C to 210 C. (Author)

A78-11022 **Design criteria for high efficiency silicon solar cells with concentration.** J. A. Castle (Spectrolab, Inc., Sylmar, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 751-759. Contract No. E(11-1)-2590.

This paper addresses the problem of designing silicon solar cells for high efficiency under concentration. The basic design approach places restrictions on the voltage drop due to series resistance. A series resistance model and efficiency performance factors associated with cell design parameters are developed to provide an engineering tool for the prediction, evaluation and optimization of concentrator cells. Test results are presented showing efficiencies ranging from 12.8% to 15.6% over a concentration range of 1 to 109 AMI solar constants. (Author)

A78-11023 **A pn junction silicon sensor for high-intensity solar flux mapping.** T. I. Chappell (Sandia Laboratories, Albuquerque, N. Mex.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 760-763. 14 refs.

A78-11024 **Novel versions of the compound parabolic concentrator for photovoltaic power generation.** A. Gorski, R. Graven, W. McIntire, W. W. Schertz, R. Winston, S. Zwerdling (Argonne National Laboratory, Argonne, Ill.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 764-770. 6 refs. ERDA-supported research.

The Argonne National Laboratory is now engaged in the final stages of assembly and evaluation of two novel concentrator/photovoltaic panels based on the compound parabolic concentrator concept. In the first version of these terrestrial panels, the concentrator is in the form of a solid transparent dielectric bar (the DCPC) with silicon solar cells bonded to the exit apertures. In the second version, the concentrator is in the form of hollow troughs of lightweight plastic that has been metallized and protectively overcoated (the CPC configuration). Tests of these panels will allow evaluation of a method that has the potential for significantly reducing the cost of photovoltaic power conversion through the use of low cost plastic concentrators. (Author)

A78-11025 **Progress report on a 1-kW terrestrial array of AlGaAs/GaAs concentrator solar cells.** L. W. James, R. L. Moon, E. O. Moore, Jr., and R. L. Bell (Varian Associates, Palo Alto, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 771-773.

GaAs concentrator solar cells show high conversion efficiencies, effective utilization of expensive materials, and potentially reasonable economics for large-scale applications. The paper describes the construction of an array containing 119 one-third-inch diameter water-cooled cells with reflective imaging optics having a geometric concentration ratio of 1100:1, in order to demonstrate the feasibility of the nest of the components. The concentrator mirrors have proven to be the most difficult component in meeting the desired cost goals. Manufacture of appropriate mirrors has delayed completion of the array by several months, so that data are presented only on the performance of the individual components of the array. (Author)

A78-11026 **Characteristics of high intensity /HI/ edge-illuminated multijunction silicon solar cells - Experimental results and theory.** C. Goradia, R. Ziegman (Cleveland State University, Cleveland, Ohio), and B. L. Sater. In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 781-788. 9 refs.

A78-11027 **Recent experimental results on high intensity /HI/ edge-illuminated multijunction silicon solar cells.** C. Goradia and M. G. Goradia (Cleveland State University, Cleveland, Ohio). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 789, 790.

Experimental measurements were made under concentrated sunlight on high intensity /HI/ edge-illuminated multijunction silicon solar cells of 1000 ohm-cm base resistivity and 0.9 mm thickness. The illumination intensity, obtained from short circuit current ratio, varied from 10 W/sq cm to 85.8 W/sq cm and over this range, the output power density varied from 0.756 W/sq cm to 5.29 W/ sq cm. (Author)

A78-11028 **High intensity solar cell.** R. L. Call and W. J. Kerwin (Arizona, University, Tucson, Ariz.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 791-793.

Solar cells designed to operate with reasonable efficiency at relative high intensities have been fabricated. Special attention to elements of a solar cell that add to the internal resistance was given in an attempt to reduce internal losses. Resistances of the bulk wafer, the fingers, the main contact, and the n diffusion layer were considered. I-V characteristic curves for different intensities were taken. Data relating efficiency and CFF with the intensity were also plotted. A comparison between cells fabricated with different finger densities is presented. (Author)

A78-11029 **A data acquisition system for in situ measurements of terrestrial photovoltaic array performance.** A. S. Cherdak and G. M. Haas (Mitre Corp., McLean, Va.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 794-800.

The effect of one year of environmental exposure on the functioning of a one-kilowatt photovoltaic array consisting of twenty 50-watt panels was studied. A data acquisition system was designed and fabricated to make in situ performance measurements of the terrestrial-design panels and their constituent modules. This data acquisition system is described. Current-voltage curves show that most of the panels have lower power output and lower fill factors than their original ratings. The nature of the deterioration and the applicability of the test procedure are discussed. M.L.

A78-11030 * **Interface design considerations for terrestrial solar cell modules.** R. G. Ross, Jr. (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 801-806. ERDA-sponsored research; Contract No. NAS7-100.

The need for increased solar array electrical efficiency and reliability in the achievement of future large-scale system cost goals is discussed. The relative performance of various array module designs currently on the market is evaluated, and further design improvements are suggested. The subjects of module efficiency, temperature control, and series/parallel reliability are analyzed. Applications for various combinations of array characteristics are considered. M.L.

A78-11031 **Thermophotovoltaic systems for electrical energy conversion.** J. R. Yeargan, R. G. Cook, and F. W. Sexton (Arkansas, University, Fayetteville, Ark.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 807-813. 10 refs. Research supported by the University of Arkansas; NSF Grant No. EPP-75-04701.

Thermophotovoltaic cells are discussed where the energy not absorbed by the bandgap semiconductor is reflected to the radiating material and used to maintain its temperature. Equations are presented for a blackbody radiator which predicts maximum efficiencies in terms of the radiator temperature and parameters of the cell. Design curves which estimate output power densities and overall efficiency as a function of source temperature are also presented. Maximum efficiencies of 56% for silicon TPV cells at radiator temperatures of 2000 K and 63% for GaAs cells with a 2400 K source are predicted. Efficiencies as high as 40% for silicon cells are expected with existing technology. Use of the TPV cells as a topping cycle for a conventional steam generating is also discussed. (Author)

A78-11032 **A tracking, high-concentration electrical and thermal solar energy collection system.** R. Kaplow and R. I. Frank (MIT, Cambridge, Mass.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 814-819. 14 refs. Research sponsored by the National Patent Development Corp.

A solar energy converter, designed with the intent of providing cost-effective, supplemental electricity and hot water for houses and institutions, has been constructed in a full-size working model form and is being tested. The model is being operated to obtain measurements of performance, to make improved cost calculations, and to optimize the system and its components. The system is designed to lend itself to inexpensive manufacturing techniques and its modular construction allows different capacity units to be assembled from standardized components. (Author)

A78-11033 **Improved performance of solar cells for high intensity applications.** R. I. Frank and R. Kaplow (MIT, Cambridge, Mass.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 820-825. 7 refs. Research sponsored by the National Patent Development Corp.

Vertical junction solar cells fabricated from stacks of silicon wafers, which have been sliced into segments to form a series of p-n junctions normal to the cell surface, have been studied. These cells have a structure which is attractive for high intensity applications, but a measured efficiency of only 8%. The reasons for this low efficiency have been determined experimentally, and improvements of up to 7.0% have been obtained by the use of a miniature lens array bonded to the cell, which redirects the incident light into a narrow band adjacent to each junction. (Author)

A78-11034 **Some economic and political aspects of photovoltaic development.** A. Clifford (Solarex Corp., Rockville, Md.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 826-831. 17 refs.

The paper reviews the pace of technological change and the current position of the terrestrial photovoltaics industry. The discussion focuses on availability of capital, the cost of electricity, and the politics of development. Factors affecting the speed of development of photovoltaics are indicated. S.D.

A78-11035 **Cost of earth power from photovoltaic power satellite.** H. Oman (Boeing Aerospace Co., Seattle, Wash.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 832-840. 7 refs.

Important problems to be resolved in a system study of a photovoltaic solar power satellite in geosynchronous orbit are examined. Attention is directed to solar cell degradation from radiation, loss of solar power by leakage through plasma, leakage current, sunlight concentration, and use of photovoltaic thin-film cells. Three methods of estimating plasma-leakage current from a very large (90 sq km) solar array in geosynchronous orbit are presented. S.D.

A78-11036 * **Economic analysis of low cost silicon sheet produced from Czochralski grown material.** K. M. Koliwad, M. H. Leipold, G. D. Cumming, and T. G. Digges, Jr. (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 841-844. 7 refs. Contract No. NAS7-100.

This study shows that the lower limits for manufacturing add-on costs to convert polysilicon to wafers is in the range of $22 to $26/sq m with the cost about equally divided between the crystal growth and wafering processes. However, the $22 to $26/sq m cost limit should be viewed as an asymptote since it is based on multicharge or continuous growth configurations, solidification rates in excess of 2 Kg/hr, multiblade wafering and a slice plus kerf of .045 cm. It should also be emphasized that the results of this study are based on as-sawn wafers, 100% yields (growth and slicing) and no profit. To the first approximation, the limiting cost factors are crucible material and furnace parts for growth and blade material and slurry for slicing. (Author)

A78-11037 **A simple model for solar energy economics in the U.K.** P. T. Landsberg (Southampton, University, Southampton, England). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 845, 846.

A78-11038 **Solar cells based on tunnel metal-insulator-semiconductor structures.** J. A. Saint Pierre, R. Singh, J. Shewchum (McMaster University, Hamilton, Ontario, Canada), and J. J. Loferski (Brown University, Providence, R.I.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 847-853. 28 refs. Research supported by the National Research Council of Canada and NSF.

Experimental results and theoretical predictions are compared concerning the variation of efficiency, short circuit current, and open circuit voltage as a function of insulator thickness for the Al-SiO2-(p-type)Si system. Agreement with theory is found to be very good, indicating that the proposed mechanism of tunneling with an electrostatically induced surface junction for the current transport is present in the experimental devices. Spectral response measurements reveal an enhanced ultraviolet response in support of the presence of surface junction. A major conclusion is that a maximum theoretical efficiency of about 21% for the Al-SiO2-(p-type)Si system can best be reached with a high substrate doping, a low metal work function (variation of efficiency as a function of metal insulator barrier height), and a low interface defect density. S.D.

A78-11039 **MIS solar cell calculations.** L. C. Olsen (Washington, University, Richland, Wash.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 854-861. 13 refs.

Theory is presented for a MIS solar cell with a charge-free interfacial layer. Conversion efficiency is calculated as a function of band gap. Detailed calculations are also presented for InP. MIS cells efficiencies can be significantly higher than the corresponding Schottky barrier (SB). In particular, MIS cells with phi sub B0 less than 2E sub g/3 have efficiencies equivalent to that for an ideal SB cell with phi sub B0 = E sub g. The peak AM1 efficiency for MIS cells is essentially the same as that for p/n devices, namely 21% at E sub g = 1.5 eV. (Author)

A78-11040 * **M-I-S solar cell - Theory and experimental results.** R. Childs, J. Fortuna, J. Geneczko, and S. J. Fonash (Pennsylvania State University, University Park, Pa.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 862-867. 8 refs. NATO-supported research; Contract No. JPL-54525.

The paper presents an operating-mode analysis of an MIS solar cell and discusses the advantages which can arise as a result of the use of transport control, field shaping (increased n factor), and zero bias barrier height modification. It is noted that for an n-type semiconductor, it is relatively easy to obtain an enhanced n factor using acceptor-like states without an increase in diode saturation current, the converse being true for p-type semiconductors. Several MIS configurations are examined: an acceptor-like, localized state configuration producing field shaping and no change in diode saturation current, and acceptor-like localized configurations producing field shaping, with a decrease of diode saturation current, in one case, and an increase in the other. B.J.

A78-11041 **A contribution to Schottky barrier solar cell theory.** C. Klimpke and P. T. Landsberg (Southampton, University, Southampton, England). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 868, 869. Research supported by the Science Research Council.

Schottky barrier solar cell theory is discussed with emphasis on recombination in the depletion region. A Shockley-Read type model, assuming a uniform energy distribution of interface states, is used to analyze interface state recombination at the boundary of the oxide and the n-type Si. Consideration is also given to the charge density in the interface layer, and the density of interface states is shown to be bounded from above. A simple variation of the quasi-Fermi levels and electrostatic potential is assumed through the junction. B.J.

A78-11042 **Cuprous oxide Schottky barrier photovoltaic cells.** D. Trivich, E. Y. Wang, R. J. Komp, and F. Ho (Wayne State University, Detroit, Mich.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 875-878. 8 refs.

In laboratory experiments Cu2O sheets have been isolated, both single crystal and polycrystal, to form Schottky barrier junctions with a variety of metals (especially copper) and the rectifying and photovoltaic properties of cells in the front-wall configuration have been investigated. The Cu2O is prepared by oxidation of copper sheet in air and the junctions on Cu2O are prepared by vacuum deposition of the various metals. Typical values for the solar cells are a short circuit current of 4-7 mA/sq cm, an open circuit voltage of 0.3 V, and a fill factor of 0.35 with conversion efficiencies approaching 1%. B.J.

A78-11043 **Controlling open circuit voltage in silicon Schottky /MIS/ solar cells.** W. A. Anderson, J. K. Kim, and A. E. Delahoy (Rutgers University, New Brunswick, N.J.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 879-882. 13 refs.

A study of experimental data on Cr/oxide/p-Si solar cells has led to a metal evaporation procedure which gives an open circuit voltage between 0.50 and 0.56 V. This voltage is independent of the method used in oxide formation when oxide thickness ranges from 10-30 A. It is concluded that slow deposition of the Cr on an oxide interface leads to a lowered metal work function and thus an increased open circuit voltage. A high n-value and fixed charge in the oxide are not necessary to obtain a high open circuit voltage. (Author)

A78-11044 * **Single crystal and polycrystalline GaAs solar cells using AMOS technology.** R. J. Stirn and Y. C. M. Yeh (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 883-892. 14 refs. NSF-supported research; Contract No. NAS7-100.

A description is given of current technology for fabricating single AMOS (antireflection-coated metal oxide semiconductor) solar cells, with attention given to thermal, plasma, and anodic oxidation, native oxide stripping, and X-ray photoelectron spectroscopy results. Some preliminary results are presented on the chemistry and electrical characterization of such cells, and the characteristics of cells fabricated on sliced polycrystalline GaAs wafers are examined. Consideration is also given to the recrystallization of evaporated Ge films for use as low-cost substrates for polycrystalline GaAs solar cells. B.J.

A78-11045 **Solar cells using Schottky barriers on amorphous silicon.** D. E. Carlson, C. R. Wronski, A. R. Triano, and R. E. Daniel (RCA Laboratories, Princeton, N.J.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 893-895. Contract No. E(04-3)-1286.

Thin film solar cells, 1 micron or less in thickness, have been fabricated using metal Schottky barriers on discharge-produced amorphous silicon. Power conversion efficiencies as high as 5.5% have been obtained using Pt Schottky barriers and ZrO2 antireflection coatings. These cells have the potential of producing low cost power since inexpensive materials such as steel and glass have been used as substrates. (Author)

A78-11046 **Large open-circuit photovoltages in silicon minority carrier MIS solar cells.** M. A. Green, R. B. Godfrey, and L. W. Davies (New South Wales, University, Kensington, Australia). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 896-899. 7 refs. Research supported by the Radio Research Board of Australia and Australian Research Grants Committee.

A78-11047 **Interface study of MIS silicon solar cells.** J. P. Ponpon, R. Stuck, and P. Siffert (CNRS, Centre de Recherches Nucléaires de Strasbourg; Strasbourg I, Université, Strasbourg, France). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 900-903. 20 refs.

MIS silicon solar cells have been realized on n-type material by using an interfacial oxide layer made by evaporation of silicon monoxide or by soaking in boiling nitric acid. The performances of the oxide layers have been investigated in terms of structure and distribution. The problem of cell stability (i.e. ageing) leads to the discussion of the more fundamental problem of potential barrier formation on Schottky diodes or MIS devices. (Author)

A78-11048 **Photocurrent analysis in MIS silicon solar cells.** E. Fabre, J. Michel, and Y. Baudet (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 904-906. 11 refs. Research supported by the Délégation Générale de la Recherche Scientifique et Technique.

The photocurrent of MIS silicon solar cells which exhibit open circuit voltages in the 500-550 mV range has been experimentally investigated. An efficiency of 11.7 percent under AM1 solar illumination is reported for a 2.6 sq cm cell. (Author)

A78-11049 **Inversion layer silicon solar cells with MIS contact grids.** P. Van Halen, R. Mertens, R. Van Overstraeten (Leuven, Katholieke Universiteit, Heverlee, Belgium), and R. E. Thomas. In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 907-912. 7 refs.

A new silicon solar cell is described in which an inversion layer forms the active area which is then contacted by means of an MIS grid. It is shown that the cells can be realized by a single-mask, completely low-temperature process by employing spin-on of a titanium oxide AR coating. The cells have been realized in both small and large area (up to 3.31 sq cm) versions with conversion efficiencies up to 11%. The highest efficiencies are shown to result when high resistivity substrates are used. Preliminary results where the cells were exposed to more than 2 AM0 intensity suggest that the cells may perform more efficiently than diffused junction cells in applications where the sun is concentrated. (Author)

A78-11050 **Diffusion length measurement by a simple photoresponse technique.** H. J. Hovel (IBM Thomas J. Watson Research Center, Yorktown Heights, N.Y.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 913-916. 12 refs.

A simple technique for measuring diffusion lengths is outlined. A Schottky barrier solar cell is made on the test material, and the spectral response is measured. The ratio of the measured responses at two wavelengths is compared to calculated ratios for the same wavelengths with diffusion length as the main variable. The technique can be applied directly to metal-insulator-semiconductor, voltage-enhanced solar cells as well as to normal Schottky barrier devices. (Author)

A78-11051 ***Improvement of efficiency in Si Schottky* barrier solar cells.** H. Matsunami, S. Matsumoto, and T. Tanaka (Kyoto University, Kyoto, Japan). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 917-919. 6 refs.

Improvement of the conversion efficiency by 127% is attained in Pt-n Si Schottky barrier solar cells. By the use of an oxide layer at the interface between the metal and the semiconductor, the open-circuit voltage is increased by 50%. The increase of the short-circuit current is performed using transparent conductive In2O3 films as antireflective coatings. Solar cells with efficiency of 8.8% are obtained with an open-circuit voltage of about 0.41V, short-circuit current density of about 29.2 mA/sq cm, and fill factor of 0.60. (Author)

A78-11052 **The effects of illumination on the depletion-region recombination currents in Schottky-barrier solar cells.** P. Panayotatos, H. C. Card, and E. S. Yang (Columbia University, New York, N.Y.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 920, 921. NSF Grant No. ENG-75-18074.

A78-11053 **Experimental study of the interface properties of MOS tunnel devices.** S. Kar (Indian Institute of Technology, Kanpur, India). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 922-928. 25 refs.

An experimental study has been made of the dependence of critical interface properties on the oxide thickness in MOS tunnel devices. The interface state density distribution was obtained from the measured admittance and the zero-bias band-bending in silicon and the flat-band bias from the measured low frequency C-V characteristics. With increasing oxide thickness, interface state density was found to go down sharply and consequently the zero-bias silicon band-bending and the flat-band bias increased considerably. Because of the sharply increasing potential barrier both in silicon and in oxide, the diode current was found to go down by many orders of magnitude. This may very likely be the reason why the open-circuit voltage increases with oxide thickness in MOS solar cells. (Author)

A78-11054 **High efficiency and large area /GaAl/As-GaAs solar cells.** G. S. Kamath, J. Ewan, and R. C. Knechtli (Hughes Research Laboratories, Malibu, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 929-933. 6 refs.

The present paper reports on the progress of our work on GaAs solar cells since our last paper in 1975. The power conversion efficiency (AM0) of the cells has increased from less than 10% to over 16.5% during this interval. Two main contributors to the increase are improvements in epitaxial growth of the layers and the optimization of the electrical contacts. The result is especially significant because the cells are 2 cm x 2 cm and the processing has been tailored to make the cell a one for one replacement for the silicon cell in satellite solar panels. Our study of the economics of GaAs cells using our technology indicates that GaAs cells have a significant role to play in future solar power applications, especially in space and in high concentration systems. (Author)

A78-11055 **Vapor-phase-epitaxial growth, processing and performance of AlAs-GaAs heterojunction solar cells.** W. D. Johnston, Jr. and W. M. Callahan (Bell Telephone Laboratories, Inc., Holmdel, N.J.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 934-938. 10 refs.

A78-11056 * **Computer analysis of heterojunction and graded bandgap solar cells.** J. E. Sutherland and J. R. Hauser (North Carolina State University, Raleigh, N.C.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 939-944. 15 refs. NASA-USAF-supported research.

The development and application of a graded bandgap solar cell computer analysis program is discussed. The basic device equations as used in the computer analysis are discussed and the techniques used to model material parameter variations are described. Finally, the results of the computer analysis of several Al(x)Ga(1-x)As and GaAs(1-x)P(x) solar cell structures are presented along with a discussion of the effects of interface states and various composition profiles on maximum solar cell efficiency. (Author)

A78-11057 * **Improved GaAs solar cells with very thin junctions.** H. J. Hovel and J. M. Woodall (IBM Corp., Yorktown Heights, N.Y.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 945-947. 6 refs. Contract No. NAS1-12812.

Violet cells with 500-1000 A junction depths have been made in GaAs by narrow junction diffusion followed by anodization. The best AM0 efficiencies obtained by this technique have been 10.5% (14% at AM1). GaAlAs-GaAs structures with very thin GaAlAs layers are much more promising, and efficiencies of over 18% at AM0 have been measured (21.9% at AM1). (Author)

A78-11058 **The potential for increasing the efficiency of photovoltaic systems by using multiple cell concepts.** N. S. Alvi, C. E. Backus, and G. W. Masden (Arizona State University, Tempe, Ariz.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 948-956. 16 refs. ERDA-supported research.

Two techniques have been investigated to increase the conversion efficiencies in concentration systems by the use of two or three different bandgap material cells. The technique of putting cells in optical series with the highest-gap material first, could lead to efficiencies of about 30-35% if a high efficiency cell with a bandgap of about 2.0 eV could be developed. Using selective mirrors to divide the solar spectrum into energy bands that selected cells could respond to has special advantages from a design point of view and could lead to comparable efficiencies as for optical series arrangements. (Author)

A78-11059 * **Tandem photovoltaic solar cells and increased solar energy conversion efficiency.** J. J. Loferski (Brown University, Providence, R.I.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 957-961. 5 refs. Grant No. NGR-40-002-093.

Tandem photovoltaic cells, as proposed by Jackson (1955) to increase the efficiency of solar energy conversion, involve the construction of a system of stacked p/n homojunction photovoltaic cells composed of different semiconductors. It had been pointed out by critics, however, that the total power which could be extracted from the cells in the stack placed side by side was substantially greater than the power obtained from the stacked cells. A reexamination of the tandem cell concept in view of the development of the past few years is conducted. It is concluded that the use of tandem cell systems in flat plate collectors, as originally envisioned by Jackson, may yet become feasible as a result of the development of economically acceptable solar cells for large scale terrestrial power generation. G.R.

A78-11060 **The structure and Schottky barrier diode properties of polycrystalline GaAs films grown by the close spaced vapour transport technique on Mo substrates.** B. G. Russel and D. L. Pulfrey (British Columbia, University, Vancouver, Canada). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 962-966. 12 refs.

A78-11062 * **Fabrication of OSOS cells by neutral ion beam sputtering.** D. E. Burk, J. B. DuBow, and J. R. Sites (Colorado State University, Fort Collins, Colo.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 971-974. 12 refs. Grant No. NsG-3083; Contract No. E(04-3)-1203.

Oxide semiconductor on silicon (OSOS) solar cells have been fabricated from various indium tin oxide $(In2O3)x(SnO2)1-x$ compositions sputtered onto p-type single crystal silicon substrates with a neutralized argon ion beam. High temperature processing or annealing was not required. The highest efficiency was achieved with x = 0.91 and was 12 percent. The cells are environmentally rugged, chemically stable, and show promise for still higher efficiencies. Moreover, the ion beam sputtering fabrication technique is amenable to low cost, continuous processing. (Author)

A78-11063 **Degradation of SnO2/Si heterojunction solar cells.** T. R. Nash and R. L. Anderson (Syracuse University, Syracuse, N.Y.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 975-977.

The cells considered were fabricated by the deposition of thin films (80-500 nm) of SnO2 onto cleaned wafers of integrated circuit quality silicon by electron beam evaporation according to a procedure described by Franz et al. (1976). The on-shelf degradation of the cells was studied by measuring the electrical characteristics of the cells periodically. Accelerated life tests were made by stressing the cells thermally and optically. The degradation is related to an increase in series resistance and a variation in open circuit voltage. An initial rapid increase in resistance is followed by a more gradual increase in resistance. A lifetime of the order of 1000 years is predicted if this second, gradual increase in resistance limits the cell life. G.R.

A78-11064 **Design factors for transparent conducting layers in solar cells.** P. A. Iles and S. I. Soclof (Optical Coating Laboratory, Inc., City of Industry, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 978-988. 16 refs.

The requirements for the transmitting and conducting properties of solar cell front surfaces were examined. This led to a design method which could evaluate transparent conductive layers, including various barrier formation methods and grid contact patterns. The method was used to test the effects of combining transparent conductive layers. The criteria used were directly related to solar cell performance; the methods outlined provide a consistent basis for evaluating and improving a wide range of cell designs. (Author)

A78-11065 **High efficiency thin window Ga/1-x/Al/x/As/ GaAs solar cells.** R. Sahai, D. D. Edwall, E. Cory, and J. S. Harris (Rockwell International Science Center, Thousand Oaks, Calif.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 989-992. 11 refs.

A78-11066 **Inversion layer silicon solar cells with 10-12% AM1 efficiencies.** C. E. Norman and R. E. Thomas (Carleton University, Ottawa, Canada). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 993-996. 8 refs. Research supported by the National Research Council of Canada.

Recent advances in the performance of native oxide inversion layer silicon solar cells are reported. The new cell design and fabrication process are presented, along with comparative I-V test results and C-V characterization of the Si - SiO2 system. A two dimensional computer model of the inversion layer structure is described and its calculated results compared with the cell measurements. The close agreement between theoretical predictions and measured performance obtained throughout the work indicate how nearly ideally the cells are operating. Possibilities for further improving the cell, to achieve 14-15% AM1 efficiencies in the near future, are outlined. The cell is concluded to be a potentially viable alternative to conventional solar cells. (Author)

A78-11067 **Rheotaxy for large grain thin film solar cell fabrication.** A. G. Milnes and D. L. Feucht (Carnegie-Mellon University, Pittsburgh, Pa.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 997-999. 12 refs.

A process, first described by Rasmanis (1963, 1964) for the growth of silicon layers on ceramic substrates glazed with oxide compounds, which are fluid at the temperature of Si growth, is studied with respect to possible applications in the case of GaAs and InP and other semiconductor layers on low cost substrates for solar cell uses. It is concluded, that the process, called rheotaxy, has considerable potential for the growth of large-grain-size thin-film material for good performance solar cells on low cost substrates. G.R.

A78-11068 **LaF3 solar cell.** A. Sher (College of William and Mary, Williamsburg, Va.). In: Photovoltaic Specialists Conference, 12th, Baton Rouge, La., November 15-18, 1976, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p. 1000-1002.

An investigation is conducted concerning the possibility to use the observed exponential temperature variation of the capacitance of a slab of LaF3 with thin metal electrodes on its surfaces for the direct conversion of solar energy into electrical energy. It is found that the maximum efficiency of the considered cells is at least 50%. Realizable efficiencies of about 25% appear possible. G.R.

A78-11069 **Energy development III.** New York, Institute of Electrical and Electronics Engineers, Inc., 1977. 176 p. Members, $10.00; nonmembers, $13.50.
to A78-11088)

Attention is given to the operation of MHD/steam systems, coal-based options for the generation of electricity, wind generator economics in a load duration context, solid waste utilization for electric power generation, and the storage of off-peak thermal energy in oil. Consideration is also given to hydrogen cycle peak shaving on the New York State grid using fuel cells, the Battery Energy Storage Test facility, air storage system energy transfer (ASSET) plants, solar energy and domestic heating needs in France, power generation in Canada, and the energy plantation as an energy alternative fuel-source. B.J.

A78-11070 **Dynamic modeling and control of magnetohydrodynamic/steam systems.** J. Aspnes (New Hampshire, University, Durham, N.H.) and D. A. Pierre (Montana State University, Bozeman, Mont.). In: Energy development III.
New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 7-15. 12 refs. Contract No. E(49-18)-1811.

Dynamic characteristics of magnetohydrodynamic (MHD)/steam electrical power generating plants are investigated, as are control requirements for desirable system response. A dynamic computer model of the MHD/steam combined cycle is developed. Representative computer simulation results showing the effects of various control configurations are given, including a quasi-optimized response based on minimizing integral-square error of actual system output compared with desired output. (Author)

A78-11071 **Coal-based options for generation of electricity.** W. B. Harrison (Southern Company Services, Inc., Birmingham, Ala.). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 16-19.

Upon reviewing the outlook for availability of energy resources in the next few decades, it is concluded that generation of electricity must be based to a large degree on coal and coal-derived fuels. Of the choices for using coal and coal-derived fuels in this application, the prospect of using solvent refined coal is one of the most attractive. In view of the attractiveness of this fuel and the current status of production technology, it is concluded here that solvent refined coal is ready for commercialization and that it is in the national interest to develop commercial production facilities as soon as possible. (Author)

A78-11072 **Corporate research and development in alternate energy.** S. W. Herman and J. S. Cannon (INFORM, New York, N.Y.). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 20-24.

The current status of the corporate role in the development of alternate energy sources is reviewed. The role of different government agencies is surveyed and four stages toward the commercialization of alternate energy are examined: (1) exploratory research, (2) the pilot plant stage, (3) the demonstration plant stage, and (4) the commercial plant stage. Depletion resources - coal gasification and liquefaction, oil shale processing, and geothermal energy are discussed along with man-made renewable resources - trash-to-energy systems - and inexhaustible resources - solar heating and cooling, solar photovoltaic conversion, solar-thermal, ocean-thermal and wind conversion and fusion. B.J.

A78-11073 **Evaluation of wind generator economics in a load duration context.** B. W. Jones and P. M. Moretti (Oklahoma State University, Stillwater, Okla.). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 25-29.

Wind generators used without energy storage are usually considered to compete with other generation facilities on the basis of the average incremental cost of generation. This approach can significantly underestimate the actual competitiveness of the wind generators. By analyzing the effect of the wind generators on the remaining load characteristics for an electric utility's generation system, they are shown to affect the required investment in other generation facilities considerably more than they affect operating costs. (Author)

A78-11074 **The utilization of solid wastes for the generation of electric power.** S. Meyers and D. B. Sussman (U.S. Environmental Protection Agency, Washington, D.C.). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 30-33. 10 refs.

The concept of energy recovery from municipal solid waste has become popular with rising energy prices and increasing problems with conventional means of waste disposal. Three basic methods of thermal processing are currently being used in this country for the recovery of energy from municipal solid waste. They are: direct combustion in a grate-fired steam generator, mechanical processing of the organic fraction into a fuel that can be used in a suspension-fired steam generator, and pyrolysis. This paper describes the systems broadly and indicates their developmental status. Efforts at energy recovery seem to be progressing well in view of the technological and marketing problems involved. (Author)

A78-11075 **The present status of fusion power.** F. R. Scott (Electric Power Research Institute, Palo Alto, Calif.). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 42-47. 8 refs.

The present status of the national fusion program is presented in terms of a research goal, the reactor core performance and a development goal-production of average fusion power. The basic conditions and current methods for producing the fusion reactor core are examined including alternate methods and fuels. A discussion of the utility requirements for fusion power as contrasted to the present national goal of a fusion power demonstration plant is also included. (Author)

A78-11076 **Control and dynamic analysis of a wind energy conversion and storage system operating at constant velocity ratio.** H. R. Simkovits and J. G. Kassakian (MIT, Cambridge, Mass.). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 48-55.

A wind energy conversion and storage system operating at constant velocity ratio is proposed and analyzed. Lead-acid batteries are used for energy storage and consideration is given to the number of battery sections required to produce efficient operation of the windmill. A charge control algorithm is developed and the system energy extraction efficiency calculated. System dynamics caused by both windspeed transients and battery switching are investigated. Optimum values of field time constants are determined. (Author)

A78-11077 **A forecast of electric power generation technology - 1975-2000.** L. G. Hauser (Westinghouse Electric Corp., Pittsburgh, Pa.). In: Energy development III.
New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 56-63. 9 refs.

Power generation consists of two separate components; (1) an energy source and, (2) suitable conversion equipment to utilize the energy source. Combined they are known as an energy system. Today the United States has 19 different energy sources which are technically available for power generation, and 12 different types of conversion equipment which are technically feasible. Matching the energy sources with suitable conversion equipment results in a total of 53 energy systems. The present state-of-the-art consists of 12 energy systems which are technically and economically feasible. The remaining 41 energy systems are assessed on the criteria of economics, reliability, national energy policy and environmental impact. The current status of development and potential future progress are reviewed in the paper. The results of this review indicate that 12 new energy systems have good potential to become economically competitive for power generation during the next 25 years. (Author)

A78-11078 Storage of off-peak thermal energy in oil. R. P. Cahn (Exxon Research and Engineering Co., Linden, N.J.) and E. W. Nicholson (Exxon Enterprises, Inc., New York, N.Y.). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 86-91. 8 refs.

The excess thermal energy from a constantly operating nuclear reactor and boiler is stored in oil during off-peak periods and recalled during high demand periods. Atmospheric pressure tankage can be used. Storage is accomplished during off-peak hours by reheating cool oil with various levels of extraction steam as well as high pressure steam, reducing turbine output. During high demand, use of any steam for BFW preheating - and steam reheating if desired - is discontinued, and the heating functions are taken over by the stored hot oil. The turbine output can be increased approximately 25% over normal levels as a result of the added availability of steam at various pressure levels. State-of-the-art technology is applicable to all phases of this system. Economics based on extensive studies of alternate energy storage schemes indicate that this system is comparable to pumped hydro and compressed air without the site restrictions which control the location of these alternates. (Author)

A78-11079 The battery energy storage test /BEST/ facility - Its purposes and description. J. W. Beck (Electric Power Research Institute, Palo Alto, Calif.) and J. C. Smith (ERDA, Washington, D.C.). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 101-107.

The BEST facility has been designed for testing and evaluating batteries for load leveling applications (storage of low-cost energy for use during peak-energy-demand hours) in electric utility systems. The objectives of the facility are to provide the necessary independent test data over a wide range of operating modes to verify expected battery system performance, and to permit careful comparison of different advanced battery systems under nearly identical test conditions. The parameters of primary importance in the specification of the design of the BEST facility are the dc bus voltage, the battery system capacity, the number of test bays and the data acquisition system. B.J.

A78-11080 Evaluation of offshore site for wind energy generation. H. S. Kirschbaum, E. V. Somers (Westinghouse Electric Corp., Pittsburgh, Pa.), and V. T. Sulzberger (Public Service Electric and Gas Co., Newark, N.J.). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 108-114. 5 refs.

An analysis of the potential for wind generation at an offshore site indicates a potential in excess of 5700 kWh/kW for a 1MW windmill rated at 20 mi/h and a hub height of 235 feet. The preliminary economics of the application of wind power, as a limited supplement to base loaded nuclear and other forms of generation, appears to offer enough promise such that a more serious study is warranted to determine the overall economic, technical, and environmental feasibility of such an application. In addition some of the statistical properties of the wind at the offshore site have been analyzed. (Author)

A78-11081 Air Storage System Energy Transfer /ASSET/ plants - A utility's evaluation. R. Beckwith (Commonwealth Edison Co., Chicago, Ill.) and Z. S. Stys (Brown Boveri Corp., North Brunswick, N.J.). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 115-123.

This paper is composed of two parts. The first is a review of the aspects of the Air Storage System Energy Transfer (ASSET) being built at Huntorf, Germany. The second is a discussion of how an ASSET facility would fit into the operations of an electric utility in the United States. (Author)

A78-11082 Coal desulfurization by the Battelle Hydrothermal Coal Process. E. P. Stambaugh, J. F. Miller, S. S. Tam, S. P. Chauhan, H. F. Feldmann, H. E. Carlton, J. F. Foster, N. Nack, and J. H. Oxley (Batelle Columbus Laboratories, Columbus, Ohio). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 124-127.

A process for chemical cleaning of coal prior to combustion is the Battelle Hydrothermal Coal Process. This process not only competes favorably on an economic scale with other desulfurization processes, but it also has significant technological advantages. The Battelle Hydrothermal Coal Process should produce no significant amount of sludge for disposal. Its primary end products are clean solid fuel and elemental sulfur - which can be marketed or easily stored - and potentially recoverable metal values. In addition, the Battelle Hydrothermal Coal Process, or modifications of the process, has the potential for producing improved feedstocks for gaseous and liquid fuels and for producing coal solutions which could be a source of coal chemicals. (Author)

A78-11083 The Gas Turbine HTGR plant with a binary cycle. T. W. Schoene, J. M. Neill, and R. L. Cummings (General Atomic Co., San Diego, Calif.). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 128-134. 5 refs.

The Gas Turbine High-Temperature Gas-Cooled Reactor (GT-HTGR) is characterized by the high temperature at which it rejects heat from its primary helium cycle. In addition to other advantages inherent in the concept, the high-temperature reject heat permits economical dry cooling, or alternatively, allows additional electric power to be produced from the waste heat. This paper concentrates on the binary-cycle version of the plant, which uses ammonia as the working fluid to convert waste heat to electricity. The paper discusses design improvements that significantly increase plant efficiency and reduce the cost of generating power. The GT-HTGR plant can achieve approximately 50% net station efficiency. Design improvements have reduced power generating costs by over 30% compared with previously reported GT-HTGR designs. This translates directly into increased cost incentives compared with competing power plant concepts. (Author)

A78-11084 Theoretical method to determine monthly efficiency of flat plate solar collectors. P. Chouard, H. Michel, and M. F. Simon (Electricité de France, Paris, France). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 135-141. 7 refs.

From the well known flat plate solar collector instantaneous efficiency, this paper presents a practical method for calculating solar heating projects. It computes the energy flowing out of a flat plate collector over a year and predicts the energy savings due to solar collectors use. (Author)

A78-11085 Solar energy and domestic heating needs. M. F. Simon and H. Michel (Electricité de France, Paris, France). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 142-146. 5 refs.

A French project (five solar houses at Aramon and five at le Havre) has demonstrated the compatibility of solar energy with domestic heating needs. This paper describes the Aramon and le Havre project and gives attention to the diurnal, seasonal and annual adaptation of solar energy to house heating needs. Consideration is also given to solar collectors, the storage tank, and heat distribution. B.J.

A78-11086 **Some problems concerning solar cell arrays in the design of solar-electrical systems.** *D. Biran and A. Braunstein (Tel Aviv University, Tel Aviv, Israel).* In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 147-150.

Solar cell arrays are nowadays of more interest while designing solar-electrical systems. Usually solar cell arrays can be installed either horizontally or tilted at a permanent worst-case angle. Another possibility is installation at a certain angle corrected on a monthly or other periodical basis. Another important factor in determining the power output of the array, is the environmental conditions in the location of the installed array. In this paper, the above mentioned problems are discussed, and experimental results obtained in Israel during some years of operation are presented. The theoretical and experimental results obtained in Israel during some years of operation are presented. The theoretical and experimental results point out some guidelines for optimum operational conditions of solar cell arrays. (Author)

A78-11087 ***The potential for application of energy storage*** **capacity on electric utility systems in the United States. II.** V. T. Sulzberger and J. Zemkoski (Public Service Electric and Gas Co., Newark, N.J.). In: Energy development III. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 151-159. Research sponsored by the Electric Power Research Institute and ERDA.

A systems analysis is used to evaluate energy storage systems which may be suitable for electric utilities. Maximum on-peak energy and power requirements capable of being supported by base-load supplied, off-peak energy are established along with the distribution on a seasonal, weekly, and daily basis. Maximum energy storage power capacity which may be supported by available off-peak energy is obtained based on an analysis of the relationship among several on-peak and off-peak characteristics. Duty cycle parameters (including charge and discharge times, charge into discharge power ratios, operating time and frequency, and required storage capability) are defined for the supportable energy storage capacity. Attention is given to the effect of the overall energy storage system efficiency on the amount of supportable on-peak energy storage capacity. S.C.S.

A78-11089 **Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, University of Missouri-Rolla, Rolla, Mo., October 12-14, 1976.** Conference sponsored by the Missouri Energy Council and University of Missouri-Rolla. Edited by J. D. Morgan (Missouri-Rolla, University, Rolla, Mo.). North Hollywood, Calif., Western Periodicals Co., 1977. 841 p. $59.50.

Several subjects related to energy were discussed for the purpose of providing social scientists, scientists, and engineers a means for rapid communication of their most recent research and to offer solutions to the energy related problems of local government, business, industry, and the general public. Topics include energy exploration, energy management, wind and solar energy, chemical energy, alternate energy sources, wind and solar energy, energy and the environment, nuclear power, energy from solid wastes, energy systems, bioconversion, building energy usage, and demand metering and rate design. M.L.

A78-11090 **Devonian - Ohio Shale productive potential.** W. M. Hennington (Mitchell Energy Corp., Houston, Tex.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 31-39. 26 refs.

The Devonian - Ohio Shale has tremendous producible hydrocarbon reserves that can currently be located and produced by slightly modified exploration, development and bore hole stimulation techniques. Drill site selection utilizing depositional structural relationships to locate the natural compaction fracture reservoir could improve productivity. The Devonian - Ohio Shale is significantly different from the Western Oil Shale since it has primary oil and gas production. This hydrocarbon source could substantially contribute to short term energy needs and the Self Help Energy Program. (Author)

A78-11091 **Hydraulic container pipelining - A future transportation system to conserve energy.** H. Liu and D. L. Gibson (Missouri-Columbia, University, Columbia, Mo.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 48-53. 15 refs.

Hydraulic container pipelining (HCP), a proposed energy-conserving transportation system, is described with attention to its energy intensiveness. Water or another fluid would move containerized cargoes through a pipe whose diameter is 10 - 20% larger than the container diameter; thus HCP is a liquid-using counterpart of the pneumatic tube. When a collar is fitted to the nose of the container in a certain way, the container will move in a 'nose-up' position at a small angle of attack. This orientation increases the hydrodynamic lift on the container so that containers whose density is greater than that of water will be lifted off the pipe surface as they move. It is thought that HCP would cause less environmental pollution than other transportation systems. If coal is transported in containers, water used for coal slurries would be conserved. Before HCP can become practical, improved pumping and cargo injection procedures are required. M.L.

A78-11092 **An analysis of optimum loading conditions for P-N junction solar cells.** R. C. Durbin and J. A. Counsil. In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 75-80.

An analysis of the voltage-current characteristics of a p-n junction solar cell yields an expression for the load resistance at which maximum power transfer occurs. Variations in the parameters which affect the maximum power transfer point are discussed. A means of matching the load to the internal solar cell resistance is explained. Application of the matching system to Electrolysis Cells is discussed. (Author)

A78-11093 **Computer aided design of a continuous duty energy system.** A. H. P. Swift, Jr. (Washington University, St. Louis, Mo.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 81-90. 6 refs.

In many areas of the United States, the average monthly solar and wind energy density profiles complement each other, which suggests utilization of a power system that employs both solar and wind energy. This paper addresses the problem of identifying these areas from weather data, developing a computer-aided method for the design of such combined solar and wind systems, and examines the economics of combined systems as compared to solar or wind only systems. (Author)

A78-11094 **The design of passive solar heating systems.** G. L. Moore (Missouri-Columbia, University, Columbia, Mo.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 91-95. 7 refs.

The quoted definition of a passive solar system is that it ... utilizes the sun's radiant energy for heating and natural processes for cooling, with only negligibly small requirements for nonrenewable energy'. Passive systems are contrasted with the 'hardware-happy' approach which seeks maximum energy output while ignoring architectural design features which would reduce energy requirements by minimizing summer overheating of the structure. The Wright approach, Hay's skytherm system, and the Thomason Solaris system are cited as passive solar systems. Other topics considered include harmony with the environing elements, efficient supplemental heating, and structural thermal storage. M.L.

A78-11095 **Utilization of waste heat from electric power generation.** D. A. Barclay and J. L. Gaddy (Missouri-Rolla, University, Rolla, Mo.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976.
North Hollywood, Calif., Western Periodicals Co., 1977, p. 104-111. 11 refs.

It is suggested that waste heat from the generation of electricity could supply all of the U.S. space heating needs so that the U.S. would become energy independent. Energy rejected in cooling water in 1975 is estimated to represent 13% of the total U.S. energy consumption, while total conversion losses amounted to 20%. Various uses of low level heat and of high level heat are considered. Necessary conditions for a practical waste heat system are stated, and an economic analysis is presented which suggests that district heating could be economical at present energy prices. The system considered would complement a 1000 MW fossil-fueled generating system. M.L.

A78-11096 **Application of special fluidized bed techniques to coal gasification.** G. K. Patterson (Missouri-Rolla, University, Rolla, Mo.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976.
North Hollywood, Calif., Western Periodicals Co., 1977, p. 122-128. 6 refs.

The design of fluidized bed coal gasifiers is discussed with attention to the effects that can be produced by the insertion of various types of internal structures. These structures can include screens of all types and orientations, baffles both horizontal and vertical, and heat transfer surfaces. Design equations for bubbling bed and baffled bed designs are examined. Advantages of the baffled bed include: more staging to allow greater temperature gradient in the bed upper zone for pretreatment of fresh coal; improved operability because of less slugging and bed height variation; greater conversion of gas/bed height because of greatly improved contacting; and improved carbon conversion. Projects for future research are suggested. M.L.

A78-11097 **The status of and need for new coal gasification technology.** J. R. Bowden (Conoco Coal Development Co., Stamford, Conn.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976.
North Hollywood, Calif., Western Periodicals Co., 1977, p. 129-134.

The economics and development of coal gasification technology are discussed. Processes considered include the CO2 acceptor, the steam-oxygen Hygas, the COGAS, and the British gas/Lurgi slagging gasifier. It is thought that high Btu gas from any new process likely to be available for commercial production by 1990 will be only slightly cheaper than presently available Lurgi technology usable on most coal reserves west of the Mississippi. It is suggested that, at this time, it is wiser to use coal to generate power instead of gas. M.L.

A78-11098 **Technoeconomic aspects of photovoltaic electric power systems /PEPS/.** J. O. Bradley and D. R. Costello (Midwest Research Institute, Kansas City, Mo.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 135-145.

The economic feasibility of central photovoltaic power plants is investigated from the perspective of an electric power utility company. The maximum acceptable price of the system is established, as a function of conventional fuel costs. Factors which would enhance the economic attractiveness of the system are analyzed. These include: increases in conventional fuel costs, decreases in photovoltaic system costs and subsidies to attract utility companies. (Author)

A78-11100 **Economic analysis of wind generation and energy storage for electric utility systems.** B. W. Jones and P. M. Moretti (Oklahoma State University, Stillwater, Okla.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 255-263.

A78-11101 **Innovative wind turbines.** R. E. Walters, J. B. Fanucci, J. L. Loth, W. Squire, P. G. Migliore, and R. Huq (West Virginia University, Morgantown, W. Va.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 268-275. NSF Grant No. AER-75-00367-000; Contract No. E(40-1)-5135.

Two types of wind energy turbines are described. The vortex concentrator is a device which creates a strong vortex in the ambient wind. The energy per unit area in the vortex region is much higher than for the undisturbed wind. The vertical axis wind turbine uses straight blades composed of airfoil shapes having high efficiency. High efficiency is attained by using circulation controlled airfoils for the blades; these airfoils contain slots near the rounded trailing edges through which a small amount of compressed air is blown to obtain high lift forces. Theoretical and experimental studies of the two systems are reported. M.L.

A78-11102 **A detailed analysis of the environmental effects of energy utilization in the U.S. economy.** H. J. Plass, Jr. (Miami, University, Coral Gables, Fla.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 368-380. 10 refs.

The total environmental social cost resulting from the consumption of various fuels used in the U.S. economy is analyzed by means of an equilibrium model including flows of energy, labor, goods, services, undesirable effects attributable to pollution, and pollution control services. The present mix of fuels, and three alternative fuel mixes more strongly dependent on coal, are analyzed by means of the model. (Author)

A78-11104 **Solar energy utilization and resource recovery application in space heating.** P. Kokoropoulos and R. Bollini (Southern Illinois University, Edwardsville, Ill.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 410-417. 17 refs.

This paper describes a hybrid system consisting of solar flat plate collectors and resource recovery system which is being proposed for space heating of a moderate sized building. The procedure for calculating the size of the solar system is outlined. Methane produced from the University's wastewater treatment plant is used for supplementary heat for space heating and for waste reduction. The use of such a hybrid system results in the conservation of significant amounts of fossil fuels. Economics of the proposed system are also outlined. (Author)

A78-11105 **Design of a large solar heating system for a campus complex of buildings.** J. R. Schneider and S. F. Glover (Sverdrup and Parcel and Associates, Inc., St. Louis, Mo.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 418-426. 5 refs.

The design program is presented describing the world's largest central solar heating system developed for the Saudi Arabian Government. Domestic hot water and building space heating is provided for a campus complex of fourteen buildings. Feasibility studies through the final design are discussed. (Author)

A78-11106 **A solar energy system for domestic hot water.** T. J. McNamara (V. A. Scavo and Associates, Chicago, Ill.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 427-436.

The design, operation, and domestic hot water heating performance of a solar energy system are described. This system is to be retrofitted and integrated into the existing conventional mechanical system at a large museum, where it is not only expected to provide substantial fuel cost savings but is also planned to serve as an exhibit of an actual working solar energy system. The estimated average annual net collected solar energy for solar system, the net usable average annual solar energy for the solar system, and the estimated percent annual solar energy contribution toward hot water heating are calculated. M.L.

A78-11107 **Developing an experimental oil shale mine.** S. Utter (U.S. Bureau of Mines, Denver, Colo.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 471-474.

The development of an experimental oil shale mine facility is discussed with attention to the exploration program and hydrological investigation, the preliminary mine layout, and plans for the large-diameter bored shaft. The geology and core drilling and testing are described. Mining methods to be studied include chamber and pillar mining with spent shale backfill, sublevel stoping with spent shale backfill, sublevel stoping with full subsidence, and block-caving mining using load-haul-dump equipment. It is estimated that it will take about 4.25 years to prepare the mine and 4 years to test the various mining methods. M.L.

A78-11108 **MHD generators for baseload power stations.** L. E. Ring and G. W. Garrison (ARO, Inc., Arnold Air Force Station, Tenn.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977; p. 559-567. 7 refs. ERDA-sponsored research.

The expected use of coal-fired baseload plants for power generation indicates the need for an efficient pollution-free system capable of operating on high-sulfur coals. In the present paper it is shown that an MHD system operating on coal can meet these requirements and can provide an overall efficiency of conventional steam power plants. The envisaged baseload MHD power plant consists of a combuster (operating at approximately 5 atm and 2800 K, using coal and preheated air); an MHD generator channel inside a superconducting magnet; a diffuser; an air preheater; and a steam generator, with the steam utilized in a conventional steam turbine. V.P.

A78-11109 **Superconducting energy storage development for electric utility systems.** R. D. Turner, H. J. Boenig, and W. V. Hassenzahl (California, University, Los Alamos, N. Mex.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 568-578. 7 refs. ERDA-sponsored research.

High load factors are desirable goals for all electric utilities to reduce the total power generation cost. Superconducting Magnetic Energy Storage (SMES) technology has progressed to the point where it shows promise as an alternate energy-storage method to pumped hydrostorage for improving electric-utility load factors. Experiments indicate that a SMES system responds quickly (i.e., in milliseconds) to power-system demand and has a high energy-storage efficiency. The next-generation superconductors suitable for larger SMES units are discussed, component and system test results are presented, and some energy-storage experiments involving a 100-kJ coil and twelve-pulse converter interfaced with an ac power system are described. (Author)

A78-11110 **Feasibility of integrated ocean thermal gradient-nuclear plants for the production of electrical power.** F. Ferrer and D. Sasscer (University of Puerto Rico, Mayaguez, P.R.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 611-616. 18 refs.

A study was made of the feasibility of integrating an ocean thermal energy conversion (OTEC) electrical power plant with a nuclear power plant. The integration was such that the waste heat of the nuclear plant was used to augment the thermal efficiency of the OTEC plant. The study was performed for three shore line sites of Puerto Rico where deep cold water is found between 2 and 10 miles from shore. (Author)

A78-11111 **ROEMMC subscript R Burner - High ash solid fuel combustion system.** J. L. Stafford (Guaranty Performance Co., Inc., Independence, Kan.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 617-624. 10 refs.

Many solid-waste disposal problems have been lately recognized as fuel sources. Few of these potential fuels are normally available in a clean (low ash) dry state, and those that do demand premium price. The ROEMMC subscript R Burner system provides fuel preparation (drying and size reduction) and combustion with dry ash separation (no slag). Technologies developed for earlier solid combustion systems are combined with inertial separation of solid-gas mixtures and applied to energy recovery from inexpensive solid residue. Operational performance data are presented. (Author)

A78-11112 **Hazardous wastes and energy recovery.** J. Eigner and M. M. Clark (Missouri Department of Natural Resources, Jefferson City, Mo.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 625-631. 16 refs.

Two general avenues to ecologically sound disposal of hazardous and toxic industrial wastes are probed: recycling of the effluent waste stream as feed to a different industry or similar industry: use of trash-to-energy recovery systems for efficient incineration of hazardous wastes. Wastes under consideration include: waste oils (lubricants, heating oils), solvents, plastics, rubber tires, paints, drugs, diverse chemicals. Energy potential (BTU) in the wastes, corrosion problems, and form in which available are considered, along with estimated quantities of wastes generated. Recovery of valuable entrained materials, use as fillers, as feedstock, compositions of representative waste streams, and toxicity of waste combustion off-gases are dealt with. R.D.V.

A78-11113 **The environmental effects and economic costs of solid waste energy recovery.** J. P. Collins (U.S. Navy, Naval Facilities Engineering Command, Norfolk, Va.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 632-638. 5 refs.

Environmental and economic impacts of solid waste energy recovery systems are discussed. Emphasis is given to the Navy Salvage Fuel Boiler facility in Norfolk, Virginia. Built in 1967, it is the first waterwall steam generating facility to use solid waste as a fuel in the United States. Nine years of operational data reflect national trends in energy recovery costs and environmental problems. Steam generation costs, environmental compliance costs and facility environmental impacts are discussed. (Author)

A78-11114 **Modular incinerator energy recovery systems - The Siloam Springs experience.** J. Pearson (John Brown University, Siloam Springs, Ark.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 646-653.

The City of Siloam Springs, Arkansas has installed and is operating an 18 ton per day solid waste disposal facility with associated energy recovery equipment. The solid waste system serves a population of 8000 and provides steam for a local food processing plant. Natural gas amounting to 1 MCF per ton is used for auxiliary fuel. Energy recovery capacity is 90,000 pounds of steam per day at 100 to 150 PSIG. (Author)

A78-11116 **Biomass as an energy mechanism.** E. C. Clausen, O. C. Sitton, E. L. Park, and J. L. Gaddy (Missouri-Rolla, University, Rolla, Mo.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 670-678. 26 refs.

Laboratory studies at the University of Missouri-Rolla have demonstrated the feasibility of producing methane by anaerobic digestion of various crop materials, such as grasses and corn stalks. These studies indicate that about 6.0 scf of methane are produced per pound of crop material destroyed. Preliminary design and economic studies of a large methane plant show that the reactors represent the largest cost item and that efforts should be concentrated on defining reaction kinetics and reactor design. This paper discusses various approaches to reactor design. A process to produce 50 MSCFD of methane is described, and the design and economics are analyzed. (Author)

A78-11117 **Thermal processing of biomass materials.** D. E. Garrett (Garrett Energy Research and Engineering Co., Inc., Claremont, Calif.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 679-683. Contract No. E(04-3)-1241.

A cursory overview is presented of research on biomass utilization in energy recovery. Wood pyrolysis, suitable chemical reactors, processing of cellulose and pulp, and treatment of municipal solid wastes and sewage sludge and the literature on them are discussed briefly. Required preprocessing of the process feedstock, presence of a drying/evaporating step in the process, and absence of workable solutions on extraction of heat/energy from off/gas streams are pointed out as crucial problems. Attention is given to cost and profitability. R.D.V.

A78-11118 **Comparative residential energy consumption and fuel costs with various types of systems - Oil-, gas-, electric-furnaces and heat pumps.** R. H. Howell and H. J. Sauer, Jr. (Missouri-Rolla, University, Rolla, Mo.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 706-714.

The electric air-to-air heat pump for residential heating offers an economic alternative to systems traditionally used extensively for home heating, such as, oil or gas fired furnaces and electric resistance heat. This simulation analysis showed that using 1976 mid-Missouri fuel costs, an oil fired furnace was the least expensive to operate of the three traditional type residential heating units. LP gas heating was 19% higher than oil heat while electric resistance heating was 26% higher in cost than oil. The typical air-to-air heat pumps showed a 29% reduction in the heating bill when compared to an oil furnace. (Author)

A78-11119 **The impact of solar central electric technology on the regulated utility.** D. A. Murray (Oklahoma, University, Norman, Okla.). In: Energy crisis: An evaluation of our resource potential; Proceedings of the Third Annual UMR-MEC Conference on Energy, Rolla, Mo., October 12-14, 1976. North Hollywood, Calif., Western Periodicals Co., 1977, p. 768-776. 18 refs.

Scale-up of the generation of electric power from solar energy to pilot-plant level is discussed. The 'framework in which the solar central electric technology will likely be developed' is outlined, admittedly without any 'detailed engineering cost estimates of specific plants.' The pro forma impact of pilot plant designs for a proposed (Hobbs, New Mexico) solar central on the local utility is discussed. Regulatory or other provisions likely to encourange economically optimal integration of solar energy facilities into the public utility grid are examined. R.D.V.

A78-11120 **Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977.** Symposium sponsored by the Institute of Gas Technology. Chicago, Ill., Institute of Gas Technology, 1977. 528 p. $40.

The use of biomass and wastes as a source of fuel is studied, with attention given to land requirements of biomass plantations, the application of forest biomass to energy production, hydrogen production through photolysis, ethanol-gasoline automotive fuels, the conversion of solid-waste cellulose to glucose, genetic engineering to improve plant photosynthesis rates, and the operation of a 100,000-gallon anaerobic digester to treat municipal solid wastes. Other topics discussed include the design of a compact reactor to produce methane from solid wastes, the efficiency of several pyrolytic processes, the gasification of biomass and wastes with a rotary kiln, the production of methane through fermentation of microalgae in waste water treatment ponds, and the culture and processing of waterhyacinths. J.M.B.

A78-11121 **Biomass and wastes as energy resources - Update.** D. L. Klass (Institute of Gas Technology, Chicago, Ill.). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 1-28. 20 refs.

Technological developments facilitating the conversion of biomass to fuels and chemicals in desirable forms are reviewed. Topics considered include the design of an ideal synthetic fuel plantation, methods for calculating the net energy production of hypothetical biomass plantations, the economics of substitute natural gas, and the competition between agriculture and biomass plantations for available land. Various conversion processes, such as incineration, pyrolysis, hydrogenation, chemical and enzyme hydrolysis and fermentation, are mentioned. Comparisons are made between the heating values of biomass, wastes and coal, and the conversion efficiencies of several types of municipal refuse-to-steam systems are considered. The use of wood as fuel for electric power generation and for the production of ethanol, furfural and phenol is also discussed. J.M.B.

A78-11122 **Biomass as a long range source of hydrocarbons.** W. W. Waterman and D. L. Klass (Institute of Gas Technology, Chicago, Ill.). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 29-48. 10 refs.

Coal and petroleum resources of the U.S. are examined, and possible future sources of hydrocarbons, including biomass, wastes and carbon dioxide extraction from stack gases, are considered as replacements for domestic fossil fuel reserves, which may be exhausted within a century. The amount of land needed to produce biomass fuels is estimated; to obtain 4223 trillion Btu equivalents, it is suggested that 56,000 square miles of land may be required for biomass plantations. Processes for the conversion of biomass to fuels and energy, including combustion, pyrolysis, partial oxidation, and catalytic gasification are reviewed. Problems associated with the large-scale use of biomass, such as selection of plant types and development of efficient harvesting methods and conversion processes, are also mentioned. J.M.B.

A78-11123 **Waterhyacinth biomass yield potentials.** E. S. Del Fosse. In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 73-99. 176 refs.

Emphases in waterhyacinth research have been on control of the plant (chemical, biological, cultural and integrated) or on aspects of waterhyacinth biology and distribution. Several countries have begun to investigate the use of waterhyacinth as animal food, silage, soil additives, and as a source for alcohol, protein, methane and paper. If an economic usage can be found for waterhyacinth, plant abundance and cost of cultivation and harvesting will be of prime importance. Solutions in which waterhyacinth has been successfully grown are reviewed, and the effect of water quality on the plant is discussed. Optimum growth conditions are summarized, including both chemical and physical parameters. Mean mineral and carbohydrate content of waterhyacinth are derived from data collected over the entire world. Theoretical considerations for maximizing waterhyacinth growth potential are discussed. Over 60 metric tons of waterhyacinth per acre may be harvested under ideal conditions. (Author)

A78-11124 **A systems analysis of bioconversion with microalgae.** J. R. Benemann, B. L. Koopman, D. C. Baker, J. C. Weissman, and W. J. Oswald (California, University, Berkeley, Calif.). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 101-126. 57 refs. NSF Grant No. AER-76-10809; Contract No. E(04-3)-34.

The production of methane through fermentation of microalgal biomass in waste water treatment ponds is discussed. Problems in harvesting the microalgae, related to straining and sedimentation techniques and the selective cultivation of larger, filamentous or colonial algae through mechanical enrichment (size-specific recycling) or nutrient limitation (nitrogen fixation), are considered. In particular, the use of a large-scale microstrainer to achieve algal species selection is mentioned. Biophotolysis, the production by algae of hydrogen and oxygen from water, is also described. It is suggested that by employing all available liquid wastes and enriching ponds with carbon dioxide, a combined waste treatment-algal biomass conversion system could supply 10% of a locality's methane requirements. J.M.B.

A78-11125 **Potentials of hydrogen production through biophotolysis.** L. O. Krampitz (Case-Western-Reserve University, Cleveland, Ohio). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 141-151. Research supported by Ethyl Corp.

A two-stage biophotolysis system for the production of hydrogen and oxygen by algae is described. Working in series, the two stages of the photosynthetic apparatus cleave water to form oxygen and electrons, then produce hydrogen through catalysis. In the system considered, a species of blue-green algae is employed to cleave water, placing the electrons at a favorable potential for the reduction of protons. The coupling of the photosynthetically reduced electron receptor triphosphopyridine nucleotide with a bacterial hydrogenase system produces the hydrogen. The hydrogenase system of a non-sulfur bacterium is used to overcome the thermodynamic barrier to hydrogen production. It is suggested that the two-stage system has advantages in terms of ease of gas collection. J.M.B.

A78-11126 **Energy and materials from the forest biomass.** J. F. Saeman (U.S. Forest Service, Forest Products Laboratory, Madison, Wis.). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 153-168. 11 refs.

The contribution of forests to reducing U.S. dependency on foreign energy sources is discussed, with mention made of the direct application of wood residues as fuel and the conversion of forest products to ethanol, furfural, methanol, formaldehyde and phenol, as well as to indirect savings resulting from the use of conventional forest products instead of more energy-intensive alternatives. It is suggested that energy available from unused but accessible manufacturing and logging wastes could produce two times ten to the 15th power Btus per year, amounting to a 3% contribution to the national energy budget. Environmental problems associated with the handling and burning of wood residues are held to be minimal. However, the chemical or biochemical conversion of forest biomass appears at present to involve high capital costs and low profits. J.M.B.

A78-11127 **Trees as a renewable energy resource.** R. L. Jamison (Weyerhaeuser Co., Tacoma, Wash.). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 169-183.

Sources of forest biomass for energy conversion, including manufacturing wastes, post-consumer paper and wood wastes, forest residuals and energy plantations, are discussed. At present, wood products industries obtain about 45% of their energy from manufacturing wastes; technical and economic barriers may limit the amount by which this percentage can be increased. In the area of post-consumer waste processing, the choice between recycling or burning paper and wood products is considered. The use of forest residuals for energy is shown to be economic under certain circumstances. Forest energy plantations, however, are not presently economic and may become even less so due to rising demand for wood products and shortages of timber. J.M.B.

A78-11128 **The use of ethanol-gasoline mixtures for automotive fuel.** W. A. Scheller (Nebraska, University, Lincoln, Neb.). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 185-200. 9 refs.

The use of mixtures of grain alcohol (ethanol) and gasoline for automotive fuel is discussed. A mixture containing 10 liquid volume percent ethanol in unleaded gasoline is found to undergo a volume increase on mixing, to be compatible with a relatively low octane fuel, and to reduce fuel consumption to about 95% of that for unleaded gasoline. In addition, the ethanol-gasoline combination provides improved starting and better performance of the automobile during winter months, due to more efficient carburation and more complete vaporization of the fuel. The economics of producing the mixture and a net energy analysis of grain alcohol production also favor introduction of the combination fuel. J.M.B.

A78-11129 **Utilization of waste cellulose for production of chemical feedstocks via acid hydrolysis.** W. Brenner, B. Rugg (New York University, New York, N.Y.), and C. Rogers (U.S. Environmental Protection Agency, Solids and Hazardous Waste Research Div., Cincinnati, Ohio). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 201-212. 17 refs. U.S. Environmental Protection Agency Grant No. R-803664-01-2.

The conversion of solid-waste cellulose to glucose is discussed; pretreatment of cellulosic wastes through milling, radiation or chemical action, followed by high-temperature acid hydrolysis, is studied as a means of obtaining high glucose yields. In particular, a small-scale laboratory converter relying on hydropulping of newspaper, radiation pretreatment and acid hydrolysis was found to be capable of glucose yields of up to 50% of the cellulose values. An analysis of costs indicates that the system may be economically feasible on a larger scale. The anaerobic fermentation of glucose to methane instead of the manufacture of ethanol from glucose is also mentioned. J.M.B.

A78-11130 **Rotary kiln gasification of biomass and municipal wastes.** R. H. Hooverman and J. A. Coffman (Wright-Malta Corp., Ballston Spa, N.Y.). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 213-235. Research supported by the Empire State Electric Energy Research Corp., U.S. Environmental Protection Agency, New York State Energy Research and Development Authority, and ERDA.

A rotary kiln gasifier-gas turbine generator system for the clean, efficient recovery of energy from biomass and wastes is described. Solids and liquids combined are dried, pyrolyzed, and steam-gasified during slow passage through a continuous-feed, externally-heated rotary kiln. The low-Btu product gas fuels a gas turbine generator, and the turbine exhaust provides process heat for the gasifier. Neither shredding, classifying, nor preliminary drying of the charge is necessary. The steam-gasification chemistry has been demonstrated in a bench-scale, batch-feed kiln. Paper, wood, and municipal solid and sewage wastes have been gasified under various conditions of steam flow, temperature, pressure, and heating rate. The feasibility of low-temperature steam gasification and the optimum process conditions are presented. (Author)

A78-11131 **Pyrolysis of solid wastes for production of gaseous fuels and chemical feedstocks.** J. K. Coyne, III (Coyne Chemical Co., Philadelphia, Pa.). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 237-248.

Gas production from five typical pyrolysis reactions involving various process temperatures, energy expenditures, waste pretreatments, and furnaces is evaluated. The chief components of the pyrogas (in most cases hydrogen, carbon monoxide, carbon dioxide, and methane) are determined for each reaction. In addition to steam production from the pyrolytic processes, a pyrolysis gas conditioning system to provide maximum conditioned synthesis gas for ammonia manufacturing is considered. J.M.B.

A78-11132 **Ammonia synthesis gas and petrochemicals from cattle feedlot manure.** W. J. Huffman, J. E. Halligan (Texas Tech University, Lubbock, Tex.), R. L. Peterson (Texas Tech University, Lubbock; Fluor Corp., Houston, Tex.), and E. de la Garza (Texas Tech University, Lubbock; Celanese Corp., Corpus Christi, Tex.). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 249-277. 29 refs. Research supported by the Pioneer Corp., Texas Cattle Feeders Association, and Phillips Petroleum; U.S. Environmental Protection Agency Grant No. S-802934-01-4; Contract No. E(29-2)-3779.

The pyrolysis and partial oxidation of cattle feedlot manure are discussed in this paper. A description of the reactor, which has a throughput of one-half ton per day, and experimental results on the simultaneous production of 0.4-1.2 liter ammonia synthesis gas per gram of dry ash-free manure and 25-65 kg ethylene per metric ton of dry ash-free manure are given. A basis for the production of the ethylene and other petrochemicals is discussed along with recent results on the decomposition of intermediate tar and liquids. The application of process technology to other feedstocks, use of oxygen instead of air, and a discussion of different reactor designs are also presented. (Author)

A78-11133 **Chicago's new refuse disposal installation.** M. Suloway (Chicago, Dept. of Public Works, Chicago, Ill.). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 303-310.

A78-11134 **Syngas process converts waste to SNG.** H. F. Feldmann, G. W. Felton, H. Nack (Battelle Columbus Laboratories, Columbus, Ohio), and J. Adlerstein (Syngas Recycling Corp., Toronto, Canada). *(Hydrocarbon Processing,* Nov. 1976.) In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 311-321.

An experimental study of the production of raw gas containing substantial amounts of methane from municipal solid wastes is reported; the experimental system relies on a compact reactor scheme providing continuous production and short waste residence times. The system separates methane production from the gasification reaction zones, insuring that no methane is burned by oxygen or reformed by steam fed into the gasifier. Two types of reactor, employing either a free-fall or moving bed to segregate solids, are compared. The use of countercurrent gas-solids flow to recover heat from the raw product gases is also discussed. J.M.B.

A78-11135 **The anaerobic digestion of Macrocystis pyrifera under mesophilic conditions.** D. L. Klass and S. Ghosh (Institute of Gas Technology, Chicago, Ill.). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 323-351. 11 refs. Research supported by the American Gas Association, Institute of Gas Technology, and U.S. Navy.

The results of work done to study the anaerobic digestion of the giant brown kelp - Macrocystis pyrifera - in laboratory digesters at mesophilic temperatures are described. The primary objective of this work was to determine whether kelp could be digested over long periods of time under conventional conditions without the addition of external nutrients. It was concluded that kelp alone will sustain an enriched anaerobic culture under mesophilic conditions over extended periods without adding any external nutrients. The nutrients contained within the kelp are sufficient to promote the digestion process. A linear relationship was found to exist between volatile solids destruction in the feed and energy recovery as methane in the product gas up to about 50% volatile solids destruction levels. It is expected that at higher destruction levels, energy recovery in the gas will begin to plateau since at about 80% destruction levels, the experimental data indicate maximum energy recoveries. Kelp digestion is estimated from thermodynamic analysis to be slightly exothermic at mesophilic temperatures. The heat of reaction was projected to be about 249 Btu/lb of kelp reacted. (Author)

A78-11136 **Operating experience with large scale digestion of urban refuse with sewage sludge.** J. T. Swartzbaugh, J. W. Miller (System Technology, Inc., Hawthorne, Calif.), and C. C. Wiles (U.S. Environmental Protection Agency, Washington, D.C.). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 353-372. U.S. Environmental Protection Agency Contract No. 68-03-2105.

The operation of a 100,000-gallon anaerobic digester to treat slurried processed municipal solid waste was studied; the amount and quality of methane and solid fuel produced was measured, the dewaterability and fuel value of the digested effluent was determined, and the economic viability of the process was analyzed. The three-month pilot program involved a 3 to 1 organic residue to raw sludge blend ratio, and a 0.08 lb volatile solids per cubic feet per day loading rate. A similar experiment on the laboratory scale, which included post-digestion filtration trials, was also conducted. In addition, economic analyses of systems capable of handling 100 or 1000 tons of unprocessed solid waste per day were carried out. J.M.B.

A78-11137 **Two-phase anaerobic digestion.** S. Ghosh and D. L. Klass (Institute of Gas Technology, Chicago, Ill.). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 373-415. 39 refs. Research supported by the Institute of Gas Technology.

Research work aimed at developing a two-phase anaerobic digestion process is reviewed, and the advantages of the two-phase process over the conventional 'high-rate' processes are pointed out. The principal features of the concept of process optimization by phase separation are pointed out, and the various methods of physically separating the nonmethanogenic and methanogenic digestion phases in separate reactors are discussed. V.P.

A78-11138 **The economics of SNG production by anaerobic digestion of specially grown plant matter.** M. D. Fraser (InterTechnology Corp., Warrenton, Va.). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 425-439. 18 refs. Research supported by the American Gas Association; Grant No. DACA23-74-C-009.

The paper deals with the economics of a method of producing fuels by collecting and storing solar radiation in plants grown purposely for their fuel value. The plant material can be used as a solid fuel, or it can be converted into synthetic natural gas (SNG) by anaerobic digestion (which produces a mixture of methane and carbon dioxide, and biological cell matter). It is pointed out that about 175 million acres of waste land appear to be available in the United States for producing plant matter. Using the SNG production method proposed in the present paper, the yield from this area would amount to more than half of the total annual consumption of natural gas in this country. The necessary capital investment and the potential cost of the gas produced are seen to be competitive, and even better than, the cost associated with coal gasification. V.P.

A78-11139 **Environmental impact of solid waste and biomass conversion-to-energy processes.** S. J. Gage (U.S. Environmental Protection Agency, Office of Energy, Minerals, and Industry, Washington, D.C.) and R. A. Chapman (U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Cincinnati, Ohio). In: Clean fuels from biomass and wastes; Proceedings of the Second Symposium, Orlando, Fla., January 25-28, 1977. Chicago, Ill., Institute of Gas Technology, 1977, p. 465-482. 6 refs.

This paper presents a brief summary of the supply and demand outlook for solid waste and biomass-derived fuels through the year 2020. The majority of the paper is devoted to discussing the potential air, solid, and liquid emissions of environmental consequence from selected systems that are currently commercially available or in the final development stages for the production of useful energy from solid waste. Collectively, these systems are capable of producing steam, electricity, oil, and gas from solid waste or biomass. EPA's program in the 'Waste-as-Fuel' technology development and environment assessment area is also discussed. (Author)

A78-11140 **Materials and energy from refuse; Proceedings of the First International Symposium, Antwerp, Belgium, October 21, 22, 1976.** Symposium sponsored by the European Federation of Chemical Engineering. Leiden, Spruyt, Van Mantgem en De Does, 1977. 193 p. In English and German. $27.30.

Attention is given to the Garrett pyrolysis process, the Andco-Torrax slagging pyrolysis solid waste conversion system, partial oxidation of refuse using the Purox system, and the prospects of materials and energy from refuse in India. Consideration is also given to methane production from wastes, the combination of refuse incineration with electric power production, combined refuse and sludge incineration, and refuse incineration with heat recovery. Metals from urban refuse, recycling of tin from secondary waste, and materials recovery from shredded junked cars are also discussed. B.J.

A78-11141 **The Garrett pyrolysis process.** S. Rysman (Cemstobel, Brussels, Belgium). In: Materials and energy from refuse; Proceedings of the First International Symposium, Antwerp, Belgium, October 21, 22, 1976. Leiden, Spruyt, Van Mantgem en De Does, 1977, p. 5-12. 8 refs.

The Occidental Resource Recovery system is designed to be a low-pollution, low net cost technique for disposal of municipal refuse and recovery of its valuable energy and mineral constituents. Ferrous metals and clean glass cullet are recovered as readily marketable commodities. The flash pyrolisis process converts the organic portion of the refuse into about one barrel of low sulfur liquid fuel from each ton of raw refuse. The pyrolytic oil product has been shown by independent tests to be usable as a substitute for No. 6 residual (Bunker C) fuel oil in a steam-generating boiler furnace. The complete process will be demonstrated at a 200 ton per day plant. (Author)

A78-11142 **The Andco-Torrax process - A slagging pyrolysis solid waste conversion system.** E. Legille and C. Mélan (Paul Wurth, S.A., Luxembourg). In: Materials and energy from refuse; Proceedings of the First International Symposium, Antwerp, Belgium, October 21, 22, 1976. Leiden, Spruyt, Van Mantgem en De Does, 1977, p. 13-17.

The Andco-Torrax process combines pyrolysis in an oxygen-deficient atmosphere with high temperature combustion of the char produced by the initial pyrolysis reaction. The combination leads to the production of a combustible pyrolysis gas, on one hand, and to the melting of the inert fraction of the waste to form an inert slag type residue, on the other. A process description is given, with attention to waste treatment and energy recovery, and the principal features of the process - the incinerator, equipment simplicity, high quality solid residue and off-gas characteristics - are summarized. A hardware description of a commercial unit is given. B.J.

A78-11143 **Partial oxidation of refuse using the Purox system.** E. K. Robinson and R. J. Easton (Union Carbide Belgium, Berchem, Belgium). In: Materials and energy from refuse; Proceedings of the First International Symposium, Antwerp, Belgium, October 21, 22, 1976. Leiden, Spruyt, Van Mantgem en De Does, 1977, p. 19-30. 10 refs.

The Purox system for pyrolysis of mixed municipal refuse (MMR) is a high temperature (1550-1650 C) partial oxidation process using pure oxygen. A medium heating value fuel gas (3360 kcal/Nm3 LHV and 3500 kcal/Nm3 HHV) and an inert slag are produced. The key element in the process is the vertical shaft converter into which MMR is introduced through a gas seal to descend by gravity to the hearth countercurrent to rising gases. Processing of one ton of MMR requires 0.2 tons of oxygen to produce 0.7 tons of clean burning fuel gas consisting mainly of 30% H2, 40% CO, 10% light hydrocarbons and 20% CO2. Initial results from a 5 U.S. tons/day capacity pilot plant have been confirmed in a 200 U.S. tons/day capacity commercial scale unit placed in operation at South Charleston, W. Va. in 1974. Several months of continuous operation in 1975 have established the reliability and commercial applicability of the Purox system. (Author)

A78-11144 **Methane production from waste (Methangewinnung aus Abfällen).** R. Rasch. In: Materials and energy from refuse; Proceedings of the First International Symposium, Antwerp, Belgium, October 21, 22, 1976. Leiden, Spruyt, Van Mantgem en De Does, 1977, p. 31-36. 18 refs. In German.

Techniques for the production of methane from organic wastes are reviewed with emphasis on biological degradation and a technique (called 'geordnete Deponie') involving the treatment of waste deposits. Special emphasis is put on thermal methods of methane production from organic refuse, including a method of degassing (i.e., pyrolysis) and a method of gasification (i.e., oxidative gas generation). B.J.

A78-11145 **Prospects of materials and energy from refuse in India.** A. C. Chaturvedi (Irrigation Commission, Lucknow, India). In: Materials and energy from refuse; Proceedings of the First International Symposium, Antwerp, Belgium, October 21, 22, 1976. Leiden, Spruyt, Van Mantgem en De Does, 1977, p. 37-42. 8 refs.

The paper reviews materials recovery from different types of wastes in India. Attention is given the recovery of grease from wool scouring, brewery wastes, and wastes from distilleries and alcohol, corn products, pulp and paper, coke byproducts and chemicals, plating and pickling. Consideration is also given to metals recovery from wastes; the recovery of zinc oxide from zinc waste; the recovery of materials from oil refineries, tannery, rubber and textiles, laundries and dairies, canning, beet sugar and candy; the recovery of cement from fly ash; the conversion of forest waste into crude oil; and stone waste utilization. B.J.

A78-11146 **Energy recovery from municipal and industrial waste.** B. G. Kreiter (Stichting Verwijdering Afvalstoffen, Amersfoort, Netherlands). In: Materials and energy from refuse; Proceedings of the First International Symposium, Antwerp, Belgium, October 21, 22, 1976. Leiden, Spruyt, Van Mantgem en De Does, 1977, p. 43-56. 46 refs.

The use of thermal conversion processes - pyrolysis and gasification, and incineration - for energy recovery from municipal and industrial wastes is reviewed, along with the use of incineration for supplying urban heat and producing electricity is discussed. Different thermal waste treatment processes are compared in terms of environmental hygiene (emissions and reliability), suitability for different types of wastes, net energy production, net operational costs, volume reduction, and recycling of materials from waste or treatment residues. B.J.

A78-11147 **Refuse incineration with heat recovery - Typical design and practical experience.** W. J. Martin and H. Weiand (Josef Martin Feuerungsbau GmbH, Munich, West Germany). In: Materials and energy from refuse; Proceedings of the First International Symposium, Antwerp, Belgium, October 21, 22, 1976. Leiden, Spruyt, Van Mantgem en De Does, 1977, p. 57-62.

Five typical steam cycle schemes for domestic-refuse incineration plants are reviewed, including: (1) district heating stations, (2) heat-and-power stations with back pressure turbine generators, (3) power stations with condensing turbine generators, (4) heat-and-power stations with tap-off condensing turbine generators, and (5) combined fossil-fuel and refuse firing. Attention is then given to theoretically utilizable heat quantity contained in annual per capita refuse production. Using incineration plants in four European cdmmunities (Paris, Munich, Vienna-Spittelau and Kezo-Hinwill) as examples, it is shown how much electrical energy and district heat were generated by from refuse in 1974. B.J.

A78-11148 **Combination of refuse incineration with electric power generation (Kombination von Müllverbrennung mit Stromerzeugung).** W. Schlotmann (Vereinigte Kesselwerke AG, Düsseldorf, West Germany). In: Materials and energy from refuse; Proceedings of the First International Symposium, Antwerp, Belgium, October 21, 22, 1976. Leiden, Spruyt, Van Mantgem en De Does, 1977, p. 63-70. In German.

Four techniques of combining solid-waste incineration with electric power plants are described. These are: (1) the combination of a vapor-generating incineration facility with an existing power plant, (2) the construction of an incineration setup into the combustion chamber of an existing power plant (e.g., the Essen-Karnap variant), (3) the combination of incineration and power-plant combustion chambers, (e.g., the Stuttgart-Münster variant), and (4) a process that combines the combustion of refuse, coal and natural gas (e.g., the Babcock Bensonkessel variant). Detailed schematics illustrating the various processes are presented. B.J.

A78-11149 **Energy from refuse - Theoretical and practical results.** P. C. Nüesch and M. Wirth (Von Roll, Ltd., Zurich, Switzerland). In: Materials and energy from refuse; Proceedings of the First International Symposium, Antwerp, Belgium, October 21, 22, 1976. Leiden, Spruyt, Van Mantgem en De Does, 1977, p. 71-78.

A theoretical discussion is presented on energy production from refuse incineration, with emphasis on refuse composition and quality and techniques of using refuse as fuel. Operational experience at three refuse incineration and energy recovery plants (at Geneva, Zürich and Lucerne) is reviewed. The relationships between the total energy consumption in the areas of the plants and the energy produced from refuse are summarized. B.J.

A78-11150 **Refuse energy in the United States - Two generations of steam generating waterwall incinerators.** J. P. Collins (U.S. Naval Facilities Engineering Command, Norfolk, Va.). In: Materials and energy from refuse; Proceedings of the First International Symposium, Antwerp, Belgium, October 21, 22, 1976. Leiden, Spruyt, Van Mantgem en De Does, 1977, p. 79-83.

A78-11151 **Combined refuse and sludge incineration (Gemeinsame Müll- und Schlammverbrennung).** R. Rasch. In: Materials and energy from refuse; Proceedings of the First International Symposium, Antwerp, Belgium, October 21, 22, 1976. Leiden, Spruyt, Van Mantgem en De Does, 1977, p. 85-91. 16 refs. In German.

Sludge contains a high level of toxic heavy metals and toxic organic compounds. In order to limit the effect of these toxic substances on the environment and to improve the efficiency of solid waste disposal systems, a technique has been developed whereby refuse and sludge are incinerated jointly. The technique incorporates the three steps of sludge drying, direct mixing (dispersal) of the sludge into the refuse, and combined combustion. A flow diagram of a combined incineration system is given and pertinent cost information is presented. B.J.

A78-11161 Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Symposium sponsored by EURATOM, Max-Planck-Institut für Plasmaphysik, and Commission of the European Communities. Oxford, Pergamon Press, Ltd., 1976. 943 p. $38.70.

The papers deal with various aspects of controlled-fusion research and development, such as vacuum and magnet technology, experimental plasma devices, problems with tritium, systems and conceptual design studies, data acquisition and handling, reactor walls and blankets, electric-power handling for plasma devices, plasma-device control systems, and plasma production and handling. Major topics include a review of the Japanese nuclear-fusion research and development program, a survey of the U.S. magnetic fusion program, vacuum pumping for controlled thermonuclear reactors, the vacuum vessel and pumping system of the Joint European Torus (JET), safety and reliability aspects of superconducting magnet systems for fusion power reactors, models for large superconducting toroidal magnet systems, the magnetic-field system design of a reverse field pinch experiment, and the design and testing of superconductors for Tokamaks. The poloidal-field circuit and mechanical structure of JET are also discussed along with designs and technical aspects of several Tokamaks and stellarators, a parametric study of a screw-pinch reactor, potential environmental effects of fusion-reactor power plants, blanket replacement in Tokamak reactors, energy storage and transfer with a homopolar machine for a linear theta-pinch hybrid reactor, and neutral-beam injection systems. F.G.M.

A78-11162 The progress and the development program of fusion technology in Japan. T. Hiraoka, S. Mori, and K. Yamamoto (Japan Atomic Energy Research Institute, Tokai, Ibaraki, Japan). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 1, 3-20. 21 refs.

The Japanese nuclear-fusion research and development program is reviewed. Recently completed Phase I projects discussed include research on toroidal magnetic confinement, construction of low-beta torus machines and various Tokamak devices, neutral-beam injection experiments, production of a high-beta screw-pinch plasma, microwave plasma-heating experiments, construction of a hybrid Tokamak/stellarator, and laser fusion studies. The on-going Phase II program is described which involves such projects as the construction of a large Tokamak device and of a Tokamak machine with a noncircular cross section, neutral-beam and RF plasma-heating experiments, a study of the thermal stability of D-T plasmas, several surface-conditioning experiments, irradiation experiments on fusion-reactor wall materials, and blanket-technology development. A long-term project is outlined which entails the construction of a large reactor plasma test facility and an experimental fusion reactor as well as the development of superconducting magnets for fusion devices. F.G.M.

A78-11163 Vacuum pumping for controlled thermonuclear reactors. J. S. Watson and P. W. Fisher (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 21-26. ERDA-supported research.

Thermonuclear reactors impose unique vacuum pumping problems involving very high pumping speeds, the handling of hazardous materials (tritium), extreme cleanliness requirements, and quantitative recovery of pumped materials. Two principal pumping systems are required for a fusion reactor, a main vacuum system for evacuating the torus and a vacuum system for removing unaccelerated deuterium from neutral-beam injectors. The first system must pump hydrogen isotopes and helium, while the neutral-beam system can operate by pumping only hydrogen isotopes. The most promising pumping techniques for both systems appear to be cryopumps, but different cryopumping techniques can be considered for each system. The main system will have to include cryosorption pumps cooled to 4.2 K to pump helium, but the unburned deuterium-tritium and other impurities could be pumped with cryocondensation panels or cryosorption panels at higher temperatures. Since pumping speeds will be limited by conductance through the ducts and thermal shields, the pumping performance for both systems will be similar, and other factors such as refrigeration costs are likely to determine the choice. (Author)

A78-11164 Vacuum vessel and pumping system of the J.E.T. experiment. D. Eckhartt (Joint European Torus Plant, Abingdon, Oxon, England; Max-Planck-Institut für Plasmaphysik GmbH, Garching, West Germany). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 33-39.

The design of the vacuum vessel and the pumping system for the Joint European Torus (JET) is described. The vessel is an all-metal completely welded double-walled modular torus of noncircular cross section and consists of 32 wedge-shaped sectors linked together by cylindrical bellows sections that provide for the required electrical resistance in the longitudinal direction. An optimum-design pumping system is outlined which uses 16 cryopumps for liquid nitrogen, each of which is backed up by a turbomolecular pump needed for liquid-helium pumping and cryopump cleaning. The current status of design work, related tests, and prototype manufacture are briefly discussed. F.G.M.

A78-11167 Aspects of safety and reliability of superconducting magnet systems for fusion power reactors. J. Powell, M. Reich, D. Hsieh, J. Lehner, G. Danby, and A. Prodell (Brookhaven National Laboratory, Upton, N.Y.). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 97-106. ERDA-sponsored research.

Safety and reliability aspects of fusion superconducting magnets are studied by using the UWMAK device and various superconducting magnet designs as starting points for an analysis of several potential problems for toroidal-field coils. Four illustrative accident classes are assumed, different types of possible magnet safety systems are considered, and an operating hierarchy of magnet safety systems is presented. Potential accident initiators and pathways are discussed, and results are reported for a number of electrical, heat transfer, and structural analyses carried out for the UWMAK-I machine and different toroidal-field coil designs. It is suggested that a containment system consisting of close-fitting coil cases for toroidal-field coils may be desirable. F.G.M.

A78-11169 The UWMAK-II study and magnet design. R. W. Boom, R. W. Conn, and W. C. Young (Wisconsin, University, Madison, Wis.). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 113-121. 9 refs. Research supported by the Wisconsin Electric Utilities Research Foundation and ERDA.

A general description of the UWMAK-II conceptual tokamak reactor system is given, with special emphasis on problems related to superconducting magnets. The toroidal-field magnets of the UWMAK-II are examined, and it is noted that the vertical-field coils are placed inside the toroidal-field coils to minimize the energy stored in the poloidal magnetic field. Plasma production in UWMAK-II is discussed, and some of the main technical aspects of the UWMAK-II study are summarized. A structural scheme is outlined for handling toroidal collapsing forces if a sector coil should lose current as a result of any one of several events. F.G.M.

A78-11170 **Poloidal field for a 1.7 MA Tokamak - *Comparison between an iron core and an air core transformer*.** R. Aymar, C. Leloup, and M. Pariente (EURATOM and Commissariat à l'Energie Atomique sur la Fusion, Département de Physique du Plasma et de la Fusion Contrôlée, Fontenay-aux-Roses, Hauts-de-Seine, France). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 123-128.

The transformer of a 1.7-MA Tokamak of circular cross section has been studied in two versions with poloidal field coils external to the toroidal field magnet: saturated iron-core transformer and air-core transformer. The power, energy, and copper weight needed are about two times smaller for the iron-core transformer. (Author)

A78-11171 **The transformer design for a proposed technical feasibility Tokamak reactor.** S. Bobbio, L. Egiziano, G. Lupò (Napoli, Università, Naples, Italy), and R. Martone (Calabria, Università, Cosenza, Italy). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 129-135.

The conceptual design of the poloidal-field windings for the FINTOR Tokamak reactor is considered. Two different cases are examined: one where the transformer is assumed to be of the air-core type and another where an axisymmetric ferromagnetic structure is postulated. A biased transformer configuration is also investigated as a means of reducing the copper weight in the air-core case and the weight of the core in the iron case. It is concluded that the air-core transformer is preferrable from the standpoint of materials costs, but the iron-core transformer is apparently better in terms of operation. F.G.M.

A78-11172 **Eddy current losses and transient magnetic forces in pulsed fusion reactors.** J. W. Gray (EURATOM and U.K. Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, England). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 137-142.

Systems studies of pulsed fusion reactors show that the required transient magnetic field introduce significant design constraints due to eddy-current losses and magnetic forces. The former can have an important effect on the circulating power fraction and overall system efficiency, while the latter influences the structural design of the blanket region. The paper discusses the basic principles of magnetic-field diffusion into thin metal walls and solid conducting materials. General design data covering a wide range of parameters (such as field rise time, field diffusion time, conductor resistivity and geometry) are given which enable the losses and magnetic forces to be easily evaluated for various reactor systems. (Author)

A78-11174 **Analysis of various field programming to produce the RFP configuration.** P. L. Mondino (EURATOM and CNR, Centro di Studio sui Gas Ionizzati, Padua, Italy). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 149-155. 7 refs.

Equivalent circuits of machines for the production of a reverse-field pinch (RFP) are studied. The field reversal can appear spontaneously, as in the Zeta device, or can be produced by programming the external field. Various models have been proposed previously to describe the behavior of the plasma, including the force-free paramagnetic model and the Bessel function model; the latter has been used by Taylor (1974) to demonstrate that the RFP is a state of minimum energy. Similar results have been obtained with the sharp-boundary model, which is used in this note to study the setting up of the configuration. The proposed method is independent of the model and can be applied to other cases. Equivalent circuits are given in which auxiliary voltage generators are employed to simulate the field reversal. Currents and voltages are calculated together with the energy balance. Some different programming modes are proposed and discussed. (Author)

A78-11175 **Design, construction and operation of the DITE divertor field system.** R. J. Hayward, K. E. Lavender, A. P. Pratt, and B. C. Sanders (EURATOM and U.K. Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, England). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 157-162. 5 refs.

One of the main aims of DITE (Divertor Injection Tokamak Experiment) is to study the operation of a divertor in a Tokamak configuration. The paper describes the magnetic computations and engineering design features of the 'bundle'-type divertor fitted to DITE. The divertor coil consists of 2 'bitter'-type water-cooled coils connected in series, which when pulsed for 425 ms at 11.5 kA, develops a field of 4.0 T. within each bore, with a temperature rise of 83 C. The thermal characteristics and severe mechanical forces due to reaction with the corresponding 1.8-T toroidal field are discussed. The current for the coils is supplied from a current-stabilized flywheel generator. The design of the target assembly and high-speed vacuum pumping system are described, and the results of single-particle tests using an electron beam to map out the magnetic profile with the completed Tokamak are given. Subsequent operational experience and design problems are also discussed. (Author)

A78-11176 **Studies on design and tests of superconductors for Tokamaks.** C.-H. Dustmann, H. Krauth, and G. Ries (Karlsruhe, Kernforschungszentrum, Institut für experimentelle Kernphysik, Karlsruhe, West Germany). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 163-168. 6 refs. EURATOM-supported research.

Constraints on superconductors to be used in Tokamak magnets are defined, and the state of the art in conductor technology and different conductor designs are compared with these constraints. The ac-loss performance and mechanical strength are analyzed. Based on the results, a conductor design is discussed. A first step for the industrial development of such a conductor is progress in the fabrication of a conductor which will be used in a small torus assembly for technology tests. (Author)

A78-11177 **The poloidal field circuit in the Joint European Torus /JET/.** P. Dokopoulos and D. L. Smart (Joint European Torus Plant, Abingdon, Oxon, England). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 177-184. 8 refs.

Some aspects of the circuit that produces the plasma (3.8 to 4.8 MA) in the Joint European Torus (JET) and maintains it in equilibrium are described. It is noted that the flux from the JET transformer is driven almost equally in both directions and that the main power source for the 3.8-MA plasma is a generator-rectifier set rated at 70 kA, 4.5 kV dc, and 600 MJ energy. An additional thyristor bridge fed by a network is also employed for the 4.8-MA plasma. All active coils are connected in parallel, passive coils may be used to produce forces that counteract fast plasma motions, and four thyristor bridges (13 kA, 1 kV) are employed to control voltages and currents in the coils as well as to provide stability of the plasma position. F.G.M.

A78-11178 **Poloidal field equilibrium calculations for JET.** A. K. Khalafallah (Joint European Torus Plant, Abingdon, Oxon, England). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 185-190.

The structure of the JET two-dimensional poloidal-field analysis package is discussed. The ability to cope with different plasma current-density distributions (skin, flat, or peaked), each with a range of beta poloidal values and varying plasma shapes, is a feature of these calculations. It is possible to construct instant-by-instant pictures of equilibrium configurations for various plasma-buildup scenarios, taking into account the level of flux in the iron core and return limbs. The equilibrium configurations are calculated for two possible sequences of plasma buildup. Examples of the magnetic-field calculations being carried out using a 3D code are also given. (Author)

A78-11179 **A survey of the U.S. magnetic fusion program.** E. E. Kintner (ERDA, Div. of Magnetic Fusion Energy, Washington, D.C.). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 225, 227-244.

Dante's Divine Comedy is used as a model for the development of practical magnetic fusion power. Four 'circles' have been encountered and partially passed: confinement of plasma collective particle behavior, heating of plasmas, determination of plasma characteristics diagnostics, and behavior of impurities in plasmas. Future projects in these areas are described. The five 'future circles of torment' are listed as magnetics for fusion power, materials for fusion power, plasma engineering, environmental aspects of fusion, and maintainability of fusion power plants. Proposed research in these areas is considered. The hope is expressed that, like Dante, researchers will win through the nine circles and achieve practical fusion power. M.L.

A78-11180 **Plan and design of ETL TPE-2 experiment.** S. Takeda, K. Hakoda, K. Hayase, Y. Hirano, I. Hirota, N. Ikeda, M. Kito, H. Kiyama, S. Kiyama, and Y. Maejima (Ministry of International Trade and Industry, Electrotechnical Laboratory, Tokyo, Japan). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 245-250. 7 refs.

A new toroidal screw pinch experiment, ETL TPE-2, is planned and designed on a large scale. The aspect ratio of 2.9 and the ellipticity of 1.6 of the discharge vessel are realized by metal discharge vessel line with quartz. To obtain a high temperature plasma, capacitor banks of 80 kV are provided in tandem feed for the toroidal magnetic field. An additional coil system is provided to reduce the irregular field and to control the dynamic motion of the plasma. The bank of this coil system has various rise times and magnitudes of the current according to a present program. A coil assembly reduced to a scale of one-fourth has been constructed. Measurements of magnetic fields show that magnitude of the irregular field is less than 0.5%. (Author)

A78-11181 **Conceptual design problems in future reversed field pinch experiments.** T. E. James and H. A. B. Bodin (EURATOM and U.K. Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, England). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 251-256. 8 refs.

The Reversed Field Pinch (RFP) system is of interest as a possible fusion reactor because of its ability to contain a high-beta plasma with relatively long field rise times which minimize the confining magnetic energy and pulsed power supply ratings required. The objectives of the next generation of RFP experiments are to (1) establish a high-beta RFP configuration by means of self reversal which is assisted by field control and sustain it for some tens of msec using additional field control; (2) study the physical properties of the plasma-field configuration during both the setting-up and sustainment phases, as a function of plasma current, and determine the scaling of temperature and confinement time; and (3) study the effect of increasing the current rise times from 2 to 50 msec. The design studies that are discussed are based on a proposal for a future experiment having torus major/minor radii of 1.8/0.6 m with a peak plasma current of about 1.0 MA rising in 1.5 to 15 ms. (Author)

A78-11182 **The mechanical structure of the Joint European Torus.** M. Huguet, L. Sonnerup, G. Celentano, J. Booth, and T. Raimondi (Joint European Torus Plant, Abingdon, Oxon, England). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 257-262.

The mechanical structure of the Joint European Torus (JET) is designed to resist with suitable stiffness the large azimuthal forces acting on the 32 toroidal-field coils. Due to the limited space available the structure is designed as a thin closed shell giving a maximum torsional rigidity with a minimum of material thickness. Externally the structure consists of a thin shell surrounding the toroidal magnet. The shell is attached at top and bottom to two disk-shaped rings which are provided with side supports for the coils. Along the inner straight portion, the coils are supported by a grooved cylinder which is attached to the upper and lower rings. To facilitate assembly and maintenance the structure is divided into eight identical sectors. Insulation gaps have been provided between sectors to reduce eddy currents and allow for the penetration of the poloidal field through the structure. One of the major problems is the design of the connections between sectors. A combination of insulated bolts and keys has been provided to resist the very high shear loads. (Author)

A78-11184 **Design aspects of a large toroidal stabilizing shell and vacuum liner assembly.** R. J. Hucklesby, H. J. Crawley, and S. Skellett (EURATOM and U.K. Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, England). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 293-298.

The paper considers design and manufacturing problems of a toroidal shell/liner system with major/minor liner radii of 180/60 cm for a high-beta reversed field pinch device with a maximum plasma current of 2 MA. Stress-analysis figures for the shell show that because of the vacuum load the net forces on the bolting system do not impose undue restraints. The key problems concerning the shell are electrical insulation and cooling at the overlap, vacuum sealing, and the integrity of the welding of a fabricated vessel for high-vacuum conditions. Alternatively, a cast-aluminum-alloy shell should prove an attractive proposition, but is dependent on the achievement of satisfactory vacuum properties. From analysis of the dynamic forces on the liner induced by the magnetic fields diffusing through its wall, the buckling stresses are found to have an adequate margin of safety over the critical case, and the problem is one of supporting the liner. (Author)

A78-11187 **Parameter study of a screw-pinch reactor.** C. Bobeldijk, J. A. Hoekzema, W. Schuurman (EURATOM and Stichting voor Fundamenteel Onderzoek der Materie, Instituut voor Plasma-Fysica, Jutphaas, Netherlands), M. Bustraan, W. M. P. Franken, H. T. Klippel, M. Muysken (Reactor Centrum Nederland, Petten, Netherlands), G. C. Damstra, H. J. Klein Nibbelink (Keuring van Electrotechnische Materialen, Arnhem, Netherlands), and P. C. T. van der Laan (California, University, Los Alamos, N. Mex.). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings.
Oxford, Pergamon Press, Ltd., 1976, p. 367-374.

In a parameter study of a reactor based on a screw-pinch configuration, the plasma is heated in two stages. The cold plasma is heated by fast implosion in order to guarantee pitch conservation of the inward moving magnetic field lines. After implosion, an adiabatic compression heats the plasma to the ignition temperature. Additional characteristics of the system are stated, and a computer program is used to search for optimal parameters. Calculations show that the net efficiency, although increasing with output energy, is low because of ohmic losses in the compression coil. It is found that a belt-shaped screw pinch, in which higher values of beta may be reached, improves the net efficiency and alleviates the technological requirements. M.L.

A78-11188 **The practical feasibility of a bundle divertor for a Tokamak power reactor.** H. J. Crawley (EURATOM and U.K. Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, England). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 381-385.

Some of the practical implications of the field pattern for a bundle divertor are discussed. Because of the locally fixed shape of the separatrix, the radial depth available for coil conductor, coolant, and structure is set by the position of the field zero relative to the divertor. The ohmic power loss has a minimum value with respect to variations in coil radius. It is concluded that the power loss in the first pair of coils in one divertor for a Tokamak reactor would be not less than 100 MW; that is greater than 5% of the station electrical output. The field intensity is at the limit of present large-superconducting-coil technology; but even if this problem could be overcome, a very large divertor system would still be required to provide space for the necessary radiation shielding. (Author)

A78-11191 **Energy yield and fuel dynamics of the fusion breeder.** A. A. Harms and C. W. Gordon (McMaster University, Hamilton, Ontario, Canada). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 399-403. Research supported by the National Research Council of Canada.

The characteristics of a fusion breeder operating in the full mutualistic mode with a companion fission reactor are examined. For this purpose, the fissile and fusile fuel descriptions are combined with gross reactor core parameters of existing fission and proposed fusion reactors to permit an assessment of fusion energy yield, fissile fuel production rates, and overall systems conversion ratio. It is found that, under the full utilization of the energy and fuel transfer linkages, the fusion breeder possesses considerable merit. Optimal design features and operational procedures can lead to fuel doubling times of the order of days with fissile fuel production rates in the kg/MW-Y range. Tritium economy, specific fuel inventories, and fission reactor conversion ratios are found to be the determining factors. (Author)

A78-11193 **Plasma stabilization requirements of the Reference Theta-Pinch Reactor /RTPR/.** R. R. Bartsch, R. A. Krakowski, and F. L. Ribe (California, University, Los Alamos, N. Mex.). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings.
Oxford, Pergamon Press, Ltd., 1976, p. 411-422. 13 refs. ERDA-sponsored research.

The Reference Theta-Pinch Reactor (RTPR) is considered as a high-beta stellarator feedback-stabilized to the m = 1 MHD mode and finite-Larmor-radius-stabilized to the Vlasov-fluid modes with m greater than or equal to 2. For an l = 1, 0 equilibrium with l = 2 feedback fields, the ratio of peak feedback power to thermonuclear power output for a linear-amplifier-driven system is found to be negligible. An impulse-control system involving capacitor drive further reduces the ratio by two orders of magnitude. Stabilization of the modes with m of at least 2 is a critical consideration that requires lowering the RTPR line density, subject to the constraint of acceptably low feedback power. The required decrease in discharge filling pressure or minor radius must also be constrained by maintaining reactor energy balance. A parametric analysis indicates the relationship between plasma stabilization and reactor energy balance. There is a critical tradeoff between the first-wall radius and the helical equilibrium field to maintain stabilization and energy balance. (Author)

A78-11194 **Technical limitations on conceptual Tokamak reactors. II.** A. F. Knobloch (Max-Planck-Institut für Plasmaphysik GmbH, Garching, West Germany). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 423-428.

Some technical constraints on possible Tokamak machines were previously derived for a circular and a strongly elongated plasma cross section in the case of a constant safety factor. These calculations are extended to a moderate plasma elongation under the less restrictive assumption of a safety factor that varies with plasma aspect ratio. The results obtained tend to favor an elliptical over a circular cross section, since the feasible magnetic-field intensity for the elliptical configuration is about 8 T instead of 12 T, the toroidal beta is twice as large, and the n-tau value for the trapped-ion mode is approximately the same. It is concluded that a low-aspect-ratio Tokamak with a magnetic-field intensity of 8 T, a circular plasma cross section, and an aspect-ratio-dependent safety factor would not be an advantageous reactor design concept. F.G.M.

A78-11200 **Time and space resolved temperature measurements of a limiter in a Tokamak discharge using an infra red camera.** D. H. J. Goodall (EURATOM and U.K. Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, England). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings.
Oxford, Pergamon Press, Ltd., 1976, p. 523-528.

The temperature of surfaces in the DITE Tokamak can be estimated by using a scanning infrared camera to observe the transient temperature rise of a moveable limiter. Measurements are made at selected times during the discharge pulse by stopping the camera's vertical scan, and by counting the horizontal lines which have elapsed since the start of the pulse. Ten time resolved temperature measurements are then made with a time resolution of less than 1ms. A black body cavity in the limiter provides a reference for emissivity calculations. Localized surface temperature increases during the discharge of several hundred degrees centigrade were observed and the temperature rise as a function of limiter distance from the plasma center was obtained. The effect of a second active limiter was also investigated. (Author)

A78-11205 **Large Tokamak power supplies - A survey of problems and solutions.** K. I. Selin and E. Bertolini (Joint European Torus Plant, Abingdon, Oxon, England). In: Symposium on Fusion Technology, 9th, Garmisch-Partenkirchen, West Germany, June 14-18, 1976, Proceedings. Oxford, Pergamon Press, Ltd., 1976, p. 735-740.

The Tokamak load characteristics are far from ideal for a power system. Schemes to adjust the load profile and the peak power loading on the power system, to ease the impact on the network are described. Power systems with advanced production and load dispatching control may supply pulse power and give good service also to very large Tokamak experiments with reliable, flexible and relatively inexpensive power to run the experiment. Cost comparisons are made with alternative or supplementary energy storing flywheel systems. (Author)

A78-11212 **International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13, 14-25 & 26-38.** Meeting supported by the Energy Research and Development Administration. Edited by C. Beach and E. Fordyce (Florida, State University, Tallahassee, Fla.). Cape Canaveral, Fla., International Solar Energy Society, 1977. Sections 1-13, 371 p.; Sections 14-25, 363 p.; Sections 26-38, 360 p. Price of three volumes, members, $25.; nonmembers, $45.

The use of solar collectors for heating and cooling systems is discussed, with attention given to liquid- and air-heating collectors, the design, orientation and selection of materials for collectors, as well as to heat pumps, passive systems, controls and instrumentation, and window walls. Topics of the papers include a National Bureau of Standards facility for rating flat-plate air heaters, polymer films for the inner glazing of flat-plate collectors, the reevaluation of solar panels in use for twenty years, heat-transfer fluids, the design of absorbers, a solar-powered desiccant air conditioner, computer programs as design tools in developing economical solar heating systems, maintenance costs of solar air heating systems, the effect of local variations in cloud cover on collector efficiency, and fluid control in flat-plate and evacuated-tube collectors. J.M.B.

A78-11213 **A detailed model of flat plate solar collectors.** R. K. Wedel (Lockheed Research Laboratories, Palo Alto, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 1-1 to 1-6. 11 refs. Contracts No. E(04-3)-181; No. E(04-03)-1256.

This paper presents the details of a computer model which determines the performance of flat plate solar collectors. The program analyzed all types of flat plate collectors, including those with honeycomb between surfaces, with both performance and a relative cost of a collector design determined. Predicted performance is compared to measured solar collector efficiencies. (Author)

A78-11214 **The analysis, design and thermal performance testing of a heat pipe flat plate collector.** R. D. Evans and D. N. Greeley (Florida Technological University, Orlando, Fla.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 1-7 to 1-10. 7 refs. Research supported by the State University of Florida.

A78-11215 **Performance analysis and experience for flat plate collector with absorber operating in a vacuum.** J. M. Estes (R.E. Gardner Engineering, Inc., Tyler, Tex.), R. F. Faulkner (Solar Systems, Inc., Tyler, Tex.), and J. D. McClure (General Dynamics, Arlington, Tex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 1-11 to 1-15. 7 refs.

A78-11216 **Experimental performance study of a 40 sq m vacuum flow flat plate solar collector array.** D. L. Spencer and T. F. Smith (Iowa, University, Iowa City, Iowa). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 1-16 to 1-20. 9 refs. Research supported by the Iowa Energy Policy Council.

A78-11217 **Performance analysis of a black liquid absorbing collector /BLAC/.** J. Trentleman and P. H. Wojciechowski (Rochester Institute of Technology, Rochester, N.Y.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 1-21 to 1-25. 10 refs. Research supported by the Rochester Gas and Electric Corp.

Analytical and experimental investigations of a black liquid, sheet flow solar collector are reported; the performance of the black liquid absorbing collector (BLAC) is compared to that of a typical tube-and-fin collector. Due to its reliance on the direct absorption process, which increases the effective transmittance-absorptance for most angles of incidence, the BLAC design has an instantaneous efficiency improvement of 10 to 15% over the conventional collector. In addition, the BLAC device, which requires no metals for fabrication, may be less costly than the tube-and-fin design, though its greater mass per unit of energy collected would require additional structural support in some cases. J.M.B.

A78-11218 **Teflon FEP fluorocarbon film for flat plate solar collectors.** R. C. Ribbans, III (Du Pont de Nemours and Co., Inc., Wilmington, Del.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 1-30 to 1-33.

The use of a commercially available fluorinated ethylene-propylene film as the inner glazing in solar flat-plate collectors is discussed. A 1-millimeter thick sheet of the fluorocarbon film is found to have a transmittance of 96%, an index of refraction of 1.34, an extinction coefficient of 0.079, and an upper temperature limit of 400 F for long-term service. Experimental trials indicate that solar collectors employing the polymer film are more efficient heat collectors than those with glass inner glazing; the gain in efficiency may be more than 30% on hazy or cloudy days. The long service life demonstrated by the fluorocarbon film (more than 15 years) and its low cost are also cited. In addition, installation techniques are presented. J.M.B.

A78-11219 **Performance of Lexan vs. ordinary glass as glazing materials for flat-plate solar collectors.** W. F. Smith (Florida Technological University, Orlando, Fla.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 1-34 to 1-37.

A commercially available polycarbonate thermoplastic film was compared to three-sixteenth inch 0.13% Fe_2O_3 glass as glazing material for single-glazed flat-plate solar hot water systems. The 0.06-inch plastic film was found to be slightly more efficient than ordinary glass glazing during clear-sky conditions, and slightly less efficient during moderately cloudy periods. The high impact strength, light weight, clear transparency, and low moisture absorption of the plastic film are also cited as advantages in its use. J.M.B.

A78-11220 **Testing of flat-plate air heaters according to ASHRAE Standard 93-77.** D. E. Jones and J. E. Hill (National Bureau of Standards, Washington, D.C.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 2-1 to 2-5. 11 refs. ERDA-sponsored research.

A procedure for testing and rating solar collectors is discussed, and a test facility for flat-plate air heaters, built at the National Bureau of Standards (NBS), is described. The test procedure, a modified version of the method prescribed in a 1975 NBS publication, calls for outdoor steady-state tests to determine near-solar-noon efficiency, as well as determination of a time constant and incident angle correction factor to permit the assessment of collector performance early in the morning and late in the day. Test results for a typical commercially available air-cooled solar collector are presented. J.M.B.

A78-11221 **Flat plate air-heater improvements.** B. E. Cole-Appel, G. O. G. Löf, and L. E. Shaw (Solaron Corp., Denver, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 2-6 to 2-10. 16 refs. Contract No. E(29-2)-3713.

Several design improvements in flat-plate solar air heaters are examined, with the objective of increasing the rate of heat transfer from the absorber to the flowing air. The steady-state energy balance equation on the absorber plate is employed to determine those parameters which may aid in raising the heat transfer rate. Collector designs involving dimpled absorbers, finned absorbers or the interruption of the absorber surface are proposed as candidates for comparison with a standard collector having non-selective coatings, two glazings and conventional tube-in-sheet or plane duct flow passages. J.M.B.

A78-11222 **Analysis of a matrix solar collector.** K. V. Chau (Florida, University, Gainesville, Fla.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 2-11 to 2-15.

A theoretical analysis of a matrix solar collector with several layers of wire screens as the absorber is presented. A limited amount of experimental work was done to check the validity of the theoretical equations. There was very good agreement between theoretical and experimental results. (Author)

A78-11223 **A solar panel for residential use.** B. F. Parker (Kentucky, University, Lexington, Ky.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 2-16 to 2-19. 10 refs.

A solar panel is designed for manufacture as a house construction module. This module can be inserted as a roof panel to build the collector as an integral part of the roof. The design utilizes the vee-corrugating technique to improve solar absorption and small triangular ducts to increase the heat transfer area between the solar plate and the transport fluid. Collector test data taken in a limited test range shows an improvement in efficiency for the new design in comparison to a flat plate collector with a plane surface and a rectangular heat collecting duct underneath. (Author)

A78-11224 **Performance tests of a solar energy collector used to heat air.** E. I. Griggs, H. C. Hewitt, Jr., and K. F. Lee (Tennessee Technological University, Cookeville, Tenn.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 2-20 to 2-24. 16 refs.

A simply constructed flat plate collector for heating air was fabricated and tested using aluminum foil as the absorber. Collector efficiencies were determined and presented as functions of time and air flow rate with efficiencies exceeding 60 percent at the higher rates; comparisons are made between collector efficiencies and those predicted by fundamental equations. An indication of the transient response of the collector is also given. (Author)

A78-11225 **Re-evaluation of flat plate solar panels in use for twenty years.** L. N. Hadley and J. C. Ward (Colorado State University, Fort Collins, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 2-25, 2-26. Contract No. EY-76-S-02-2830.

The transmissivity of the glass covers and the absorptivity of the absorbing panels have been measured for samples taken from the flat-plate collectors of the George O. G. Löf solar heated home in Denver, Colorado. These panels have been in continuous use for twenty years. Measurements were made over the spectral range 0.35 to 2.2 microns. The measurements indicate that both the glass covers and the absorber plates have retained a high efficiency over this period. (Author)

A78-11226 **Selecting optimum tilts for solar collectors as a function of cloudiness.** E. Hernández, E. Mayer, and R. Martínez (Universidad Nacional Autónoma de México, Mexico City, Mexico). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 3-1 to 3-5.

A method for selecting the optimum tilts for solar collectors which relies on both the latitude of the collector location and the annual local distribution of cloud cover is discussed. Geometrical considerations which take into account the latitude, solar declination, hour angle and other factors to determine the optimum tilt angle for a fixed collector panel are reviewed; the effect of regional cloudiness is then included in the analysis. Optimum tilt angles for several locations in Mexico are given. The majority of the tilt angles are found to vary significantly from the latitude of the location, which suggests that the local cloud cover is a significant factor in the analysis. J.M.B.

A78-11227 **Finite size corrections for a reflector-collector system.** S. Baker, D. K. McDaniels, and H. D. Kaehn (Oregon, University, Eugene, Ore.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 3-6 to 3-10. 7 refs.

The amount of solar energy collected by reflector-collector systems over an entire day has been calculated and compared to that collected by a simple flat-plate collector configuration. It is found that the optimum winter orientation of the system at 45 deg N latitude occurs with the reflector oriented about 5 deg downward and with the collector tilted upward at 85 deg to the horizontal plane. Calculations are made to assess the effects of finite reflector size. It is shown that the practical optimum reflector length is of the order of 1.5-2.0 times the collector height; it is also shown that no additional reflector width is needed to minimize losses as the sun's hour angle moves away from solar noon, provided that the width-to-height ratio is greater than three. The improvement obtainable from curving the reflector is estimated. (Author)

A78-11228 **Solar collection at different temperatures by different collector types under various orientation methods.** R. E. Crane and H. G. Lorsch (Franklin Institute Research Laboratories, Philadelphia, Pa.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 3-11 to 3-14. 5 refs.

Four types of solar collectors, representative of presently available technology, were investigated with four different orientation methods for their suitability to collecting energy at medium and high temperatures. The annual energy collection rates per unit collector area were determined for Inyokern, California. The investment cost required per unit of annual energy collected by a large collector field was determined as a function of collector operating temperature, collector type, and orientation method. (Author)

A78-11229 **Optimized spacing between rows of solar collectors.** N. Lior, J. O'Leary, and D. Edelman (Pennsylvania, University, Philadelphia, Pa.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 3-15 to 3-19. 11 refs. Research supported by the Pennsylvania Science and Engineering Foundation.

If it is desired to increase the amount of solar energy collected over a solar collector mounting area of a given size, the collector rows may be placed closer together, allowing some mutual shading. A method is described, utilizing the University of Pennsylvania computer program SOLSYS, to analyze the heat transfer in partially shaded solar collectors, and to optimize the inter-row spacing for increasing the portion of the heating load supplied by solar energy. The method is applied to an example of a solar heating retrofit of a row home. For the given example, an increase of 19% in the seasonal solar energy contribution is obtained, at the expense of adding 33% more collector area (a fourth row). Other geometries can increase the contribution further. (Author)

A78-11230 **The estimation of daily, clear-sky solar radiation intercepted by a tilted surface.** T. A. Weiss (Du Bois and King, Inc., Randolph, Vt.) and G. O. G. Löf (Colorado State University, Fort Collins, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 3-21 to 3-25. 18 refs.

The amount of solar energy that is intercepted by surfaces of any orientation is estimated from a new model of the clear-sky, spatial distribution of solar radiation. The model uses direct, isotropic reflected, and anisotropic diffuse radiation. The effects of azimuth, tilt, season, latitude, atmospheric turbidity, and reflectivity of the surroundings were studied. A general relationship between orientation and intercepted energy was found for the four stations that were studied. Results from the model are in close agreement with measured data. This model is also a better estimator of intercepted energy than the more commonly used models. (Author)

A78-11231 **An approximate equation for predicting the solar transmittance of transparent honeycombs.** K. G. T. Hollands (Waterloo, University, Waterloo, Canada), K. N. Marshall, and R. K. Wedel (Lockheed Research Laboratories, Palo Alto, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 4-1 to 4-5. 10 refs.

An approximate equation is presented for predicting the solar transmittance of transparent honeycombs. The method accounts for scattering which occurs in such honeycombs by introducing diffuse components for both the reflectivity and transmissivity of the honeycomb wall. Required inputs to the equation are the optical properties of the honeycomb wall material, averaged over the solar spectrum. Methods of determining these properties are described. Although strictly applicable to a square-celled honeycomb, the equation should be approximately valid for hexagonal honeycombs as well. The equation is compared to the measured transmittance of a hexagonal-celled Lexan honeycomb with good results. (Author)

A78-11232 **The dependence of optical properties on the structural composition of solar absorbers.** P. O'Neill, A. Ignatiev, C. Doland, and A. F. Hildebrandt (Houston, University, Houston, Tex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 4-6 to 4-10. 12 refs.

Specimens of gold black were produced under controlled laboratory conditions so as to study the dependance of their optical properties on the particle-like nature of the material. A theoretical model incorporating the particulate nature of the gold black films has been applied to describe their optical properties. This theory is related to the experimentally measured optical properties and its general nature is contrasted to previous theories of the optical properties of gold black. (Author'

A78-11233 **Optimization of particulate type selective solar absorber.** C.-W. Lee (Colorado, University, Boulder, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 4-11 to 4-15.

A particulate type solar collector is described that consists of small conductive particles imbedded in a porous transparent dielectric matrix. This type of absorber material can help minimize convective losses by transpiration of air through the absorbing layer so that effective heat exchange takes place between air and the layer. Radiation loss from the heated layer is minimized by using the wavelength dependence of the small conductive particles. Some calculations pertaining to the design optimization of such an absorber are performed. A model with gold particles indicates that the particle size should be between 0.01 and 0.05 microns diameter. For fixed particle size the cutoff wavelength can be adjusted by controlling the area ratio of the particles. P.T.H.

A78-11234 **Heat losses from solar energy absorbers enclosed in glass tubes.** T. R. Todd, Jr. and E. H. Perry (Memphis State University, Memphis, Tenn.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 4-16 to 4-19. 10 refs.

A theoretical study was undertaken to examine the heat losses from solar energy absorbers enclosed in glass tubes. Three absorber geometries were considered: circular cylinder, horizontal fin, and vertical fin. The heat losses from the absorbers were studied as a function of the pressure within the glass tube. As the pressure decreases, the convective heat losses disappear first, and at very low pressure the conduction losses become negligibly small leaving only radiative heat losses. Some typical results are given, showing the effect of pressure on the overall heat loss. (Author)

A78-11235 **Natural convection characteristics of flat plate collectors.** K. R. Randall, M. M. El-Wakil, and J. W. Mitchell (Wisconsin, University, Madison, Wis.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 4-20 to 4-24. 11 refs.

Local and average heat transfer coefficients for ntural convection between parallel plates have been experimentally studied using interferometric techniques. The experimental conditions were similar to these existing in flat-plate solar collectors. Correlations have been developed for the local and average heat transfer Nusselt numbers as functions of tilt angle and Grashof number. The results are useful in determining the top loss coefficient for flat plate collectors and, eventually, for finding means of minimizing these losses. (Author)

A78-11236 **Experimental investigation and computer modeling of a solar natural circulation system.** J. W. Baughn and D. A. Dougherty (California, University, Davis, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 4-25 to 4-29. 6 refs.

The flow and temperature behavior of a flat plate solar water heater with natural circulation (solar thermosyphon system) has been studied experimentally and with an analytical model. The analytical model is similar to Ong's (1976). An important improvement was including the effect of transition from laminar to turbulent flow on the friction coefficients. With this improvement, excellent agreement between the measurements and the analytical model were obtained. The accumulated efficiency of the natural circulation system was compared analytically to a similar pumped flow system. The difference in accumulated efficiency for the system and solar day selected was small. (Author)

A78-11237 **Analytical and experimental study of thermosyphon solar water heaters.** B. Nimmo, W. Clark, and J. Pearce (Florida Technological University, Orlando, Fla.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 4-30 to 4-34. 8 refs. Research supported by the State University of Florida.

The paper describes a theoretical analysis of thermosyphon solar water heater, which extends previous work by considering transient environmental conditions (insolation and ambient temperature) as well as the possibility of drawoff of hot water from the storage tank. The differential equation which describes the fluid temperature profile in the collector as a function of time and location is solved using a collector loss coefficient determined from a four-node transient collector model (glass cover, collector deck and fluid, back insulation, and pan). The analytical results are compared to experimental data obtained using the Florida Technological University-Florida Solar Energy Center mobile testing unit. Agreement of predicted and experimental results for collector inlet and outlet temperatures, mean storage tank temperature, and circulating mass flow rate was excellent with differences of the order of 10% or less with drawoff. B.J.

A78-11238 **The application of stainless steel to solar collectors.** J. D. Redmond, E. A. Lizlovs (Climax Molybdenum Company of Michigan, Ann Arbor, Mich.), and R. M. Davison (Climax Molybdenum Co., Greenwich, Conn.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 5-1 to 5-4. 9 refs.

Exposure tests performed at 90 C in O2-saturated potable water have been used to evaluate the pitting and crevice corrosion resistance of several stainless steels (austenitic steels Type 304 and 316 and ferritic steels Type 409, 430, 439, and 444) which have been considered for absorber plate materials in solar collectors. A major result of the study is that the addition of 2% Mo to the Type 444 steel greatly increased its resistance to pitting and was particularly effective in mitigating crevice corrosion. These results indicate that Type 444 could be used in a once-through system in which the heat transfer fluid is potable water or swimming pool water. B.J.

A78-11239 **Thin film CrO/x/ selective absorbers stable above 500 C.** H. S. Gurev (Arizona, University, Tucson, Ariz.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 5-5 to 5-7. 13 refs. NSF Grant No. DMR-7501267; Contract No. E(29-2)-3709.

A thin-film tandem absorber is described which has been fabricated by reactively evaporating a chromium oxide (CrO/x/) absorber onto a stabilized silver film reflector and then coating the resulting stack with a 500-A layer of SiO2 via electron-beam evaporation. A solar absorptance of 87.4% and an emittance of 5.7% are measured at 600 C in vacuum for a typical SiO2-CrO(x)-Ag stack. It is found that heating in air at 650 C for 10 min causes small but beneficial changes in room-temperature optical properties, that absorptance increases and emittance decreases after such heating, and that further heating (to 120 min) produces only minor changes. The 500-A SiO2 overcoat is shown to be critical to the oxidation resistance of the absorber stack, inasmuch as bare CrO(x)-Ag sandwiches fail catastrophically within 10 min at 650 C in air, losing their silver reflector films by agglomeration. F.G.M.

A78-11240 **Non-corrosive, non-freezing, and non-toxic heat transfer fluids for solar heating and cooling.** K. W. Kauffman (Franklin Institute Research Laboratories, Philadelphia, Pa.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 5-8 to 5-12. 6 refs.

Aqueous heat transfer fluids using inorganic salts have been developed which provide freezing protection to -15 C or better, form protective anti-corrosive coatings on aluminum and steel, and which are substantially non-toxic. The performance and reliability of these fluids are compared to that of aqueous glycols and non-aqueous organic heat transfer fluids. (Author)

A78-11241 **Optically thin diffusion barriers enhance the life of metal/metal oxide selective surfaces.** M. C. Keeling (Motorola, Inc., Phoenix, Ariz.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 5-13, 5-14.

It is noted that solar selective metal/metal-oxide composites such as black chrome are susceptible to near- and medium-term degradation as a result of substrate-metal migration through the upper oxide layer and its subsequent oxidation in the warm collector environment. This paper demonstrates that the addition of a barrier metal substrate tends to reduce and sometimes even eliminate solid diffusion of the substrate species. Several candidate barrier metals are considered, and it is shown that a stable metal/metal-oxide system can be obtained by depositing a barrier metal such as nickel on a copper substrate prior to electrodeposition of black chrome. F.G.M.

A78-11242 **Mirrors for solar energy application.** H. Taketani (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.) and W. M. Arden (Sheldahl Co., Northfield, Minn.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 5-15 to 5-19.

The specular reflectance efficiencies of candidate mirrors for central-receiver solar-energy application were measured within 4 mrad by using a spectroflectometer and two different bidirectional-reflectance-distribution-function photometers. Both first- and second-surface mirrors that employ silver as the reflective material are found to have specular reflectance efficiencies in excess of 90%, but not first-surface mirrors with chemically deposited silver. Abrasion, film-integrity, and outdoor-exposure test results are reported which indicate that polymerized first-surface mirrors require continued formulation studies to improve their properties in these areas, while second-surface mirrors would necessitate low-iron glass to achieve the desired high reflectance efficiency when single- or double-strength-thickness glass is desired for rigidity or structural reasons. A correlation between the kinetic energy of impacting particles and losses in reflectance and transmission efficiency is determined from abrasion tests on acrylic and glass substrates. F.G.M.

A78-11243 **Solar building energy use analysis.** M. Ucar, J. E. LaGraff, E. E. Drucker, and W. H. Card (Syracuse University, Syracuse, N.Y.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 6-1 to 6-6. 7 refs. ERDA-supported research.

A generalized algorithmic computer program has been developed for the mathematical simulation of the thermal behavior of multi-zone solar heated buildings. The system modeled employs a series of water-to-air heat pumps connected in a closed loop; flat plate water cooled solar collectors; a water storage tank; and a cooling tower. Weather data are represented by sinusoids, which save programming and computing time. The results indicate that the use of sinusoidal functions for temperature, and monthly average values for cloud cover is quite realistic and accurate. Temperature functions for 13 selected cities are presented. Also, a preliminary analysis of the feasibility of using desiccant systems with solar regeneration for dehumidification in the summer was made. (Author)

A78-11244 **Evaluation of an energy conserving research house involving multi-modal operation of solar and heat pump systems.** J. E. Woods and P. W. Peterson (Iowa State University of Science and Technology, Ames, Iowa). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 6-8 to 6-12. 15 refs. Research supported by the Iowa State University of Science and Technology.

A78-11245 **A solar powered desiccant air conditioning system.** E. Lodwig (Niagara Blower Co., New York, N.Y.), D. A. Wilke, and J. Bressman. In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 7-1 to 7-3.

A solar energy conservation plant is discussed which demonstrates the feasibility of utilizing solar energy to provide domestic hot water and heat during the heating season and air conditioning during the cooling season for a nonresidential building. The air conditioning system employs a liquid dessicant to dry air and is equipped with both a double-glazed flat-plate collector system and an evacuated-tube system. The actual air-conditioning process is described in detail, and it is noted that the mechanical configuration and components available for the solar power plant are compatible with existing conventional systems. F.G.M.

A78-11246 **Theoretical analysis and design - A solar powered ammonia/water absorption air conditioning system.** E. A. Farber, C. A. Morrison, and H. A. Ingley (Florida, University, Gainesville, Fla). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 7-4 to 7-9. 10 refs.

A78-11247 * **Site-dependent factors affecting the economic feasibility of solar powered absorption cooling.** J. C. Bartlett (IBM Corp., Federal Systems Div., Huntsville, Ala.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 7-10 to 7-14. Contract No. NAS8-32036.

A procedure has been developed which can be used to determine the economic feasibility of solar powered absorption cooling systems. This procedure has been used in a study to investigate the influence of the site-dependent parameters on the economic feasibility of solar absorption cooling. The purpose of this study was to make preliminary site selections for solar powered absorption cooling systems. This paper summarizes the results of that study. (Author)

A78-11250 **Theoretical modeling of an ammonia/water absorption cycle with solar energy storage.** J. W. Baughn and M. J. McDonald (California, University, Davis, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 7-24 to 7-28. 11 refs.

An ammonia/water absorption cycle with a flat-plate collector heat source has been modeled with a computer. The model includes the capability of storing energy while operating as an intermittent cycle and operates either as a heat pump or as an air conditioner. Calculations with this model show that this combined use of an absorption cycle is possible given sufficient insolation. In the heat pump mode, the energy storage concentration is greater than storing hot water, but the efficiency is lower. In the air conditioning mode, storage is shown to be feasible, although no comparison to other means of solar cooling is made. (Author)

A78-11251 **A general design method for closed-loop solar energy systems.** S. A. Klein and W. A. Beckman (Wisconsin, University, Madison, Wis.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 8-1 to 8-5. 6 refs.

The performance of solar space and domestic water heating systems can be estimated by a simple procedure referred to as the 'f-chart' method. However, the 'f-chart' method is not applicable for other uses of solar energy such as solar air conditioning and process heating. A method of estimating the performance of solar energy systems for these other applications is presented here. The method uses the 'f-chart' approach and the Liu and Jordan phi-curves. (Author)

A78-11252 **Optimization of solar heating in residential buildings using a stochastic performance model.** M. H. Walker, W. S. Duff, and G. F. Lameiro (Colorado State University, Fort Collins, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 8-6 to 8-10.

A stochastic performance prediction model (STOLAR) and an optimization program (algorithm plus cost function) are utilized in optimizing collector area and storage capacity for residential solar energy heating systems. The stochastic model provides: total heat load, auxiliary heat load, and heat supplied by solar energy over a specified time period, as output. The optimization program outputs a combination of design variables maximizing present worth. Several collector systems are compared: an evacuated tube liquid collector, a flatplate liquid collector, and a flatplate air collector. R.D.V.

A78-11253 **Computer optimization of solar collector area based on life-cycle costing.** L. O. Degelman (Maryland, University, College Park, Md.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 8-11 to 8-15. 15 refs. Research supported by the University of Maryland.

A description is given of a model and computer program for optimizing the area of flat plate solar collectors for heating of buildings. The model is capable of being applied to all types of fixed position flat plate solar collectors used for space and domestic hot water heating; though it can be adapted to concentrating and tracking type collectors with minor modifications to the computer program. Variables in the model include collector slope and orientation, initial cost, cost of heating energy, economic life of the collector system, interest rate, annual cost escalation rate on heating energy, peak heating loads and local weather conditions. The hourly outdoor temperature and solar conditions are generated by a simulation model in the computer program. Output from the program includes life-cycle costs for collector systems of optional areas, costs, slopes and absorber types. (Author)

A78-11254 **Moderate-level-of-rigor methods for solar heating system performance prediction.** P. R. Armstrong (Colorado State University, Fort Collins, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 8-16 to 8-20. 9 refs.

Various performance prediction techniques for solar-aided heating systems are considered, from FCHART to SIMSHAC. A statistical model of intermediate rigor and flexibility and based on joint probability densities of load-insolation and computations over a range of time increments and collector orientations is considered, along with a long time-step model (two intervals per day) involving low-dimension vector-state simulation. One-day meteorological data resolution, analysis of large data samples (10 to 30 years), and fixed thermal conductance load are common to the two models. R.D.V.

A78-11255 **Prediction of the monthly and annual performance of solar heating systems.** P. J. Lunde (Center for the Environment and Man, Inc., Hartford, Conn.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 8-21 to 8-25. 8 refs.

A simple method for prediction of solar hot water heating system performance is presented which predicts monthly and annual system performance with good accuracy (relative to hourly simulations) over a wide range of system variables using a well-mixed storage capacity of 97.60 kg/sq m (20 lb H2O/sq ft) collector area. The method relies on heavily preprocessed site-specific radiation and weather data which are used in combination with system parameters to calculate intermediate functions from which the proportion of the monthly load carried by solar energy can be determined. If long-term weather and radiation data are preprocessed, the method automatically yields results equivalent to simulations over the entire period for which the data are available. (Author)

A78-11256 **Simplified techniques for sizing residential solar heating systems.** C. D. Barley, C. B. Winn (Colorado State University, Fort Collins, Colo.), and S. E. Huck (Anderson Engineering Co., San Antonio, Tex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 8-26 to 8-30. 11 refs.

Proper sizing of optimal collector area for residential solar heating systems is addressed. Several approaches are surveyed: FCHART, the Ward method, and the relative-areas method. Relevant design charts are provided. All of the methods are found about equally suitable for optimum area determinations, with the relative-areas method offering advantages in determining annual fraction of heating load. R.D.V.

A78-11257 **Solar system cost/performance analysis.** R. Bruins-Slot and P. Timberman (Sun House Design, Occidental, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 8-31 to 8-34.

This paper presents methods of assessing (1) the financial feasibility of using solar heating, (2) the optimum system size, and (3) the capitalization of solar equipment. The general considerations and equations are presented. Three graphs illustrate the use of the equations: the first is a plot of the building and solar system energy performance derived from a computer simulation; the second graph plots the ratio of system worth to system performance. The optimal system size is obtained from this curve. The third graph defines the financial break-even time; from this, the feasibility of using the system can be judged. (Author)

A78-11260 **Fluid flow control strategies in flat-plate and evacuated tube collectors.** T. M. Conway (Colorado State University, Fort Collins, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 9-11 to 9-14. 5 refs.

Fluid flow control strategies embodied in the CSU flat-plate liquid collector and the Corning evacuated tube solar collector are compared. The thermal mass of the collecting fluid in contact with the solar absorbing surface is relatively small in both solar collectors, so that the collector fluid temperature can climb rapidly when the fluid is stagnant. Pump control timing then becomes crucial. Maximization of collection combined with minimization of power drain for pumping is aimed at in control optimization. Response and reliability of an integrated solar radiation intensity sensor or of collector fluid intensity collector is deemed most crucial to effective control. R.D.V.

A78-11261 **Preliminary comparison of proportional and full on-off control systems for solar energy applications.** R. J. Schlesinger (Rho Sigma, Inc., Van Nuys, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 9-15 to 9-18.

With the advent of proportional controllers, for solar energy hot water and heating, analysis of their effectiveness relative to the conventional on-off (Slam-Bang) system is in order. A preliminary investigation, using typical operating parameters for each type of controller was undertaken with the aid of a computer simulator model. The input conditions, the simulation model, and the results are presented. The analysis shows that under certain conditions, notably days of low insolation, the proportional control offers advantages over Slam-Bang systems. The conditions and degree of the gains to be realized are covered in detail. (Author)

A78-11262 **A suboptimal controller for a domestic solar heating system utilizing a time varying price for electricity.** A. H. Eltimsahy and E. A. Santos, Jr. (Toledo, University, Toledo, Ohio). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 9-19 to 9-23.

A78-11264 **Maintenance costs of solar air heating systems.** J. C. Ward and G. O. G. Löf (Colorado State University, Fort Collins, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 10-2 to 10-8. Contract No. EY-76-S-02-2830.

The performance of a solar air heating system in Colorado has been recorded during the 1959-1960, 1974-1975, and 1976-1977 seasons in order to determine annual maintenance cost. Temperature observations were carried out using 20 copper-constantan thermocouples and two twelve-channel recorders. Solar radiation data was integrated and recorded on an hourly basis, and daily observations were made of the amount of hot water used, the electricity used by the system's single blower, the electricity used in the home, gas used by the auxiliary furnace, and gas used for hot water heating. It is concluded that the annual maintenance cost of such a system (expressed as a percentage of the original installed cost) is approximately 1% per year. This figure may be compared to an unavoidable annual decline in performance of about 1%. It is suggested that although these figures are calculated for air-heating systems, corresponding costs for liquid-heating systems will not be any less. S.C.S.

A78-11265 **Design considerations for residential solar heating and cooling systems utilizing evacuated tube solar collectors.** D. S. Ward and J. C. Ward (Colorado State University, Fort Collins, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 10-9 to 10-14. 5 refs.

A78-11269 **A hybrid passive/active solar house.** B. D. Hunn (California, University, Los Alamos, N. Mex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 11-16 to 11-20.

A hybrid passive/active solar-heating house has been designed and constructed in New Mexico. The system consists of a two-story Trombe wall made of one-foot thick slump block covered with a double glazing. In place of a natural convection loop circulating air to the heated space, a blower circulates air through the wall into a rock bed. A forced-air distribution system (with a natural gas auxiliary furnace) is connected to the rock bed. Direct gain of solar heat is also obtained through 13 sq meters of windows. A separate flat plate liquid collector array heats water going to a preheater tank for domestic hot water. Experimental operation has shown that the inside surface temperature of the wall fluctuates predictably between 18 and 32 C providing heat to the house during the evening when it is needed most. It is concluded that this hybrid passive/active system, when compared to active solar heating systems, is economically advantageous. S.C.S.

A78-11272 **The computer-aided design of windows as passive solar collectors.** M. Milne (California, University, Los Angeles, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 12-1 to 12-5. 5 refs. Research supported by the University of California.

The use of windows as passive solar collectors is discussed, and SOLAR-2, an interactive computer-aided design program for designing an energy efficient window-sunshade assembly, is described. Windows with properly designed shading and orientation will supply a significant portion of a building's heating needs during the winter months and also exclude radiation and reduce cooling loads during summer months. The designing of a building's passive solar collector windows will be facilitated by the SOLAR-2 computer program which can deal with the computational complexity of evaluating each window's geometry, orientation, transmitting materials, shading devices, and construction details. M.L.

A78-11273 **Solar energy applications for heat-absorbing glass.** C. Deminet (Boeing Aerospace Co., Seattle, Wash.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13.
Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 12-6 to 12-8.

Commercially-available infrared-absorbing glass transmits over 70% of the visible part of the solar spectrum and absorbs nearly 100% of the infrared. The application of such glass to solar energy production has been suggested as the composition of the heat-absorbing glass may be adapted for various applications. Such applications include: (1) liquid collectors, where the collector consists of a glass-panel structure with vacuum cells and liquid passages, (2) collectors where the circulating fluid is air, (3) Trombe walls, based on heat-absorbing black masonry structures, and (4) heat-absorbing glass blocks for greenhouses. S.C.S.

A78-11275 **A study of the differential spectral absorption flat-plate solar collectors.** A. Cheung and G. French (South Dakota School of Mines and Technology, Rapid City, S. Dak.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13.
Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 12-14 to 12-18. 7 refs.

This paper presents an investigation of a transparent type window collector. This window collector operates on the principle that different materials have different cutoff wavelengths. By choosing an appropriate working fluid, the collector can be made transparent to visible light and still absorb a major portion of the solar radiation. The overall solar energy transmitted and recovered are computed using the net radiation method. The angle of refraction and the reflection are determined by using the generalized Snell's and Fresnel's Laws. The analytical results indicate that, with water as the working fluid, overall recovery factors of 20 to 25% are possible. The results further indicate that the thermal efficiency of these window collectors can be made competitive with the common flat plate collector, if a working fluid with cutoff wavelength lower than water is used. (Author)

A78-11276 **Thermal mass and beadwalls in two new buildings.** P. Shippee (Colorado Sunworks, Boulder, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13.
Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 12-19 to 12-21.

This paper reports on the use of beadwalls (for moveable insulation) and thermal mass (for solar heat sink storage) to capture solar energy for residential space heating. Two buildings which apply this type of system in different ways are discussed. Cost and performance indicate that passive solar heating is the next fully developed alternative technology for fuel saving/energy conservation after adding cost effective insulation. Architectural integration of large thermal mass within the building is the major design challenge. Beadwalls are the most effective method for nonmanual vertical moveable insulation although they may not be the most cost-effective method for all climates. (Author)

A78-11277 **A performance evaluation of a solar house in Quebec.** R. G. Kerr, M. Turaga, M. M. Shapiro (Concordia University, Montreal, Canada), and R. D. McConnell (Hydro-Québec, Institut de Recherche, Varennes, Canada). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 13-1 to 13-5. Research supported by the Brace Research Institute and Hydro-Québec.

A solar-heated house in Quebec was monitored during the 1976-1977 heating season for meteorological data, electrical consumption, and temperatures. Particular attention was given to an evaluation of the efficiency of the vertical air-heating collector, and the percentage of heating load met by solar energy. The estimate of the solar contribution was derived using both ASHRAE techniques and by normalizing measured solar heat input to fan operation. It is concluded that approximately 40-45 percent of the heat was provided by solar energy. S.C.S.

A78-11279 **Solar heating and cooling of mobile homes test results.** A. S. Jacobsen (General Electric Co., Valley Forge, Pa.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13.
Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 13-11 to 13-15.

An integrated solar heated and cooled mobile home has been developed by a combined ERDA/GE project. The basic sub-systems include: a solar collector array, an energy storage medium, and heating/cooling equipment. The system may be controlled either manually or automatically from a console located in a bedroom. The system operates in a variety of modes including one for excess heat rejection. Tests were performed using actual equipment, and the results were compared to those of a computer simulation, exhibiting good agreement. The specific parameters evaluated include thermal energy storage (in which larger than predicted losses occurred), collected solar energy, and heating load demand. Steady state and transient performance tests were conducted to evaluate solar air conditioning performance using both a Rankine driver vapor-compression air conditioner and an absorption air conditioner. S.C.S.

A78-11280 **Evaluation of a residential solar heating and cooling system with high performance evacuated tubular collectors.** W. S. Duff, G. O. G. Löf, C. B. Winn (Colorado State University, Fort Collins, Colo.), J. Leflar, and D. Meredith. In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 13-16 to 13-20.

A78-11281 **Shenandoah Solar Recreational Center - An overview.** J. R. Williams (Georgia Institute of Technology, Atlanta, Ga.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 13-23 to 13-27. 7 refs. ERDA-supported research.

The Shenandoah Solar Community Center in Georgia is presently the world's largest building (5481 sq meters) using solar energy for heating, air conditioning, and hot water heating. The solar array is composed of 63 8 x 21 ft flat plate solar collector panels with the copper internal-tube absorber plates insulated to a K value of 0.28 watts/sq ft/deg C. The center utilizes 1042 sq meters of glazed black chrome collectors with 2415 square meters of highly polished aluminum reflectors. A 56.8 cubic meter hot water storage tank and two 113.6 cubic meter chilled water storage tanks are buried beneath the earth berm surrounding the building. The system operates in basically two modes, summer (above 55 F) and winter (below 55 F), with provisions for a summer mode with insuficient insolation. The building incorporates energy conserving features (such as the earth berm which creates conditions having minimal heating requirements) and a small number of large collector modules which reduces installation costs. S.C.S.

A78-11282 **Monitoring and evaluation of solar heating in northern New England.** A. O. Converse (Dartmouth College, Hannover, N.H.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 1-13. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 13-28 to 13-32. Research supported by the Central Vermont Public Service Corp., Grumman Aerospace Corp., Owens-Illinois Corp., Pittsburgh Plate Glass Foundation, Garden Way Laboratories, State of Vermont, and NSF.

Five buildings of different designs have been characterized by field monitoring. These data were then used in a computer simulation for a standard year to provide the basis for comparison of the different designs. The economic performance is characterized by the rate of return. Two water heating installations were also studied. (Author)

A78-11283 * **Characterization of terrestrial service environments - The simultaneous occurrence of combined conditions of solar insolation and climatic variables.** R. E. Thomas, D. C. Carmichael (Battelle Columbus Laboratories, Columbus, Ohio), and W. F. Carroll (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 14-1 to 14-6. 9 refs. ERDA-supported research; Contract No. NAS7-100.

Computational methods for occurrences of combined environmental and pollution variables are compared. General statistical data and diurnal statistics on 24 environmental variables are treated. Combinations of variables dealt with include: air temperature, relative humidity, wind speed, total insolation; air temperature and weather event (rain, fog); air pollutant and weather event; wind speed, wind direction, and weather event; air temperature, total insolation, and weather event; air temperature, relative humidity, wind speed, computed direct insolation levels; air temperature, relative humidity, air pollution. R.D.V.

A78-11284 **An accurate, economical, solar insolation computer model for the United States.** R. L. Hulstrom (Martin Marietta Aerospace, Denver, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 14-7 to 14-11. 6 refs.

A computerized solar insolation model (SIM) for ascertaining solar insolation of a collector panel arbitrarily oriented is described. SIM was developed for study of a solar photovoltaic residential prototype system. Percent sunshine data reported in the National Climatic Atlas is used for input, rather than data on cloud cover. SIM equations and procedures are described. R.D.V.

A78-11285 **Estimation of availability of solar energy.** D. Rapp (Texas, University, Richardson, Tex.) and A. A. J. Hoffman (Texas Christian University, Fort Worth, Tex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 14-12 to 14-16.

A procedure is developed for estimating availability of solar energy in localities where adequate data are not available. The hourly variations in solar intensity with day of the year during clear weather (essentially no clouds and unlimited visibility) are shown to follow regular repeatable patterns. These patterns have been determined for four southwestern locations. From these data, it is possible to estimate the maximum possible available solar energy for perfectly clear weather. The effect of clouds and reduction in visibility is to reduce the solar intensity below the value appropriate to any hour of any day in clear weather. A study of the dependence of reduction in solar intensity on cloud cover and visibility is now being conducted for several southwestern locations. Results are available at two locations. A model for the dependence of direct normal solar intensity on total insolation is also being developed. (Author)

A78-11288 **Hourly direct-normal solar radiation data tapes for the United States.** C. M. Randall, M. E. Whitson, Jr. (Aerospace Corp., Los Angeles, Calif.), and E. C. Boes (Sandia Laboratories, Albuquerque, N. Mex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 14-26 to 14-30. ERDA-supported research.

Improved estimates of hourly direct-normal insolation have been prepared for the 26 United States sites where the hourly total-hemispheric insolation values have recently been reviewed and corrected by the U.S. National Oceanic and Atmospheric Administration (NOAA). These computer compatible data tapes covering up to 25 years, are in the NOAA SOLMET format and are intended for use in solar energy systems design and performance analysis. The improved estimation procedures, which are the principal topic of this paper, are based on simultaneous observations of hourly direct-normal and total-hemispheric insolation from 5 United States locations with widely differing climates. The estimation algorithm reported here reproduces both the distribution of direct insolation values as well as their mean values by statistical techniques constrained by limits which the radiative transfer processes impose. (Author)

A78-11289 **Analysis of two methods used to generate climatological data for design of solar energy buildings.** D. I. Stillman and T. C. Chen (Parsons, Brinckerhoff, Quade and Douglas, Inc., New York, N.Y.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 14-31 to 14-35. 15 refs.

A78-11295 **Efficiency of paraffin wax as a thermal energy storage system.** A. D. Fong and C. W. Miller (California, University, Berkeley, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 16-6 to 16-10.

A study of paraffin wax as a thermal energy storage medium was conducted to determine the performance of the wax as compared to water. The particular wax used, with 205 KJ/kg contained within a heat of fusion range extending from 45 C to 63 C, had a thermal energy storage capacity that was approximately 2.5 times greater than that of water in the same temperature range. Heat storage and heat removal tests yielded performance coefficients of 0.5 to 0.6 in this region. This coefficient could be increased by an improved heat exchanger design. By studying the effect of different heat exchanger configurations, an improved design was determined which would increase the melting process. Cells, of aspect ratio (height/width) on the order of 1, were used to help enhance the convection heat transfer. (Author)

A78-11296 Optimization of an annual storage solar heating system over its life cycle. F. C. Hooper and C. R. Attwater (Toronto, University, Toronto, Canada). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 16-11 to 16-15.

For systems combining annual storage solar heating and auxiliary heating, the optimum combination is found when the true incremental cost of solar heating capacity is equal to the life cycle average cost of fuel. This will fall slightly below the size of solar heating system adequate to provide 100% of heat requirements on the average year. In many cases, 100% solar heating without auxiliary heating will be more cost effective over the life cycle than a combined system. (Author)

A78-11297 Gravel-filled trenches in earth for annual thermal energy storage. P. L. Blackshear, P. Emerson, B. R. Baliga, and M. Riaz (Minnesota, University, Minneapolis, Minn.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 16-16 to 16-19. Contract No. E(11-1)-4009.

The use of gravel-filled trenches for annual thermal energy storage is analyzed via digital computer. These results are compared to the performance estimates given by the single blow model. Constraints of pressure drop, stability, and trench geometry are considered with respect to volumetric, first and second law efficiencies. (Author)

A78-11298 Modeling underground storage in aquifers of hot water from solar power systems. C. F. Tsang, C. B. Goranson, M. J. Lippmann, and P. A. Witherspoon (California, University, Berkeley, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 16-20 to 16-24. 17 refs. ERDA-sponsored research.

The feasibility of storing hot water from solar energy collectors in underground aquifers is explored. Using a numerical model for computing heat and mass flow in a three-dimensional water-saturated porous medium, three cases are studied: (1) daily storage, (2) seasonal storage with semi-annual cycles, and (3) seasonal storage with annual cycles. The hydrodynamic and thermal behaviors of the storage system are analyzed and illustrated. In all the cases studied the energy retrieval is found to be over 80%. (Author)

A78-11299 Dual phase annual cycle, index of application. D. Cerruti (Texas Solar, Houston, Tex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 16-25 to 16-28. 6 refs.

A dual phase annual cycle (DPAC) hybrid solar residential heating/cooling system is described. A method for feasibility evaluation of the system in a specified region is presented. A numerical Index of Application for DPAC systems in various USA cities is presented. R.D.V.

A78-11302 Mass and energy transfer in a hot liquid energy storage system. W. F. Phillips (Utah State University of Agriculture and Applied Science, Logan, Utah) and R. A. Pate. In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 17-6 to 17-10. 13 refs.

Combined experimental and theoretical analysis is carried out on a hot liquid energy storage system. Stratified models with rocks or eutectic salt as storage media are compared to the hot-water or hot-liquid systems with mixing. Viscous entrainment with large mixing currents within the tank is taken into account, with complete and incomplete mixing compared. Greater adequacy of the viscous entrainment model, over complete mixing and stratified layer models, is claimed. R.D.V.

A78-11304 ROCKBED - A computer program for thermal storage. J. A. Clark, R. L. Nabozny (Michigan, University, Ann Arbor, Mich.), and J. H. Heetderks (Eastman Kodak Co., Rochester, N.Y.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 17-17 to 17-20. 17 refs.

The governing differential equations and their initial and boundary conditions describing the response of a rock-bed thermal storage system are approximated in finite-difference forms and incorporated in the computer program ROCKBED. This program enables the temperature of both the solid (rock) and fluid (air) to be determined as a function of time and the distance along the bed. Other input design parameters include packing fraction of the solid material, heat transfer coefficient in the bed, fluid flow rate, size of bed and particles and the thermal properties of both fluid and solid. The program is valid for both the charging and discharging modes of operation and for arbitrarily time-varying inlet fluid temperatures in either operational mode. Energy/enthalpy integrals are incorporated into the program which provide a continuous check on the thermal balances. Comparison of the results of the finite difference formulation with an exact analytical solution for time-varying inlet temperatures, is given. (Author)

A78-11305 A numerical simulation of heat transfer in rock beds. W. D. Eshleman, C. D. Baird (Florida, University, Gainesville, Fla.), and D. R. Mears (Cook College, New Brunswick, N.J.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 17-21 to 17-25.

A numerical packed bed heat exchange model originally developed for application to heat transfer from beds of fruit and vegetables is modified for application to beds of rock. The model is recommended for working out guidelines for analysis and design of rock beds to serve as heat reservoirs for storage and controlled release of heat. A technique for determining bed convective heat transfer coefficients is included, and simulation of simplified solar collector and of a process load returning constant-temperature air to collector and storage is described. R.D.V.

A78-11306 **Fundamental studies of direct contact latent heat energy storage.** D. D. Edie, C. G. Sandell, L. E. Kizer, and J. C. Mullins (Clemson University, Clemson, S.C.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 17-26 to 17-30. 10 refs. Contract No. E(40-1)-5190.

Efficiencies of a heat of fusion energy storage system utilizing immiscible heat transfer are reported. In this device an immiscible fluid is circulated through an aqueous solution containing the phase change material. Heat is transferred by direct contact, eliminating the need for permanent heat exchange surfaces. Results of bench scale tests using a Na2HPO4 solution as the phase change material and a commercial hydrocarbon solvent as the immiscible fluid are presented. In order to predict the dynamic performance of the direct contact, as well as other latent heat storage systems, the solid growth rate of this and other phase change materials also is being studied. Crystal growth velocities are reported as a function of undercooling for Na2SO4.10H2O, Na2HPO4.7H2O and Na2HPO4.12H2O. (Author)

A78-11307 **An ionic model for the systematic selection of chemical decomposition reactions for energy storage.** W. E. Wentworth, C. F. Batten, G. E. Corbett (Houston, University, Houston, Tex.), and E. C. M. Chen (Houston, University, Clear Lake City and Houston, Tex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 18-1 to 18-4. 8 refs.

Energy storage cycles based on reversible, uncatalyzed chemical reactions are proposed and discussed. While tabulating thermodynamic properties, turning temperatures, and energy densities of metalic salt decompositions, it was noted that the heats of reaction can be placed in an ordered array which suggested that there is an independent parameter associated with each metal ion and each anion which can be used to correlate the enthalpies of decomposition. An ionic model has been formulated to explain this data for the group IA and group IIA metal hydroxides, carbonates, and sulfates. The model allows estimation of unmeasured thermodynamic data required for the selection of energy storage cycles based on these reactions. (Author)

A78-11308 **Rock properties for thermal energy storage systems in the 0 to 500 C range.** H. O. Pfannkuch and M. H. Edens (Minnesota, University, Minneapolis, Minn.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 18-5 to 18-9. 8 refs. Grant No. EY-76-S-02-4009.

Thermophysical properties of rocks depend strongly on their mineral composition, the storage temperature, and on the history of periodic temperature application (cycling). Long-term and large-scale rock bed thermal storage systems expect operating ranges between 200 C and 500 C, for which little and only scattered information is available. This paper presents a collection and critical review of experimental data from the literature on specific heat, thermal conductivity and diffusivity of representative rock forming minerals and dense (nonporous) rocks between ambient and 773 K. (Author)

A78-11309 * **Large-scale thermal energy storage using sodium hydroxide /NaOH/.** R. H. Turner and V. C. Truscello (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 18-12 to 18-15. 9 refs. Contract No. NAS7-100.

A technique employing NaOH phase change material for large-scale thermal energy storage to 900 F (482 C) is described; the concept consists of 12-foot diameter by 60-foot long cylindrical steel shell with closely spaced internal tubes similar to a shell and tube heat exchanger. The NaOH heat storage medium fills the space between the tubes and outer shell. To charge the system, superheated steam flowing through the tubes melts and raises the temperature of NaOH; for discharge, pressurized water flows through the same tube bundle. A technique for system design and cost estimation is shown. General technical and economic properties of the storage unit integrated into a solar power plant are discussed. (Author)

A78-11310 **Dual-medium thermal storage system for solar thermal power plants.** R. C. Mitchell, G. R. Morgan, and W. Unterberg (Rockwell International Corp., Rocketdyne Div., Canoga Park, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 18-16 to 18-20. Contract No. E(04-3)-1108.

The application of a dual medium thermal storage system to the ERDA 10 megawatt electrical pilot plant and to subsequent commercial plants of 100 MWe and larger is discussed. The system uses a low-cost stationary solid bed to store most of the energy, with a suitable liquid to transfer energy into and out of the bed (and to store part of the energy directly). The design, construction, and successful testing of a 5 megawatt-hour thermal storage subsystem and the preliminary design for the 10 MWe pilot plant thermal storage subsystem are described. The main advantage of the dual medium type of thermal storage system is that it offers the simplicity and flexibility of an all-liquid sensible heat storage system, but at a much lower cost. M.L.

A78-11311 **The use of wind power by electric utilities.** H. Davitian (Brookhaven National Laboratory, Upton, N.Y.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 19-1 to 19-5.

The maximum power that can be practically extracted from the wind is roughly 1 - 3 times 10 to the twelfth KWh/year which is in the range of current U.S. electricity consumption. Wind machines used by utilities are likely to be characterized by two-blades, a horizontal axis rotor, heights over 200 feet, and a synchronous generator with power ratings in the 1 megawatt range. One such machine could produce about 7 times 10 to the sixth KWh/year in an 18 mph mean wind. Currently available estimates for the costs of producing and installing machines are in the range of $500 - $700/KW for the 100th machine produced. The value of wind machines to utilities will be in this range in some parts of the U.S., given expected increases in fuel costs. This preliminary analysis of the economics of wind power indicates a promising potential for regions of the U.S. with high wind power availability and high fuel costs. (Author)

A78-11313 **Reference wind speed statistics for wind turbine design.** C. G. Justus, W. R. Hargraves, and A. Mikhail (Georgia Institute of Technology, Atlanta, Ga.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 19-11 to 19-15. Grant No. EY-76-S-06-2439.

A78-11314 **Optimum and near-optimum blade configurations for high speed wind turbines.** D. E. Cromack and P. L. Lefebvre (Massachusetts, University, Amherst, Mass.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 19-16 to 19-19. 6 refs. Contract No. E(49-18)-2365.

Presented are the results of a parametric study showing comparisons for high speed windmill rotors of 2, 3, and 4 blades and of aerodynamically optimum, near optimum, and constant chord zero-twist blade shapes. Near optimum blades consisting of linear-taper and linear-twist represent a significant degree of simplification for manufacture. Results of this study indicate that only a small performance loss is incurred for near-optimum blades when compared to the optimum chord and twist blades providing that the taper and twist are properly distributed. Curves are presented for the selection of design parameters for several near optimum blades. (Author)

A78-11315 **A practical approach to vortex augmentation of wind turbines.** N. F. Pedersen. In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 19-20 to 19-24.

The case for vortex augmentation is built by reviewing the limitations imposed on the extraction of energy from the wind by means of a conventional impulse turbine. The vortex augmented reaction wind turbine is analyzed by means of the ideal gas laws and conventional emperical flow coefficients. The results are plotted to show the relations between turbine size and turbine output as a function of wind velocity. Costs of construction are estimated and the relation to turbine output shown. (Author)

A78-11316 **Cost-effective electrical power generation from the wind.** C. J. Todd, R. L. Eddy, R. C. James, and W. E. Howell (Bureau of Reclamation, Denver, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 19-25 to 19-29. 7 refs.

Wind Energy Conversion Systems (WECS) now being developed are expected to be able to provide large amounts of electrical energy at selected windy sites at costs competitive with energy from new coal and nuclear powerplants. WECS and hydroelectric facilities for storage connected to the same large-scale transmission grids are expected to put large energy resources within reach of load centers up to 2000 km from the wind sites. Diversity of wind sites reduces the cost of storage required to smooth fluctuations in wind energy. Transmission from the best sites to load centers is expected to be preferable to local generation from the wind and sun at inferior sites. All elements of the integrated system are within the present state of the art. (Author)

A78-11317 **Wind energy - A supplement to hydro-electric energy using the Columbia River Valley as an example.** P. I. Chen and V. K. Garg (Portland State University, Portland, Ore.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25.
Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 19-30 to 19-35. 13 refs.

A78-11318 **On the correlation between daily amounts of solar and wind energy and monthly trends of the two energy sources.** J. E. Arnold (Texas A&M University, College Station, Tex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25.
Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 19-36 to 19-40. Research supported by the Texas A&M University.

A78-11319 **A feasibility study of a combined wind-solar system for space and domestic hot water heating.** A. L. Evans, R. L. Reid (Cleveland State University, Cleveland, Ohio), and R. C. Hendricks. In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 19-41 to 19-45. 7 refs.

In this study, a combined wind-solar system was simulated where the electrical energy produced by the wind generator was stored thermally in the water storage tank of the solar system. An examination of wind and solar data for Cleveland, Ohio showed the system to be particularly attractive for this location. A computer simulation was run over a year period using a modified version of TRNSYS. TRNSYS had previously been modified to include an economic subroutine for breakeven time and present worth. The program was further modified to include a wind generator subroutine. The economic analysis showed that a combined wind-solar system with home-assembled wind generators will be more economical than a pure solar system if the installed solar system cost is greater than $120/sq m. (Author)

A78-11320 **The application of solar energy to boiler feedwater heating in steam-electric power plants.** H. G. Lorsch (Franklin Institute Research Laboratories, Philadelphia, Pa.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25.
Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 20-1 to 20-5. 7 refs.

The technical and economic feasibility of augmenting the heating of boiler feedwater in steam-electric power plants by solar energy was investigated. It was found that this does not constitute a cost-effective method of fossil fuel conservation. Under the most favorable conditions, an investment of $1200 or more is required to save one barrel of oil per year. Even if all potentially suitable U.S. power plants were equipped with solar augmentation, the resultant saving in oil and gas represents less than one-quarter of one percent of the current U.S. consumption of these fuels. (Author)

A78-11321 * **Solar Stirling power generation - Systems analysis and preliminary tests.** M. K. Selcuk, Y.-C. Wu, P. I. Moynihan, and F. D. Day, III (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 20-6 to 20-10. Contract No. NAS7-100.

The feasibility of an electric power generation system utilizing a sun-tracking parabolic concentrator and a Stirling engine/linear alternator is being evaluated. Performance predictions and cost analysis of a proposed large distributed system are discussed. Design details and preliminary test results are presented for a 9.5 ft diameter parabolic dish at the Jet Propulsion Laboratory (Caltech) Table Mountain Test Facility. Low temperature calorimetric measurements were conducted to evaluate the concentrator performance, and a helium flow system is being used to test the solar receiver at anticipated working fluid temperatures (up to 650 or 1200 C) to evaluate the receiver thermal performance. The receiver body is designed to adapt to a free-piston Stirling engine which powers a linear alternator assembly for direct electric power generation. During the next phase of the program, experiments with an engine and receiver integrated into the concentrator assembly are planned. (Author)

A78-11322 **Solar tower - Thermal collection energy component: 10 MWe pilot plant.** A. C. Meyers, III and A. F. Hildebrandt (Houston, University, Houston, Tex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 20-11 to 20-15. 14 refs. Grant No. EG-76-G-05-5178.

Net energy analysis is characterized and key terms are defined. The analysis is applied to the thermal collection segment of the 10MWe solar tower central receiver pilot plant to determine the amount of energy this subsystem component represents with respect to the construction and operation of the facility. The first step in net energy analysis is to determine the material make-up of the various components. The process energy consumption for production of raw steel and of concrete are calculated, as are the capital energy required and the time required to recover capital energy. M.L.

A78-11323 **A novel gas adsorption cycle for solar thermal power generation.** T. L. Hartman, Jr., T. L. Hartman, III, and J. R. Williams (Georgia Institute of Technology, Atlanta, Ga.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 20-16 to 20-19. 5 refs.

The present configuration for solar thermal power towers are severly restricted by the low thermal efficiency which results from the temperature and pressure restriction under which they must operate. This paper presents a new thermodynamic cycle which, while operating under the same pressure and temperature restrictions, offer significantly increased performance. It should be noted that this cycle is not restricted to solar power applications, but may also be of utility in nuclear and fossil fuel applications. This paper presents a summary of previous research, a detailed heat balance of the cycle, and the scope and initial results of on-going research. (Author)

A78-11324 **Analysis of closed cycle Brayton systems for solar electric power generation.** J. R. Gintz and G. L. Vieth (Boeing Aerospace Co., Seattle, Wash.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 20-20 to 20-24. Research supported by the Electric Power Research Institute.

A performance and cost analysis of three Brayton-type gas cycles was done for a high temperature/central receiver solar power plant. The three cycles were closed cycle helium and open and closed cycle air. These analyses are an important inclusion in solar power plant studies because of the direct effect cycle efficiency has on heliostat costs, with these costs typically estimated to be on the order of 50% of the plant costs. (Author)

A78-11325 **A liquid sodium cooled solar tower system.** L. L. Vant-Hull (Houston, University, Houston, Tex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 20-25 to 20-29. 9 refs. Grant No. EG-76-G-03-1426.

A low pressure liquid sodium cooled central receiver system is described. The high thermal conductivity of liquid metals leads to a more compact and efficient receiver while the generation of turbine steam from hot stored sodium decouples the turbine from the receiver and leads to very efficient trouble free operation. Safety and economics of the sodium system are comparable to a water steam system with hot oil and rocks thermal storage. (Author)

A78-11326 **Results of experiments with heliostats for central receiver power plants.** J. P. Thornton and D. Waddington (Martin Marietta Aerospace, Denver, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 21-1 to 21-6. Grant No. EY-76-C-03-1110.

Procedures for testing central receiver power plant heliostats are described. Two techniques for determining the mirror performance factor (MPF) are explained - the first is a water calorimeter which can measure total energy from images as large as 7.32 m in diameter and is capable of measuring fluxes in excess of 450,000 BTU/hour; the second consists of 13 radiometers which respond to heliostat beams swept laterally across the bank at a known rate. MPF is defined for each of the two techniques with attention to attendant performance factors. It was determined that heliostat performance can be measured to within a few percent by using either a water calorimeter or bank of radiometers. M.L.

A78-11327 **Subsystem research experiments on a central receiver collector.** C. R. Easton, J. B. Blackmon, and R. E. McCormick (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 21-7 to 21-10. ERDA-sponsored research.

The testing of heliostats, a subsystem associated with a central receiver collector, is described. The heliostats (either singly or as an array), their controls, and appropriate component-level test articles were studied. The objectives and techniques of several tests - controls development, heliostat structural, environmental, life, and beam quality - are explained. It is concluded that, as a result of these tests, no development or qualification testing is required to build a fully satisfactory collector for a central receiver power plant. M.L.

A78-11328 **An analytic evaluation of the flux density due to sunlight reflected from a flat mirror having a polygonal boundary.** F. W. Lipps and M. D. Walzel (Houston, University, Houston, Tex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 21-11 to 21-14. 5 refs. Contract No. E(04-3)-1108.

Computer algorithms for the flux density of reflected sunlight from a heliostat become an essential part of the optical simulation problem for the solar central receiver system. An exact analytic result is available for heliostats having polygonal boundaries. A comparison is made between the analytic method and the Hermite function method, which is much faster but less accurate. The analytic method provides a basis for evaluating all other flux density calculations. (Author)

A78-11329 **One MWth solar cavity steam generator solar test program.** T. R. Tracey, F. A. Blake (Martin Marietta Aerospace, Denver, Colo.), C. Royere (CNRS, Odeillo, Pyrénées-Orientales, France), and C. T. Brown (Georgia Institute of Technology, Atlanta, Ga.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 21-15 to 21-20. Grant No. EY-76-C-03-1068; Contract No. E(40-1)-4921.

The solar test program for a 1 MWth solar cavity steam generator is described. In this system, the parabolic concentrating mirror receives the redirected beam of solar radiation from the heliostat field and focuses it to a point in the focal building; the experimental equipment placed at this point is irradiated by the concentrated solar radiation. It is concluded that the thermal performance of the generator has demonstrated the potential of the cavity receiver concept. Both the cavity efficiency and the boiler efficiency exceeded 90 percent, with potential further improvements indicated. High solar utilization factors were realized during long test runs, with rated pressures maintained over 91 percent, and rated superheat over 78 percent of available daily insolation. No excessive thermal stresses were detected. M.L.

A78-11330 **A cellwise method for the optimization of large central receiver systems.** F. W. Lipps and L. L. Vant-Hull (Houston, University, Houston, Tex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 21-21 to 21-25. Contract No. E(04-3)-118; Grant No. EG-76-G-05-5178.

An optimization procedure based on minimizing the cost of thermal energy produced by a central receiver system is described. The anticipated collector field, composed of a large number of heliostats, is divided into an array of computational cells associated with a tower of a given height. The RCELL program is used; this program performs a set of variations on the geometry in each cell and outputs the optimum design. Factors considered include the system performance model and figure of merit, optimization, the effect of land and wiring costs, and the effect of receiver losses. M.L.

A78-11331 **Fixed mirror/distributed focus solar thermal electric power systems development.** R. R. Walters, M. J. O'Neill, and Y. P. Gupta (E-Systems, Inc., Energy Technology Center, Dallas, Texas.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 21-26 to 21-30. 5 refs.

This paper presents the current developments in the overall design, performance and cost analyses of a solar thermal power system concept which uses large fixed spherical mirror segments for the concentrator. This concept is referred to here as the Fixed Mirror/Distributed Focus Solar Thermal Electric Power System (FMDF-STEPS) where a large multi-megawatt power facility would use an array of FMDF collector modules. Results of optical, thermal, structural and economic studies utilizing detailed computer modeling of the FMDF-STEPS are presented along with cost/performance data in terms of dollars per kilowatt of installed costs. These data are compared with that for other solar system concepts currently under consideration by the Energy Research and Development Administration (ERDA). (Author)

A78-11332 **Baseline design of commercial central receiver solar power plant.** F. A. Blake (Martin Marietta Aerospace, Denver, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 21-31 to 21-35. Grant No. EY-76-C-03-1110.

A central receiver type solar plant design is discussed with attention to experimental studies of the subsystems. The commercial plant with a rated output of 150 MWe during sunlight operation and an output of 105 MWe from storage consists of fifteen solar collector modules, a thermal storage field, and an electrical power generation unit. Each of the collector modules feature 1718 focusing heliostats which focus sunlight into tower mounted cavity receiver steam generators. A 10 MWe pilot plant is described, and research on the thermal storage subsystem, collector subsystem, receiver subsystem, and electrical generation is considered. M.L.

A78-11334 **Low cost, high-efficiency solar cells using indium-tin oxide on semiconductor /OSOS/ solar cells.** J. B. DuBow, I. S. Duff, and J. Shewchun (Colorado State University, Fort Collins, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 22-5 to 22-8. 5 refs.

A78-11335 * **Solar photovoltaic power stations.** C. R. Chowaniec, P. F. Pittman (Westinghouse Electric Corp., East Pittsburgh, Pa.), R. R. Ferber (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.; Westinghouse Electric Corp., East Pittsburgh, Pa.), and B. W. Marshall (Sandia Laboratories, Albuquerque, N. Mex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 22-9 to 22-13. Contract No. E(11-1)-2744.

The subsystems of a solar photovoltaic central power system are identified and the cost of major components are estimated. The central power system, which would have a peak power capability in the range of 50 to 1000 MW, utilizes two types of subsystems - a power conditioner and a solar array. Despite differences in costs of inverters, the overall cost of the total power conditioning subsystem is about the same for all approaches considered. A combination of two inverters operating from balanced dc buses as a pair of 6-pulse groups is recommended. A number of different solar cell modules and tracking array structures were analyzed. It is concluded that when solar cell costs are high (greater than $500/kW), high concentration modules are more cost effective than those with low concentration. Vertical-axis tracking is the most effective of the studied tracking modes. For less expensive solar cells (less than $400/kW), fixed tilt collector/reflector modules are more cost effective than those which track. M.L.

A78-11336 **The use of silicone gel for potting photovoltaic arrays.** D. A. Sierawski and C. G. Currin (Dow Corning Corp., Midland, Mich.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 22-14 to 22-17. 5 refs.

This paper describes the suitability of silicone gel for protecting solar cells in photovoltaic arrays. A silicone gel because of its soft nature will provide stress relief to the cells and interconnects. Because of its excellent adhesion a silicone gel will afford corrosion protection to the cells. This relation of adhesion and corrosion protection is explored. (Author)

A78-11337 **Characteristics of solar cells designed for concentrator systems.** D. T. O'Donnell, S. Y. Harmon, S. P. Robb, C. E. Backus, and D. L. Jacobson (Arizona State University, Tempe, Ariz.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 23-1 to 23-5. 15 refs. ERDA-supported research.

Solar cells designed for concentrator systems are reviewed. Four approaches considered are a modified conventional silicon cell design, an edge illuminated design, an interdigitated design, and a design using an AlGaAs/GaAs heterojunction. Experimental tests are summarized. It is expected that silicon cells will be developed that can operate at normal efficiencies at over 100 suns of concentration and that GaAs will be able to operate at over 2000 suns. Efficiencies decrease approximately in a linear manner with increased temperature so that a trade-off analysis would be required for a system that combines electrical and thermal outputs. M.L.

A78-11338 **Residential photovoltaic prototype system definition study.** M. S. Imamura and J. A. Sanders (Martin Marietta Aerospace, Denver, Colo.). In: International Solar Energy Society, *Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings.* Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 23-6 to 23-10.

The main effort was directed at the parametric sensitivity study and definition of the conceptual design. A computer program containing the solar irradiance, solar array, and energy balance models was developed. Using this program, analyses were conducted to determine the sensitivities of solar insolation and the corresponding solar array output at five sites selected for this study as well as the performance of several solar array/battery systems. Based on the results of this analysis, a baseline electrical configuration was chosen and three design options were recommended. Architectural renderings of two photovoltaic residential concepts, one aboveground and the other underground, are also presented. (Author)

A78-11339 **Experimental investigation of a solar cell/inverter system.** A. H. Eltimsahy and R. DeLombard (Toledo, University, Toledo, Ohio). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 23-11 to 23-15.

Experimental results of the investigation of the performance of a solar cell/inverter system (SCI) used for coupling to a conventional three-phase power network are presented. Using the mathematical model for silicon solar cells and a programmable power supply, a simulator is designed and built that allows the variation of the solar cell array size. This simulator is driven by an actual small solar cell array (reference array). The cells are then coupled to the network by means of a three phase 6 pulse silicon controlled rectifier bridge inverter similar to those used in d.c. transmission lines. Experimental studies of the steady state performance show that successful operation is possible when the solar cells are used under constant voltage and maximum power. Sample results of waveforms under successful operation are investigated. The proposed SCI system is shown experimentally to deliver over 80% of the optimal solar cell array power to the electric network. If solar cell arrays ever become economically feasible, direct conversion of the array energy to a.c. power is the most likely approach to their utilization. (Author)

A78-11340 **Dye sensitization of Schottky barrier solar cells.** T. Skotheim (California, University, Berkeley, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 23-16 to 23-19. 8 refs.

A new kind of solar cell has been made in which an organic dye is incorporated into the junction region of a Schottky barrier device consisting of Au on TiO2. This paper compares the performance of two different devices: one with approximately ten monolayers of a thiacarbocyanine dye between the semiconductor substrate and the transparent metal overlayer, and one with a semitransparent layer of hydroquinone between the dye layer and the metal. It is found that a thin layer of hydroquinone increases the quantum efficiency by more than a factor of ten to about 1% at the peak of absorption. (Author)

A78-11341 **The application of color response data of silicon cells for improving photovoltaic efficiency.** D. Ertel (Miami, University, Coral Gables, Fla.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 23-20 to 23-24.

The photovoltaic efficiency of silicon solar cells is discussed in terms of the seemingly unavoidable constraints caused by the inherent chemical properties of the semiconductor silicon. The computation of efficiency, efficiency limiting factors, and the theoretical maximum efficiency are considered. Color response studies suggest that photovoltaic efficiency might be drastically improved by filtering out useless wavelengths and concentrating light in the infrared end of the spectrum. The color response studies involved the use of spherical containers of potassium permanganate or cobalt chloride solutions as filters; these filters increased electrical output. M.L.

A78-11342 **Estimated cost of electricity produced by four types of compound parabolic concentrators.** R. Cole, A. Gorski, W. McIntire, W. Schertz, and R. Winston (Argonne National Laboratory, Argonne, Ill.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 23-25 to 23-30. 13 refs. ERDA-supported research.

Four types of compound parabolic concentrators (CPC) are compared with respect to the estimated costs for producing electricity from photovoltaic panels composed of each type CPC. The four CPC are dielectric (DCPC) cone, hollow CPC (HCPC) cone, DCPC trough, and HCPC trough. Numerical results indicate that the lowest costs would be achieved by a DCPC cone with crude two-axis tracking. The estimated low cost is primarily due to the high optical efficiency of the concentrator and to the characteristics of the DCPC cone which permit the use of a crude two-axis tracking system. The DCPC and HCPC troughs also achieve significant cost reductions compared to the cost of unconcentrated solar panels. The formulation of the cost analysis is explained, and the roles of silicon, dielectric reflector materials, hollow CPC reflector materials, and support and tracking costs are discussed. M.L.

A78-11343 **Solar hybrid repowering.** D. J. Groves, J. D. Maddox (Public Service Company of New Mexico, Albuquerque, N. Mex.), W. G. Parker (Westinghouse Electric Corp., Pittsburgh, Pa.), and W. R. Lang (Stearns-Roger, Inc., Denver, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 24-1 to 24-5.

A study was completed to assess the engineering and economic feasibility of solar hybrid repowering. An existing gas- and oil-fired steam generation unit appears to be a good demonstration candidate. A parametric economic analysis was performed based on a typical 22 MWe unit. This included the addition of central receiver hardware to displace 100 percent of the fossil boiler firing at winter solstice, with fuel oil backup for demand periods of inclement weather or tracking. The estimated low cost is primarily due to the high optical efficiency of the concentrator and to the characteristics of the DCPC cone which permit the use of a crude two-axis tracking system. The DCPC and HCPC troughs also achieve significant cost reductions compared to the cost of unconcentrated solar panels. The formulation of the cost analysis is explained, and the roles of silicon, dielectric reflector materials, hollow CPC reflector materials, and support and tracking costs are discussed. M.L.

A78-11344 **Impact of domestic solar heating systems utilizing off peak storage on electric utilities.** A. H. Eltimsahy, R. G. Molyet, and E. J. Wozniak, Jr. (Toledo, University, Toledo, Ohio). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 24-6 to 24-10. 5 refs.

This paper focuses on the impact of using solar energy for domestic space heating systems that utilize off-peak storage (using electric resistance heating) on the electric power network. The methodology used is that of digital computer simulation of an existing system on the campus of The University of Toledo (the system uses Libbey-Owens-Ford's flat plate solar collector). The program inputs parameters such as component sizes, initial temperatures, set temperatures, solar insolation for each day the simulation is run, the outside air temperature, etc. The effects of these systems on a northwestern Ohio electric utility are evaluated. Plots of the new demand curves and load factors are analyzed. The runs presented are for different values of: number of houses in the area utilizing these systems, heat pump size and off-peak storage period. (Author)

A78-11345 **Preferred residential solar heating and cooling systems compatible with electric utility operation.** D. Nathanson (Arthur D. Little, Inc., Cambridge, Mass.) and J. E. Cummings (Electric Power Research Institute, Palo Alto, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 24-11 to 24-15. Research supported by the Electric Power Research Institute.

A78-11346 **Design options in solar total energy systems.** A. A. J. Hoffman (Texas Christian University, Fort Worth, Tex.) and D. Rapp (Texas, University, Richardson, Tex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 24-16 to 24-19.

A solar total energy system consists of a collector field which converts solar radiation to thermal energy in a working fluid which in turn drives a heat engine. Shaft power from this engine drives a mechanical electrical generator while exhaust from the heat engine is used for such applications as space heating, domestic hot water, and process heat. Cooling can be accomplished by electrically driven compression chillers or thermally driven absorption chillers. This paper discusses a multitude of subsystem options and their effects on the overall system. Such options include choices of type of concentrator, reflecting surfaces, tracking method, alignment (i.e. EW vs NS), working fluid, temperature, receiver, field size, storage (arrangement, type, capacity), heat engine capacity and type (steam or organic rankine), heat exchangers, controls, and methods of cooling (compression and absorption). Based on the experience of the authors, this paper discusses the implications of these options on the efficiency, economy, and safety of the system. (Author)

A78-11347 **Analytical performance and economic evaluation of residential wind or wind and solar heating systems.** G. Darkazalli (Texas, University, Arlington, Tex.) and J. G. McGowan

(Massachusetts, University, Amherst, Mass.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 24-20 to 24-24. Contract No. E(49-18)-2365.

A performance and cost model for a variety of wind space and water heating systems for single family residences is presented. In addition to wind powered systems, combined wind and solar systems are modeled and compared to conventional and solar only heating systems. Analytical results are presented for a site in Amherst, Massachusetts. System capital economic details include an itemized cost breakdown of the wind heating system components. The results demonstrate that wind powered systems are presently competitive with electric based heating systems and will be competitive with oil or gas systems in the future. (Author)

A78-11348 **Nitinol engine development.** R. Banks, R. Kopa, and M. Wahlig (California, University, Berkeley, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 24-25 to 24-27. ERDA-supported research.

An engine which relies on the thermomechanical properties of a nickel-titanium alloy to convert low-temperature heat to mechanical work is described. Alternating hot and cold water baths cause alloy wires in a cam-track and trolley system to expand and contract; the shape memory of the alloy permits the engine to operate over a long period without significant deterioration in its performance. Problems related to fractures in the wires are mentioned. J.M.B.

A78-11349 **Forecast markets, economics and shipbuilding program for OTEC/industrial plant-ships in tropical oceans.** E. J. Francis (Johns Hopkins University, Laurel, Md.) and J. Seelinger (Maritime Administration, Washington, D.C.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 24-28 to 24-32.

The unique Applied Physics Laboratory concept for Ocean Thermal Energy Conversion (OTEC) ammonia-producing plant-ships 'grazing' the tropical oceans is presented. A tropical Atlantic Ocean grazing pattern provides 43 F (24 C) temperature differential 11 of 12 months, reducing costs through an optimized power cycle. Ammonia produced is shown to be commercially competitive at $96-99 per short ton delivered to U.S. ports. 24-31 plant-ships are needed for U.S. market share prior to 1990; 7 additional for South Atlantic market. Special needs are highlighted for Brazil and India. The article concludes that it would be imprudent for U.S. and tropical countries not to initiate an OTEC/ammonia program as soon as possible. (Author)

A78-11350 **Hydrogen from sunlight: The biological answer - Development of a low-cost biological solar panel.** J. Friedland. In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 25-1 to 25-5. 13 refs.

Development of a hydrogen-producing apparatus which relies on a blue-green marine algal species is discussed. The species studied is capable of yielding as much as one milliliter of hydrogen per milliliter of algae during a 24-hour period. In addition, several selectively permeable polymer membranes are reviewed for use in separating the hydrogen gas from the anaerobic atmosphere under which the algae are cultured. A thin film of poly(vinylidene chloride) is found to allow transmission of more than 90% of the available hydrogen, while permitting less than 1% of the argon or nitrogen to pass. The adaptation of the experimental hydrogen generating system to large-scale fuel production is also mentioned. J.M.B.

A78-11351 **Solar energy conversion with microalgal sewage treatment ponds.** J. R. Benemann, B. L. Koopman, J. C. Weissman, and W. J. Oswald (California, University, Berkeley, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 25-6 to 25-10. 17 refs. NSF Grant No. AER-76-10809; Contract No. E(04-3)-34. ERDA Project 239.

Algal species control in sewage treatment ponds is discussed, and the problems associated with microalgal bioconversion are reviewed. Microstraining and recycling of filamentous or large colonial algae, as well as the selective cultivation of nitrogen-fixing blue-green algae, are considered; the adjustment of pond depth, detention times, loadings, pH and carbon dioxide levels to control algal growth is also mentioned. It is suggested that combined sewage treatment-algal biomass production facilities could provide tertiary waste water treatment and also yield substantial amounts of methane and fertilizer. J.M.B.

A78-11352 **Photosynthetic and water efficiency of Salsola pestifer.** A. B. Meinel and M. P. Meinel (Arizona, University, Tucson, Ariz.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 14-25. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 25-11 to 25-13.

Salsola pestifer (tumbleweed) has a photosynthetic efficiency of 0.5% but is the most efficient plant for water use efficiency. The plant grows over a wide area of the western United States as a weed. Measured yields in metric tons per acre offer a crop requiring minimum care yielding 320$/acre. Direct combustion of the pelletized plant is proposed. (Author)

A78-11353 **Constraints in solar life cycle cost modeling.** J. F. Halldane and G. Meckler (Gershon Meckler Associates, Washington, D.C.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 26-5 to 26-9. 5 refs.

The commercialization of solar energy systems is primarily dependent on their cost. Life cycle costing is a methodology to compensate a high initial solar capital for a low operation cost through less utility energy over time. Present life cycle cost models tend to be constrained by an emphasis on investment; a traditional 'savings approach' in cash flow analysis; large variations in power demand, insolation and data; a concept of payback period; and an energy benefit alone. Respectively, these problems have failed to provide all the interested parties with meaningful costs; limited the analyses of different time dependent cash flows; presented a greater professional risk in design; downgraded the difficulty in finding capital; and limited the benefits attributable to a system. The paper discusses these constraints. A benefit-resource factor model is presented for assessing a priority of action in designing for a minimal utility energy and a life cycle cost having both modified demand and functional performance of a space. (Author)

A78-11354 **A solar economic performance model for residential applications.** L. Groome, P. Narayanan, S. Shantzis, and R. W. Shaw, Jr. (Booz, Allen and Hamilton, Inc., Bethesda, Md.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 26-10 to 26-14. Research supported by the U.S. Department of Housing and Urban Development.

This paper describes a mathematical model that has been developed to study the economics and financing of solar energy systems as applied to hot water and space heating in residential structures. The model is designed as an aid in the evaluation of solar economics for participants in the residential market including home-buyers, lending institutions, builders, and architects. In addition it can be used by economic analysts for incentive and other policy studies. (Author)

A78-11355 **Economic evaluation of solar cooling and heating of buildings.** T. C. Chen and D. I. Stillman (Parsons Brinckerhoff Quade and Douglas, Inc., New York, N.Y.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 26-15 to 26-17.

A systems approach to the economic analysis of solar heating and cooling systems is described. The four basic steps used in the evaluation of the economics of heating and cooling systems from systems and life-cycle cost viewpoints are discussed: (1) definition of the objectives and constraints (environmental, technological, economic and legal-institutional considerations), (2) generation of a set of comparable system alternatives, (3) evaluation of the total life-cycle cost of each alternative, and (4) selection of the least-cost alternative. B.J.

A78-11356 **Effect of tax-credits on the economics of solar heating for homeowners.** R. L. Reid (Cleveland State University, Cleveland, Ohio) and R. C. Hendricks. In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 26-18 to 26-22. 7 refs.

The effects of tax credits on solar heating economics is studied in the context of the economic parameters of breakeven time and incremental present worth, using a hypothetical 114 sq m house in Hampton, Virginia for the study. The tax credit schedule used was 40% of the first $1000 and 25% of the next $6400 to a maximum of $2000 total credit. It is concluded that the proposed tax credit would stimulate solar heating and cooling of residential and commercial buildings for both new and retrofit construction. B.J.

A78-11357 **An evaluation of residential heating methods in terms of energy conservation, environmental impact and life-cycle economics.** M. J. Wallin (Drexel University, Philadelphia, Pa.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 26-23 to 26-27. 9 refs.

A78-11358 **Solar shade control.** S. F. Kraemer (Kraemer and Kendall, Colorado Springs, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 26-28 to 26-30.

In the United States there is no legal right to direct sunlight. Therefore, new laws will have to be developed to assure the availability of direct solar radiation to solar energy systems. Aerial photos of urban development in residentially zoned areas at the winter solstice indicate 60-70% of the potential shading problems occur from trees. A solar shade control law defining a shadow of a tree on a solar collector as a public nuisance should be a valid exercise of police power. Therefore, the adoption at the state or local level of a solar shade control law declaring a shadow a public nuisance under certain circumstances is proposed. Such a law creates no bureaucratic proceedings, commissions, or government costs, and is preventive in nature. (Author)

A78-11359 **Computer aided preliminary energy analysis and energy use options for architectural students.** R. N. S. Chiang, L. S. Martin (Virginia Polytechnic Institute and State University, Blacksburg, Va.), and D. Fitzhugh. In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 27-21 to 27-26.

A78-11360 **Environmental and safety implications of solar technologies.** J. G. Holmes, J. E. Baluss, P. E. Mihlmester, S. G. Miller, T. L. Super, and J. B. Thomasian (Energy and Environmental Analysis, Inc., Arlington, Va.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 28-5 to 28-9. 9 refs.

A series of environmental reviews (ERDA 77-47/1-8) prepared for ERDA's division of Solar Energy and Environmental Analysis is summarized. A survey is presented of the environmental impacts of the following ERDA-funded solar technologies: heating and cooling, solar thermal electric, total energy systems, industrial/agricultural applications, photovoltaic conversion, wind, ocean thermal, and biomass energy conversion. B.J.

A78-11361 **Near term commercial uses for terrestrial photovoltaics.** R. M. Winegarner (Optical Coating Laboratory, Inc., Santa Rosa, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 28-10 to 28-12.

It has been estimated that terrestrial photovoltaics will not become competitive with central station supplied electrical power until 1990 or beyond. At that time photovoltaics may be used on a large scale for central plant power, on-site power for industrial use and possibly even on-site residential power. In the interim, however, there are several commercial markets in which terrestrial photovoltaics will compete competitively. Six segments of the United States commercial market have been evaluated: corrosion protection, communications, mobile vehicles, navigation, remote power, and certain novelty applications. This evaluation concludes that the near term commercial market potential for terrestrial photovoltaics is on the order of 376 kilowatts in 1977 and 18 megawatts in 1983. (Author)

A78-11362 **Solar electric-energy market penetration.** R. K. Sarin and K. Nair (Woodward-Clyde Consultants, San Francisco, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 28-13 to 28-17.

A Bayesian approach was employed to forecast the solar electric market penetration by the years 1990 and 2000. The study identified a multitude of factors, including relative cost of competitive energy systems, government incentives, future environmental regulations, and new technologies, that would affect the solar market share. The judgments of several experts from utility companies, government agencies, and research laboratories were utilized in a systematic manner to quantify the probability distributions of future solar market share as a function of the various factors. The likelihood of the occurrence of these factors was also assessed, and the solar market share was forecasted for the most-likely future scenarios. (Author)

A78-11363 **Assessment of incentives to accelerate market penetration of solar heating and cooling systems.** R. H. Bezdek and A. A. Ezra (ERDA, Div. of Solar Energy, Washington, D.C.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 29-1 to 29-5.

A modified version of the Mitre/Metrek Solar Heating and Cooling Market Penetration Model was used to analyze five different tax incentives in addition to the base case of no incentives. The solar market share is plotted as a function of the relative price of solar energy and the effects of different tax incentives on the production of solar heating and air conditioning systems are compared. B.J.

A78-11364 **The economic viability of solar assisted industrial process heat systems - The need for government economic incentives.** W. C. Dickinson (California, University, Livermore, Calif.) and H. J. Freeman (California Polytechnic State University, San Luis Obispo, Calif.). In: International Solar Energy Society, Annual

Meeting, Orlando, Fla., June 6-10, 1977, Proceedings.. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 29-9 to 29-13. Contract No. W-7405-eng-48.

Standard industrial life-cycle-costing techniques were employed to determine the economic attractiveness of solar thermal systems for industrial process heat and the effect of possible government economic incentives. It was concluded that incentives will be needed to open up a mass market for such systems in the near future. (Author)

A78-11365 **Engineering cost estimates for solar technologies.** P. Curto, A. Cherdak, G. Miller, and P. Spewak (Mitre Corp., Metrek Div., McLean, Va.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 29-14 to 29-18.

In support of solar energy technology analysis and market development studies, a study was performed to estimate engineering costs for each of several designs for solar technologies. These technologies include: wind energy conversion systems, solar thermal electric and total energy systems, photovoltaic systems, ocean thermal energy conversion systems, biomass-derived fuels and energy conversion systems, agricultural and industrial process heat systems, and solar heating and cooling of building systems. All costs are presented in mid-year 1976 dollars. The applications of these data are widespread, and may include market penetration studies, regional and national impacts, environmental assessment, resource management (manpower, materials and financial), and scenario studies. (Author)

A78-11366 **Effects of solar data accuracy on the performance and economics of solar energy systems.** P. Berdahl, M. Martin, D. Grether, and M. Wahlig (California, University, Berkeley, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 29-19 to 29-23. Research supported by the California Energy Resources Conservation and Development Commission and ERDA.

A78-11367 **Review of overseas solar technologies relative to international cooperation.** L. O. Herwig (ERDA, Div. of Solar Energy, Washington, D.C.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 30-6 to 30-11.

A brief review is presented of the overseas interests and activities in solar technology and cooperative programs and of the increasing cooperative relationships between the U.S. and various other countries. A more detailed review of overseas interests and cooperation in small solar thermal power systems is presented to illustrate the broadening interest in some technologies. In particular, technologies as developing in Japan, the U.S.S.R., France, Germany, and other countries are summarized. Those technologies with greatest international interest include water and air heating for varied uses: heating and cooling of space for residential, commercial, and industrial use; pumping of water for general uses and for irrigation; and production of electricity by smaller power systems including solar thermal, photovoltaic, and wind systems. (Author)

A78-11368 * **Marshall Space Flight Center development program for solar heating and cooling systems.** M. Cash (NASA, Marshall Space Flight Center, Huntsville, Ala.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 30-12 to 30-16.

A78-11369 * **Economic trade-offs between the performance of collector thermal performance tests on a Solar Simulator as opposed to outdoor testing.** J. C. Reily, D. E. Melton (NASA, Marshall Space Flight Center, Huntsville, Ala.), D. R. Reese, S. L. Patrick, and R. E. Losey (Wyle Laboratories, Inc., Solar Energy Systems Div., Huntsville, Ala.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 30-17 to 30-20.

In 1976 a large Solar Simulator was designed and installed at Marshall Space Flight Center. This Solar Simulator is the largest of its type in the country and has a 'working' area of 4 ft x 8 ft. Recently completed comparison tests show excellent correlation with data collected in the natural sun. The Solar Simulator has been in operation since September 1976 and the costs of operation are now determinable together with the cost of design and construction. The authors compare the total operational costs of obtaining test data using the simulator with analogous costs of testing in the natural sun. In addition, productivity is compared. (Author)

A78-11370 **Survey of the applications of solar thermal energy systems to industrial process heat.** E. H. Hall and J. A. Eibling (Battelle Columbus Laboratories, Columbus, Ohio). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 34-1 to 34-6. Research supported by the Honeywell, Inc.; Contract No. W-7405-eng-92. ERDA Task 85.

The results of a survey of the process heat requirements of 20 industries are presented to aid in the identification of potential applications of solar thermal energy systems. The quantities of process heat currently used, and a breakdown of the temperature ranges, forms, sources, and costs of process heat are given. On the basis of these detailed process analyses, a current, total process heat requirement of 7.87 x 10 to the 15th Btu/year has been identified. Of this total, about 1.5 x 10 to the 15th Btu/year, or 19.4 percent, is used at temperatures below 350 F. Conceptual solar system designs are evaluated with respect to expected performance and cost for different applications in different areas of the country. (Author)

A78-11371 **A solar collector for industrial and commercial applications.** D. F. Rost, G. J. Ameduri, C. K. Alexander, Jr. (Solar Energy Engineering, Poland, Ohio), and H. F. Schuler (General Extrusions, Inc., Youngstown, Ohio). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 34-7 to 34-11.

Many industrial and commercial applications are excellent candidates for solar energy systems because they need process heat during the entire year. A limited-tracking concentrating solar collector is designed specifically for these markets. It features five cycles of a half-parabola shape in a 3.0-m by 1.36-m light-weight module. It requires no tracking mechanism as it is easily realigned in seven positions to produce maximum performance throughout the year. The cost-effectiveness of this collector is being demonstrated by a 370-sq m array interfaced with a heat pump to provide process heating. (Author)

A78-11372 **Design and analysis of a uniaxial tracking device with a cylindrical parabolic solar concentrator system.** R. J. Carlton and H. C. Hewitt, Jr. (Tennessee Technological University, Cookeville, Tenn.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 35-1 to 35-4.

The results of thermal testing of four cylindrical parabolic solar concentrators with a uniaxial tracking device are presented. Exit temperatures of 200-260 F were accomplished with 50 percent efficiency. An inexpensive uniaxial tracking device with an adjustable accuracy as low as + or - 1 foot along with programmable hysteresis is described. Construction of the concentrators is outlined, with emphasis on durability, efficiency, and cost. (Author)

A78-11373 * An analytical and experimental investigation of a 1.8 by 3.7 meter Fresnel lens solar concentrator. L. J. Hastings, S. L. Allums, and W. S. Jensen (NASA, Marshall Space Flight Center, Huntsville, Ala.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 35-5 to 35-9.

Line-focusing acrylic Fresnel lenses with application potential in the 200-370 C range are being analytically and experimentally investigated. The measured solar concentration characteristics of a 1.8 by 3.7 m lens and its utilization in a solar collection mode are summarized in this paper. A peak concentration ratio of 64 with 90% of the transmitted energy focused into a 5 cm width was achieved and demonstrated the feasibility of the Fresnel lens solar concentrator concept. (Author)

A78-11374 Design, construction and test of a collector system using a linear asymmetric Fresnel reflector. J. R. Butz, N. Fukuta, and J. A. Armstrong (Denver, University, Denver, Colo.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 35-10 to 35-13. Research supported by the Denver Research Institute.

The concept of a linear asymmetric Fresnel reflector to be used in a concentrating collector was explored in a research and development program. A design handbook which presents detailed geometric relationships in a parameterized form was produced. A prototype reflector and receiver were fabricated and tested. (Author)

A78-11375 * The linear Fresnel lens - Solar optical analysis of tracking error effects. R. M. Cosby (Ball State University, Muncie, Ind.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 35-14 to 35-18. NASA-supported research.

Real sun-tracking solar concentrators imperfectly follow the solar disk, operationally sustaining both transverse and axial misalignments. This paper describes an analysis of the solar concentration performance of a line-focusing flat-base Fresnel lens in the presence of small transverse tracking errors. Simple optics and ray-tracing techniques are used to evaluate the lens solar transmittance and focal-plane imaging characteristics. Computer-generated example data for an f/1.0 lens indicate that less than a 1% transmittance degradation occurs for transverse errors up to 2.5 deg. In this range, solar-image profiles shift laterally in the focal plane, the peak concentration ratio drops, and profile asymmetry increases with tracking error. With profile shift as the primary factor, the ninety-percent target-intercept width increases rapidly for small misalignments, e.g., almost threefold for a 1-deg error. The analytical model and computational results provide a design base for tracking and absorber systems for the linear-Fresnel-lens solar concentrator. (Author)

A78-11376 Parabolic collector for total energy systems application. L. R. Paradis, A. L. Levine, and E. C. Vallee (Raytheon Co., Missile Systems Div., Bedford, Mass.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 35-19 to 35-23.

A parabolic point-concentrator solar collector has been designed and fabricated as part of a total energy systems development program. The point concentrator is a toric parabola 6.7 m in diameter with an effective aperture of 35 sq m. Azimuth and elevation drive systems are computer controlled and provide maximum aperture utilization over the course of the year. Mirrors are curved glass, hard mounted on an aluminum substructure, concentrating the solar energy into a cavity absorber located on the collector optical axis. (Author)

A78-11377 Optical analysis of the Fixed Mirror/Distributed Focus /FMDF/ solar energy collector. M. J. O'Neill (E-Systems, Inc., Dallas, Tex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 35-24 to 35-28. 9 refs.

For the past three years, E-Systems has been actively developing the Fixed Mirror/Distributed Focus (FMDF) solar energy collector for solar-thermal-electric and other applications. This collector utilizes a large stationary mirror concentrator of spherical geometry to focus incident sunlight upon a tracking linear receiver. This paper describes the optical characteristics of the FMDF collector. A closed-form analytical solution based upon cone optics is presented for the flux concentration distribution over the linear receiver. Results of this cone optics solution are compared with the numerical calculations of other investigators. M.L.

A78-11378 Non-evacuated solar collectors with compound parabolic concentrators. M. Collares-Pereira, N. B. Goodman, P. Greenman, J. O'Gallagher, A. Babl, L. Wharton, and R. Winston (Chicago, University, Chicago, Ill.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 36-1 to 36-5. 13 refs. Grant No. EY-76-S-02-2446.

Properly designed solar collector panels using compound parabolic concentrator (CPC) troughs with concentration ratios in the range from 3 to 10 are suitable for operation (assuming at least 40% efficiency) at 100 to 150 C above ambient even if the absorber is not surrounded by a vacuum. The first generation of CPC collectors fell short of the expected performance because of various parasitic heat losses through the reflectors and insulation. Analysis of the data indicated, however, that optical performance and frontal heat losses agreed with the predictions and that CPC collectors with reasonable performance could be built. The present paper describes the design of CPC collectors with concentrations of 3 and 6.5, and reports the test results. (Author)

A78-11379 Long-term average performance predictions for compound parabolic concentrator solar collectors. R. Cole (Argonne National Laboratory, Argonne, Ill.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 36-6 to 36-11. 10 refs. ERDA-supported research.

This paper describes how the methods of Liu and Jordan can be extended to calculate the performance of collectors such as the compound parabolic concentrating (CPC) collector. The method allows calculation of the monthly average of daily heat collection given only the monthly average of the measured daily insolation on a horizontal plane and the monthly-average daytime ambient temperature. The calculations were checked against Liu and Jordan's calculations for two-pane flat-plate collectors at three locations and were found to be in good agreement. Annual heat collection of trough-type CPC collectors with evacuated receivers and selective surfaces was calculated for temperatures up to 316 C. Performance of the CPC compares favorably with flat-plate collectors at low temperatures and with parabolic trough collectors at high temperatures. The optimum concentration ratio was calculated as a function of collector temperature and number of tilt adjustments per year. (Author)

A78-11380 Optimization of a fixed solar thermal energy collector. J. D. Garrison (San Diego State University, San Diego, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 36-12 to 36-15. 10 refs.

Criteria are presented for optimizing solar thermal energy collection. These criteria are then used in the design of a fixed solar thermal energy collector. This design is obtained by proceeding carefully through a series of optimization steps, and is almost uniquely determined by these steps. Apparently, the performance predicted for this collector is near optimum, and is superior to the performance of current fixed collector models. While seeking near optimum performance, features have been retained which should lead to low cost. Skills now in use in the glass and lighting industries are expected to lead to low cost mass production of this collector. (Author)

A78-11381 **Evaluation of an optimized solar thermal collector by a new method.** J. D. Garrison (San Diego State University, San Diego, Calif.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 36-16 to 36-20. 7 refs.

A model for calculating, on the average, the angular distribution and intensity of solar radiation at the site of a solar collector is presented. The irradiance on a horizontal surface and the time of day and year are required as input data. This model is used to complete the design of an optimum fixed solar thermal energy collector. It is then also used to examine the performance of this collector under various operating conditions, and to compare this performance with other fixed collectors. (Author)

A78-11382 **Optical properties of cylindrical elliptic concentrators.** R. E. Jones, Jr. (Lakehead University, Thunder Bay, Ontario, Canada). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 36-21 to 36-24. 5 refs.

The optical properties of elliptic concentrators are investigated using numerical ray tracing. Elliptic concentrators are shown to be non-ideal concentrators and the angular acceptance is studied for two different designs. The relationship between angular acceptance and concentration for a general cylindrical concentrator is derived using the second law of thermodynamics. (Author)

A78-11383 **The compound trapezoidal collector /an optimized stationary concentrator/.** J. Villanueva and H. V. Truong (Florida Atlantic University, Boca Raton, Fla.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 36-25 to 36-29. 5 refs.

The design, evaluation, and optimization of a nontracking compound trapezoidal groove collector are described. The proposed collector geometry consists of two successive trapezoidal grooves whose relative dimensions are optimized to accept (with no more than one reflection) all the solar energy impinging upon it when the sun's rays are directed along the optical axis of the collector. Computer simulation of the proposed collector shows that instantaneous concentration ratios as high as 5 can be achieved with this geometry, while time averaged concentrations of about 3.5 (during a complete collecting period of eight hours) are possible. The angular acceptance of this collector compares favorably with the truncated compound parabolic collector proposed by Winston and with single trapezoidal groove collectors. M.L.

A78-11384 **An internal cusp reflector for an evacuated tubular heat pipe solar thermal collector.** U. Ortabasi and W. M. Buehl (Corning Research and Development Laboratory, Corning, N.Y.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 36-30 to 36-36. 5 refs.

This study involves optical analysis of a slightly concentrating symmetric cusp reflector inside a tubular glass envelope with a cylindrical heat pipe as the solar absorber. The basic design features of this nontracking evacuated modular collector and the principles of heat removal are described. Differential equations of the cusp reflector optics are derived, and solutions for the largest possible aperture inside a given diameter envelope and acceptance angle are presented. The optical efficiency of a single collector tube has been simulated by means of a Monte-Carlo ray-tracing program. For a concentration ratio of 1.15, the flux distribution around the heat pipe is computed as a function of incidence angle. In addition, the impact of mirror defects and absorber misalignment on optical performance is analyzed. (Author)

A78-11385 **On the design of flat reflector - collector combinations.** W. T. Downey and A. O. Converse (Dartmouth College, Hanover, N.H.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 37-1 to 37-5. 9 refs.

The desirability of adding a flat reflector to a flat plate solar water heating system has been studied through computer simulation. We find that the reflector is slightly cost effective in the North (Hanover, N.H.), but not in the South (Savannah, Ga.). (Author)

A78-11386 **Augmented solar energy collection using different types of planar reflective surfaces - Theoretical calculations and experimental results.** D. P. Grimmer (California, University, Los Alamos, N. Mex.), K. C. Herr (Aerospace Corp., Los Angeles, Calif.), K. G. Zinn, and B. E. Wood. In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 37-6 to 37-11. 9 refs. ERDA-sponsored research.

A78-11387 **Measurements on the effect of planar reflectors on the flux received by flat-plate collectors.** R. L. Reid (Cleveland State University, Cleveland, Ohio), M. Chilcoat, and M. J. Yuko. In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 37-12 to 37-15.

The effect of planar reflectors on the flux received by flat plate collectors was determined both through experiments and an analytical model. The particular application studied was an inverted V-roof solar house configuration. Experimental data were taken for mirror Plexiglas and aluminum. These results were compared with the analytical model written for specular reflection. Results from the model were generated for flux received both with and without the reflector for a yearly period. (Author)

A78-11388 **Enhancement of flat plate solar collector performance through the use of planar reflectors.** J. M. Hill and E. H. Perry (Memphis State University, Memphis, Tenn.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 37-16 to 37-19. 5 refs.

A study was undertaken to determine insolation and collector performance enhancement factors resulting from the presence of specular planar reflectors in front of flat-plate solar energy collectors. The study involved both a mathematical analysis of the problem and experimental measurements of the enhancement factors. Among the variables included in the analysis are the collector and reflector tilt angles, the reflector-to-collector height ratio, and the collector aspect ratio. The study shows that such reflectors can significantly improve the performance of flat-plate solar collector arrays. (Author)

A78-11389 **Analytical and experimental study of total internal reflection prismatic panels for solar energy concentrators.** M. J. O'Neill and Y. P. Gupta (E-Systems, Inc., Dallas, Tex.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38.

Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 37-20 to 37-24.

For more than a year, E-Systems has pursued the analysis, design, development and testing of prismatic panels which utilize total internal reflection (TIR) to accomplish the concentration of solar energy. Such panels offer the potential of better performance at lower cost for numerous solar concentrator applications, including heliostats for Central Receiver (Power Tower) electric power plants and various parabolic concentrators. This paper presents a description of the new reflector concept, and results of preliminary theoretical and empirical studies of its performance. (Author)

A78-11390 **Solar collector cost reduction with reflector enhancement.** A. M. Clausing and A. L. Edgecombe (Illinois, University, Urbana, Ill.). In: International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Proceedings. Sections 26-38. Cape Canaveral, Fla., International Solar Energy Society, 1977, p. 37-25 to 37-29.

This study is concerned with the use of fixed specular reflectors in combination with conventional flat-plate solar collectors is to reduce the high capital cost of solar collector systems. The study was precipitated by the use of solar energy for grain drying; the seasonal use of the collector system in this application necessitates an inexpensive system in order to be cost effective. A mathematical formulation of a general reflector-collector system is given which encompasses a wide range of geometries and is applicable to any sun position. Two key parameters are introduced, the reflector effectiveness and the reflector efficiency, which provide a meaningful and simple means of evaluating the performance and cost effectiveness of reflector-collector systems. Instantaneous and time-averaged performance data are given for reflector-enhanced collector systems, and comparisons are provided with conventional collector systems which clearly show the benefits of the reflector enhancement. (Author)

A78-11391 * # **Evaluation of initial collector field performance at the Langley Solar Building Test Facility.** R. J. Boyle, R. H. Knoll (NASA, Lewis Research Center, Cleveland, Ohio), and R. N. Jensen (NASA, Langley Research Center, Hampton, Va.). *International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Paper.* 20 p. 6 refs.

The thermal performance of the solar collector field for the NASA Langley Solar Building Test Facility is given for October 1976 through January 1977. An 1180 square meter solar collector field with seven collector designs helped to provide hot water for the building heating system and absorption air conditioner. The collectors were arranged in 12 rows with nominally 51 collectors per row. Heat transfer rates for each row are calculated and recorded along with sensor, insolation, and weather data every 5 minutes using a mini-computer. The agreement between the experimental and predicted collector efficiencies was generally within five percentage points. (Author)

A78-11392 * # **A low cost, portable instrument for measuring emittance.** G. McDonald (NASA, Lewis Research Center, Cleveland, Ohio). *International Solar Energy Society, Annual Meeting, Orlando, Fla., June 6-10, 1977, Paper.* 10 p.

A low cost, portable instrument has been developed with which emittance can be measured by comparison to a standard. A reflector collects infra-red radiation from a heated sample onto a low mass, black detector and the temperature rise of the black detector is measured with a thermocouple and meter. Graphical examples are presented for determination of emittance from measurements made on a sample at any known temperature. (Author)

A78-11458 **Liptinites and lipoid substances in an oil source rock (Liptinite und lipoide Stoffe in einem Erdölmuttergestein).** M. Teichmäller and K. Ottenjann (Nordrhein-Westfalen, Geologisches Landesamt, Krefeld, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie,* vol. 30, Sept. 1977, p. 387-398. 21 refs. In German. Research supported by the Deutsche Gesselschaft für Mineralölwissenschaft und Kohlechemie.

The reported investigation has the objective to provide a description of the various liptinite macerals of an oil source rock on the basis of microscopic and, in particular, fluorescence-microscopic observations, taking into account changes with increasing diagenesis level. The investigation makes use of 31 samples from a slate mineral in West Germany. Micrographs were obtained, and measurements were conducted of the spectral fluorescence characteristics and the fluorescence intensity of the samples. Quantitative studies of the alteration of fluorescence intensity as a function of the diagenesis level were also carried out. A number of micrographs are presented to illustrate the characteristic features of the macerals of the slate. G.R.

A78-11459 **Polycyclic aromatic hydrocarbons in the exhaust gas of motor vehicles (Polycyclische aromatische Kohlenwasserstoffe im Abgas von Kraftfahrzeugen).** G. Grimmer, H. Böhnke, and A. Glaser (Biochemisches Institut für Umweltcarcinogene, Ahrensburg, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie,* vol. 30, Sept. 1977, p. 411-417. 13 refs. In German.

The reported investigation has the objective to characterize on the basis of their mass spectra after a gas-chromatographic separation all polycyclic aromatic hydrocarbons which are emitted by an internal combustion (gasoline) engine and to identify known compounds with the original substances. The carcinogenic effect of exhaust gas condensate from motor vehicles is considered. It is pointed out that the carcinogenic properties of the exhaust gas condensate is related to the presence of polycyclic aromatic hydrocarbons. Attention is given to details regarding the collection of the exhaust gas condensate, aspects of gas chromatography, the combination of gas chromatography with mass spectrometry used in the investigation, and the composition of the polycyclic aromatic hydrocarbon mixture found in the exhaust gas of motor vehicles. G.R.

A78-11489 **Status report on the alternative energy sources.** F. J. P. Clarke (U.K. Atomic Energy Authority, Harwell, Berks., England). *(British Association for the Advancement of Science, Annual Meeting, University of Aston, Birmingham, England, Aug. 31-Sept. 7, 1977.) Atom,* Oct. 1977, p. 268-280.

The considered alternatives to oil and gas as sources of energy are sun, wind, waves, tides, and geothermal heating. With respect to solar energy, the UK in connection with its climatic conditions is mainly studying an employment of blackened flat plate collectors for water heating and space heating. Problems are mainly related to the economy of the heating and heat storage systems in comparison to the costs of conventional systems. Investigations designed to reduce the costs and improve the efficiency of solar systems are planned. The employment of aerogenerators for the utilization of wind power is basically feasible. The major unknown about windpower lies in its economics. Studies are being conducted concerning the design of an aerogenerator optimized for UK hill-top sites and an aerogenerator which can provide electricity to the national grid from offshore locations. In the case of wave power, current programs are concerned with an examination of technological practicability at an economic cost. It is estimated that it will take about 20 years to complete a tidal-energy project. G.R.

A78-11490 **Chemical and isotopic techniques in geothermal investigations.** A. J. Ellis (Department of Scientific and Industrial Research, Chemistry Div., Petone, New Zealand). *Geothermics,* vol. 5, no. 1-4, 1976, p. 3-12. 40 refs.

The origin of chemical constituents in geothermal fluids is discussed, with attention given to the more soluble elements such as Cl, Br, I, Li, Cs, As, and B, and the dissolved gases. Mineral and solution equilibria are evaluated to derive underground temperatures, water pH and CO2 partial pressure from the analysis of steam and water flows of natural sources or of geothermal wells. Isotopic exchange equilibria involving H, C, O, or S provide additional geothermometers which may be applied when chemical methods are complicated by steam separation or mixing processes. The isotopic make-up of water serves to identify water sources, water ages and mixing processes in geothermal systems, and to delineate trends during the operation of a geothermal field. Chemical and isotope analyses also indicate the occurrence of changes in underground temperature, the degree of rock/water interaction, and the tendency for mineral deposition. (Author)

A78-11491 **Chemical geothermometers and mixing models for geothermal systems.** R. O. Fournier (U.S. Geological Survey, Menlo Park, Calif.). *Geothermics,* vol. 5, no. 1-4, 1976, p. 41-50. 35 refs.

Qualitative chemical geothermometers utilize anomalous concentrations of various 'indicator' elements in groundwaters, streams, soils, and soil gases to outline favorable places to explore for geothermal energy. Some of the qualitative methods, such as the delineation of mercury and helium anomalies in soil gases, do not require the presence of hot springs or fumaroles. However, these techniques may also outline fossil thermal areas that are now cold. Quantitative chemical geothermometers and mixing models can provide information about present probable minimum subsurface temperatures. Interpretation is easiest where several hot or warm springs are present in a given area. At this time the most widely used quantitative chemical geothermometers are silica, Na/K, and Na-K-Ca. (Author)

A78-11492 **Geothermal reservoir temperatures estimated from the oxygen isotope compositions of dissolved sulfate and water from hot springs and shallow drillholes.** W. F. McKenzie and A. H. Truesdell (U.S. Geological Survey, Menlo Park, Calif.). *Geothermics,* vol. 5, no. 1-4, 1976, p. 51-61. 42 refs.

A78-11493 **Stable isotopic studies of Japanese geothermal systems.** H. Sakai and O. Matsubaya (Okayama University, Misasa, Tottori, Japan). *Geothermics,* vol. 5, no. 1-4, 1976, p. 97-124. 70 refs.

Stable isotopic studies on Arima type brines, Green Tuff type thermal waters and three volcanic systems, Hakone, Ibusuki, and Satsuma-Iwojima, were reviewed with emphasis on the origins of the water and sulfur species in these systems. Of the three volcanic systems, Hakone is a subaerial volcano consisting of calderas, central cones and a caldera lake, whereas Ibusuki belongs to a caldera half-drowned in the ocean. Satsuma-Iwojima is a volcanic island erupted within a drowned caldera about 40 km off the southern coast of Kyushu. Comparisons of the isotopic data of the waters and sulfur species from the three different volcanoes indicated that the waters of meteoric, oceanic and magmatic origins are involved in various ways and proportions in the volcanic activities. A considerable fraction of the volcanic sulfur species is shown to be recyclic in origin. It was demonstrated that a combined use of chemical and isotopic data on thermal waters and dissolved sulfates would yield useful information on the hydrological aspects of many geothermal systems. (Author)

A78-11668 # **Photocells employing smooth AlGaAs-GaAs heterojunctions to extend the spectral response range (Fotoelementy s rasshirennoi oblast'iu spektral'noi chuvstvitel'nosti na osnove plavnykh geterostruktur AlGaAs-GaAs).** Zh. I. Alferov, V. M. Andreev, M. B. Kagan, V. I. Korol'kov, T. S. Tabarov, and F. M. Tadzhibaev (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR). *Pis'ma v Zhurnal Tekhnicheskoi Fiziki,* vol. 3, Aug. 12, 1977, p. 725-729. 10 refs. In Russian.

The photocells investigated were prepared with smooth nGaAs-pGaAs-pAl(x)Ga(1-x)As heterojunctions, increasing the x-parameter from zero to x = 0.3 or 0.4 toward the surface. The aim was to extend the spectral response into the 0.3 to 0.5 micron region of the solar spectrum to meet the requirements for solar energy conversion. This extension proved possible by lowering the rate of surface recombination with the aid of a 0.3 to 1.5 micron thick AlAs film, protected by its own oxide, (at a pulling field of 1 kWt/cm) deposited on the heterojunction. V.P.

A78-11699 # **Increasing the resources of jet fuels (Ob uvelichenii resursov reaktivnykh topliv).** E. D. Radchenko, I. V. Rozhkov, B. A. Englin, M. V. Khokhlacheva, M. D. Khaikin, and A. V. Guseva (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Neftianoi Promyshlennosti, Moscow, USSR). *Khimiia i Tekhnologiia Topliv i Masel,* no. 10, 1977, p. 8-12. 13 refs. In Russian.

Some aspects of the problem of increasing jet fuel resources by increasing the crystallization point from the present Soviet specification of -60 C to -40 C and -50 C foreseen in the ASTM Standards are discussed. Data are given on the dependence on the crystallization point of the content of jet fuel fractions in oils from new oil fields in West Siberia and the Komi ASSR. V.P.

A78-11814 **Fusion-neutron-induced nuclear recoil emission probabilities.** O. K. Harling, M. T. Thomas, R. L. Brodzinski, and L. A. Rancitelli (Battelle Pacific Nortwest Laboratory, Richland, Wash.). *Journal of Applied Physics,* vol. 48, Oct. 1977, p. 4328-4336. 23 refs. Contract No. E(45-1)-1830.

Recoil emission probabilities with 14.8-MeV (d,t) neutrons and with a 40-MeV (d,Be) neutrons source were measured, and recoil emission ratios for metal targets are reported. Targets of Nb, Mo, V, 316 SS, Fe, Ni, Cr, Ti, and Au were used and 23 different fast-neutron-induced reactions were studied. Values for the total radioactive recoil sputtering ratio are provided. Effective recoil atom ranges have been obtained from the experimental data and are compared with theoretically calculated ranges. Implications of radioactive recoil sputtering, regular neutron sputtering, and chemical corrosion for future controlled fusion machines are discussed. It is suggested that neutron ejection of radioactive wall atoms might be a major concern in the operation and maintenance of future fusion reactors. M.L.

A78-11815 **Evaluation of the CdS/CdTe heterojunction solar cell.** K. W. Mitchell, A. L. Fahrenbruch, and R. H. Bube (Stanford, University, Stanford, Calif.). *Journal of Applied Physics,* vol. 48, Oct. 1977, p. 4365-4371. 25 refs. NSF-supported research.

A variety of CdS/CdTe heterojunction solar cells have been prepared by the vacuum evaporation of n-CdS films onto single-crystal p-CdTe substrates. Comparisons have been made between cells prepared using different substrate resistivities, substrate surface preparations, and CdS film resistivities. The mechanisms controlling the dark junction current, photocarrier collection, and photovoltaic properties with junction interface states present are modeled. A solar efficiency of 7.9% under 85 mW/sq cm of solar simulator illumination was measured on a cell with an indium-tin-oxide coating and a glycerol antireflection coating. (Author)

A78-11927 * **Photoelectrolysis of water at high current density - Use of ultraviolet laser excitation.** A. B. Bocarsly, J. M. Bolts, P. G. Cummins, and M. S. Wrighton (MIT, Cambridge, Mass.). *Applied Physics Letters,* vol. 31, Nov. 1, 1977, p. 568-570. 33 refs. NASA-supported research.

The behavior of TiO2 and SrTiO3 photoanodes in cells for the photoelectrolysis of H2O has been investigated for high-intensity 351-,364-nm excitation from an Ar ion laser. Intensities up to 380 W/sq cm have been used. For TiO2 a small amount of surface decomposition is found after irradiation at high intensity, whereas SrTiO3 undergoes no detectable changes. Current-voltage properties for both electrodes are essentially independent of light intensity up to the level of 380 W/sq cm, and there is little if any change in quantum efficiency for electron flow. Photocurrent densities have been shown to exceed 5 A/sq cm for O2 evolution. Data show that the energy storage rate associated with the SrTiO3 photoelectrolysis can exceed 30 W/sq cm; this represents the highest demonstrated rate of sustained optical-to-chemical energy conversion. (Author)

A78-11933 **High-efficiency GaAs shallow-homojunction solar cells.** C. O. Bozler and J. C. C. Fan (MIT, Lexington, Mass.). *Applied Physics Letters,* vol. 31, Nov. 1, 1977, p. 629-631. 8 refs. USAF-sponsored research.

Conversion efficiencies as high as 15.3% (17% when corrected for contact area) have been obtained for single-crystal antireflection-coated GaAs solar cells fabricated without the use of Ga(1-x)Al(x)As layers. These devices employ a thin n(+)/p/p(+) structure prepared by chemical vapor deposition. Surface recombination losses in this structure are reduced because the n(+) layer is so thin (1300 A) that most of the carriers are generated in the p layer below the junction. (Author)

A78-11965 **Dust removal in energy generating plants - (Staubbewältigung in energieerzeugenden Betrieben).** H.-J. Ochs. *Metall,* vol. 31, Oct. 1977, p. 1111-1113, 1115. In German.

The paper characterizes the nature and degree of emissions from oil, gas and particularly coal-fueled electric power plants with emphasis on gaseous (CO and CO2) and particulate pollutants. Methods of monitoring - optical techniques and air sampling - are discussed along with the effects of smokestack characteristics on pollution levels. Particular attention is given to dust removal strategies involving the use of cyclone filters and electrofilters. B.J.

A78-12030 **Adaptation for economization, or adaptation for the economization of energy (Adaptation pour l'économie ou adaptation pour l'économie d'énergie).** P. Lecomte (Société Nationale Industrielle Aérospatiale, Division Avions, Paris, France). *(Association Aéronautique et Astronautique de France and International Civil Aviation Organization, Congrès International Aéronautique, 13th, Paris, France, June 2, 3, 1977.) L'Aéronautique et l'Astronautique,* no. 65, 1977, p. 3-12. 12 refs. In French.

Tradeoffs between overall economies and fuel economies in the design and operation of aircraft are discussed. It is suggested that turboprop craft with a cruise speed between Mach 0.6 and 0.7 could be used for efficient freight transport; advanced turboprop designs may also offer attractive economic passenger transport. In addition, a medium-range straight-wing airplane with a cruise speed of Mach 0.75 may provide both efficient use of fuel and an attractive mode of transport. Economies obtained through the modification of braking systems, landing gear, as well as mass reductions in the design phase, are mentioned. J.M.B.

A78-12031 **Energy savings - The viewpoint of an aircraft manufacturer (Les économies d'énergie - Point de vue d'un avionneur).** P. Amblard (Avions Marcel Dassault-Bréguet Aviation, Vaucresson, Hauts-de-Seine, France). *(Association Aéronautique et Astronautique de France and International Civil Aviation Organization, Congrès International Aéronautique, 13th, Paris, France, June 2, 3, 1977.) L'Aéronautique et l'Astronautique,* no. 65, 1977, p. 13-18. In French.

Technological developments leading to the design of aircraft which consume less fuel than present models are reviewed. In particular, high bypass ratio engines, supercritical wingspans, active control, and the use of light-weight composite materials for both secondary and primary aircraft structures are considered. Advanced techniques in aerodynamic analysis, especially in the field of boundary layer control, are also mentioned. It is suggested that the aircraft design process should be more closely coordinated with the long-range planning of commercial airlines. J.M.B.

A78-12214 **Remote sensing - A burgeoning science.** D. G. Goodenough (Department of Energy, Mines and Resources, Centre for Remote Sensing, Ottawa, Canada). *Engineering Journal,* vol. 60, Sept.-Oct. 1977, p. 23-26. 22 refs.

Remote sensing objectives and techniques are described. Topics considered include data processing, platforms and sensors, and processing and analysis devices. A nighttime thermogram of a shopping center is presented as an example; a light tone indicates heat loss areas, which correspond to areas where a waterproof enclosure membrane had broken, as verified by on-site inspection. Remote sensing can facilitate environmental monitoring, winter navigation in ice-infested waters, global crop information systems, and energy exploration. M.L.

A78-12221 **Underground hydroelectric pumped storage - A practical option.** F. M. Scott (Harza Engineering Co., Chicago, Ill.). *Energy,* vol. 2, Fall 1977, p. 20-22.

It is pointed out that hydroelectric pumped storage is, perhaps, currently the only practical or demonstrated means to store energy economically in significant quantities. In the case of conventional pumped storage projects, there are often problems related to the distance between suitable storage sites and the higher load centers. However, underground pumped storage facilities can be built in many areas near load centers, and they require far less land surface as heads up to 4,400 to 4,800 feet can be utilized. The design and the operational characteristics of such underground facilities are illustrated with the aid of examples involving three alternative arrangements. Attention is given to the mechanical equipment, the power station arrangement, the time required for construction, and project construction costs. In one case, energy can be stored at an estimated cost of $270 per kilowatt. G.R.

A78-12222 **Biomass and waste production as energy resources - Update.** D. L. Klass (Institute of Gas Technology, Chicago, Ill.). *Energy,* vol. 2, Fall 1977, p. 23-27. 11 refs.

Various arguments which have been made against biomass energy applications are considered. It is found that there exist factors which negate these arguments. In particular, it is felt that difficulties can be overcome with the aid of suitable research and development projects. Attention is given to the use of water conservation techniques, the recycling of nutrients, the selection of genetically-engineered biomass species for conversion to synfuels, the optimization of conversion processes, the solution of pollution problems, the determination of conversion efficiencies, the utilization of wood as biomass raw material, new research developments, solid waste conversion, and anaerobic digestion systems. G.R.

A78-12346 # **Heat-transfer allowing for ion slip in an MHD channel (Teploobmen v MGD-kanale, uchityvaiushchii skol'zhenie ionov).** M. L. Mittal and A. N. Bhat (Indian Institute of Technology, Bombay, India). *Teplofizika Vysokikh Temperatur,* vol. 15, July-Aug. 1977, p. 852-865. 13 refs. In Russian.

In the present paper, the influence of ion slip on the steady-state heat transfer in an MHD channel with a constant wall temperature is analyzed. Numerical values of the heat transfer coefficient are obtained for various values of some characteristic MHD-generator parameters. It is shown that ion slip leads to changes in the temperature distribution and to a decrease in the mean mass temperature and local Nusselt number. V.P.

A78-12348 # **Investigation of the efficiency of a Faraday MHD-generator coupled to a thermonuclear reactor (Issledovanie effektivnosti Faradeevskogo MGD-generatora v skheme s termoiadernym reaktorom).** V. V. Breev, V. P. Panchenko, and V. V. Chernukha (Akademiia Nauk SSSR, Institut Atomnoi Energii, Moscow, USSR). *Teplofizika Vysokikh Temperatur,* vol. 15, July-Aug. 1977, p. 879-887. 10 refs. In Russian.

The use of a Faraday MHD generator as a converter of thermonuclear to electric energy is discussed. A quasi-one-dimensional method for calculating such generators is proposed, and supersonic MHD-generators operating with water, argon, and helium (with potassium and lithium additions) are examined. Some aspects of obtaining maximum efficiency in the case of a generator operating with an equilibrium plasma are studied. V.P.

A78-12352 # **Stability of nonequilibrium plasmas (Ob ustoichivosti neravnovesnoi plazmy).** R. V. Vasil'eva, A. V. Erofeev, and V. A. Shingarkina (Akademiia Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR). *Teplofizika Vysokikh Temperatur,* vol. 15, July-Aug. 1977, p. 901-904. 6 refs. In Russian.

The quasi-uniform interaction between a magnetic field and a thermally ionized gas flow is a problem requiring attention in the design of MHD generators employing a nonequilibrium plasma with alkali metal additions as the working medium. The shock-tube experiments described in the present paper were carried out to study the interaction between a thermally ionized plasma flow and a magnetic field, with the object of determining the characteristics of the plasma state and the critical conditions for the onset of ionization instability. At the same time, the results obtained verify certain analytical data concerning the conditions for the existence of a stable nonequilibrium weakly ionized plasma. V.P.

A78-12386 # Analysis and classification of methods for calculating concentrating systems (Analiz i klassifikatsiia metodov rascheta kontsentriruiushchikh sistem). R. A. Zakhidov (Akademiia Nauk Uzbekskoi SSR, Tsentral'noe Proektno-Konstruktorskoe i Tekhnologicheskoe Biuro Nauchnogo Priborostroeniia, Tashkent, Uzbek SSR). *Geliotekhnika,* no. 4, 1977, p. 3-13. 47 refs. In Russian.

A review and classification is presented of the methods for calculating the radiation field and the design parameters of concentrating systems in solar energy equipment having single-mirror, multi-mirror, and facet type configurations. The method of elementary conical beams, the Gaussian-beam method, and the method of Gaussian deflection of the normal are described. Attention is given to the accuracy and limits of the various techniques. S.C.S.

A78-12387 # Concentration by conical and cylindrical concentrators of radiation scattered by near-solar regions of the sky (Kontsentratsiia fokonami i foklinami radiatsii, rasseiannoi okolosolnechnymi uchaskami neba). V. K. Baranov. *Geliotekhnika,* no. 4, 1977, p. 14-21. 9 refs. In Russian.

Previously derived formulas defining the ability of conical and cylindrical concentrators to concentrate the energy of extended radiation sources are combined with a model of solar-radiation scattering (in a clear sky, a lightly-clouded sky, and a densely-clouded sky) for the purpose of estimating the contribution of scattered radiation to the overall energy concentrated by such solar collectors. The analysis shows that in a densely-clouded sky the contribution of scattered radiation is negligible. In a clear or lightly-clouded sky the total radiation concentrated by the two types of collectors exceeds concentrated direct radiation by 5-10%, and even (for the cylindrical concentrators) up to 15%. When a silicon element is used as a receiver, the difference in the spectral composition of direct and scattered radiation does not significantly influence the system's effectiveness. S.C.S.

A78-12388 # Prospects for using Fresnel lenses for concentrating systems of solar energy equipment (Perspektivy ispol'zovaniia linz Frenelia dlia kontsentriruiushchikh sistem geliotekhnicheskikh ustanovok). N. S. Lidorenko, K. V. Zhukov, F. Kh. Nabiullin, and E. V. Tver'ianovich (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). *Geliotekhnika,* no. 4, 1977, p. 22-25. 11 refs. In Russian.

A78-12391 # Some results of an experimental study of the Stirling engine (Nekotorye rezul'taty eksperimental'nogo issledovaniia dvigatelia Stirlinga). G. Ia. Umarov, V. S. Trukhov, Iu. E. Kliuchevskii, I. A. Tursunbaev, E. P. Orda, and N. P. Vogulkin (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). *Geliotekhnika,* no. 4, 1977, p. 34-37. In Russian.

This model Stirling engine, developed for solar energy systems, incorporates a displacer and a piston in a single cylinder. The volume measured by the displacer is found to be 60 cu cm. The engine's thermodynamic characteristics are studied in various operating modes. The engine rotations fluctuate within a range of up to 100 atm. The results obtained are compared with the theory. S.C.S.

A78-12392 # Heat optimization for solar power plants Concentration of radiation and the temperature of the working medium (Teplovaia optimizatsiia solnechnykh energeticheskikh stantsii - Kontsentratsiia izlucheniia i temperature rabochego tela). D. I. Tepliakov and R. R. Aparisi (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). *Geliotekhnika,* no. 4, 1977, p. 38-47. 10 refs. In Russian.

The thermal interface of the concentrator and steam generator of a solar power plant is studied with emphasis on the concentrator efficiency and the temperature of the working medium in the steam generator. The dependence of the thermodynamic efficiency of conversion of radiation into mechanical work on the coordination between the concentrator and the steam generator is demonstrated.

A78-12393 # Comparative analysis of the geometrical characteristics of solar power plant boilers (Sravnitel'nyi analiz geometricheskikh kharakteristik kotlov solnechnykh energeticheskikh stantsii). L. N. Vladimirova and B. A. Garf (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). *Geliotekhnika,* no. 4, 1977, p. 48-53. In Russian.

A78-12394 # Experience in the utilization of absorption-cooling solar equipment with an open-type regenerator of the solution (Opyt ekspluatatsii absorbtsionnoi kholodil'noi solnechnoi ustanovki /AKhSU/ s otkrytym regeneratorom rastvora). A. A. Kakabaev, O. Klyshchaeva, A. Khandurdyev, and N. Kurbanov (Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). *Geliotekhnika,* no. 4, 1977, p. 73-76. In Russian.

Results are reported of a four-year study of a nine-room three-floor model home utilizing absorption-cooling solar equipment with a cooling power of 50,000 kcal/hour. Some improvements in design and use of such equipment are suggested. It is seen that absorption-cooling equipment has potential for use in buildings located in southern regions. S.C.S.

A78-12440 Stimulated electronic Raman scattering in Cs vapour - A simple tunable laser system for the 2.7 to 3.5 micron region. D. Cotter and D. C. Hanna (Southampton, University, Southampton, England). *Optical and Quantum Electronics,* vol. 9, Nov. 1977, p. 509-518. 26 refs. Research supported by the Paul Instrument Fund and Science Research Council.

Stimulated electronic Raman scattering (SERS) in atomic vapors provides a simple method of extending the tuning ranges of pulsed dye lasers well into the infrared region. The special advantages of this technique in comparison with other types of tunable infrared lasers are discussed, and are illustrated by describing a SERS system which uses a modest nitrogen laser-pumped dye laser (about 20 kW). This produces infrared radiation tunable from 2.67 to 3.47 microns by SERS in cesium vapor, which is contained in a heat pipe oven. Photon conversion efficiencies of up to 50% are obtained. The heat pipe oven design, system operation, and optimization of experimental parameters are described in detail. (Author)

A78-12486 Experimental and computational results on direct energy conversion for mirror fusion reactors. W. L. Barr, R. W. Moir, and J. D. Kinney (California, University, Livermore, Calif.). *Nuclear Fusion,* vol. 17, Oct. 1977, p. 1015-1022. 18 refs. Contract No. W-7405-eng-48.

Results are presented for measurements of space-charge effects on the efficiency of a direct converter. The device consists of a 22-stage electrostatic periodic-focusing direct energy converter, a magnetic expander, and a hydrogen plasma source. At low beam density, the measured average efficiency is 86.5% + or - 1.5% as compared with the predicted one of 88.6% + or - 1.5%. At higher beam density, the measured efficiency decreases with increasing space charge in agreement with predictions. The effect of space charge is increased if the ion energy is decreased or the energy distribution is made narrower. Design criteria for scaling the recovery system for a reactor show that this direct converter is probably economical only if the mean ion energy is greater than 500 keV. (Author)

A78-12557 * # The effect of ambient temperature and humidity on the carbon monoxide emissions of an idling gas turbine. C. W. Kauffman and A. K. Subramaniam (Cincinnati, University, Cincinnati, Ohio). *Combustion Institute, Spring Technical Meeting, Cleveland, Ohio, Mar. 28-30, 1977, Paper.* 33 p. 17 refs. Grant No. NsG-3045.

Changes in ambient temperature and humidity affect the exhaust emissions of a gas turbine engine. The results of a test program employing a JT8D combustor are presented which quantize the effect of these changes on carbon monoxide emissions at simulated idle operating conditions. Analytical results generated by a kinetic model of the combustion process and reflecting changing ambient conditions are given. It is shown that for a complete range of possible ambient variations, significant changes do occur in the amount of carbon monoxide emitted by a gas turbine engine. (Author)

A78-12604 Clean fuels from coal - Finding the right combination. R. C. Rittenhouse. *Power Engineering,* vol. 81, Oct. 1977, p. 36-44.

Attention is given to various current and projected coal degasification procedures for low and medium-Btu gas noting advanced gasification combined cycle systems and low-Btu gasifier integrated systems having combined cycle and solvent-refined coal subsystems. Studies of comparative fuel costs are reviewed for various alternatives. The Lurgi gasifier system is described in terms of projected development and design improvement. The solvent-refining coal (SRC) and fluidized bed combustion processes are discussed noting expected costs and the recently developed atmospheric fluidized bed pilot plant in West Virginia. Environmental considerations are treated briefly, comparing the impacts of various fuels and techniques. S.C.S.

A78-12844 Analysis of petroleum type hydrocarbons in marine samples using gas chromatography and mass spectrometry. J. L. Laseter and M. C. Legendre (New Orleans, University, New Orleans, La.). In: Oceans '76; Proceedings of the Second Annual Combined Conference, Washington, D.C., September 13-15, 1976. New York, Institute of Electrical and Electronics Engineers, Inc.; Washington, D.C., Marine Technology Society, 1976, p. 23C-1 to 23C-5. 15 refs. U.S. Bureau of Land Management Contract No. AA550-CT6-19.

The indigenous hydrocarbons in samples of zoo-plankton, shrimp (Penaeus aztecus) and sediment are extracted by refluxing with a series of organic solvents fractionated by column chromatography and then resolved by high resolution gas chromatography. The above fractions were then spiked with the aliphatic or aromatic components isolated from a Louisiana crude oil and rechromatographed. Identification of resolved hydrocarbons is achieved by use of a gas chromatograph-mass spectrometer combination. Capillary columns enable almost complete resolution of all the isoprenoid, branched and cyclic alkanes that are important in determining the presence of petroleum in a marine sample. Many of the key petroleum aromatic compounds could also be resolved by use of capillary columns from many of the naturally occuring esters, alkenes and related organics. The greater the reliance on gas chromatography as the principle tool to establish the presence of trace petroleum pollution in marine samples, the greater the need to employ high resolution chromatography. (Author)

A78-12876 International Scientific-Technological Conference on Space, 17th, Rome, Italy, March 25, 26, 1977, Proceedings (Convegno Internazionale Tecnico Scientifico Sullo Spazio, 17th, Rome, Italy, March 25, 26, 1977, Atti). Conference sponsored by the Ministero degli Affari Esteri, European Space Agency, and Associazione Industrie Aerospaziali. Rome, Rassegna Internazionale Elettronica Nucleare ed Aerospaziale, 1977. 598 p. In Italian, English, French, and German.

Space technology, earth resources monitoring and solar energy are discussed, with attention given to the experimental communications satellite Sirio, Spacelab projects, the Meteosat and Exosat satellites, and the launch vehicle Ariane. Topics of the papers include atmospheric transparency, satellite monitoring of hailstorm damage, planetary dynamics of the earth, the thermal control, power supply, propulsion, communications, and antenna systems of the satellite Sirio, structural and dynamic analyses of Sirio, domestic solar energy facilities in Europe, the Cactus accelerometer, stratospheric balloons, passive atmospheric sounding systems for Spacelab, and the dynamic behavior of communications satellite antennae. J.M.B.

A78-12908 # The use of natural resources - Solar energy applied to the construction of human habitats (L'uso delle risorse naturali - L'energia solare nella costruzione dell'habitat umano). I. Amirante, G. Caterina, R. La Creta, and A. Vitale (Napoli, Università, Naples, Italy). In: International Scientific-Technological Conference on Space, 17th, Rome, Italy, March 25, 26, 1977, Proceedings. Rome, Rassegna Internazionale Elettronica Nucleare ed Aerospaziale, 1977, p. 431-442. 11 refs. In Italian.

A solar space heating system for homes in a rural community in Italy is described. The design program emphasizes conservation of the existing community structure. In addition to solar space heating, a system for converting solid wastes to methane, and a rainwater collection system are discussed. J.M.B.

A78-12909 # Some recent domestic solar energy systems in Europe (Su alcuni recenti impianti Europei per l'utilizzazione domestica dell'energia solare). G. de Comelli (Trieste, Università, Trieste, Italy). In: International Scientific-Technological Conference on Space, 17th, Rome, Italy, March 25, 26, 1977, Proceedings. Rome, Rassegna Internazionale Elettronica Nucleare ed Aerospaziale, 1977, p. 443-453. 15 refs. In Italian.

Solar space heating, air conditioning, and domestic hot water systems in a dozen experimental domestic solar energy facilities constructed in Europe since 1970 are discussed. Solar collector type, the heat transfer fluid employed, heat pumps, and the accumulation systems for the facilities are compared. J.M.B.

A78-12936 # Supervisory and transmission system for the control of atmospheric pollution in areas surrounding thermoelectric plants. M. Aiminio (Ente Nazionale per l'Energia Elettrica, Direzione Produzione e Transmissione, Rome, Italy). In: International Electronics Congress, 24th, Rome, Italy, March 28-30, 1977, Proceedings. Rome, Rassegna Internazionale Elettronica Nucleare ed Aerospaziale, 1977, p. 103-111.

Air quality monitoring systems employed to assess sulfur dioxide pollution in the vicinity of power plants are discussed. The monitoring systems rely on standardized peripheral units consisting of low-capacity remote control equipment, a telegraphy channel, and a VHF transceiver; both wire and radio transmission of the data are thus available. Advantages of the monitoring systems, including applicability to a wide variety of remote locations, ease of maintenance due to standardization, and low cost, are considered. J.M.B.

A78-12995 Air pollution by coal dust. P. P. A. Smit, P. H. M. te Riele, and P. C. Richards (Koninklijke/Shell Laboratorium, Amsterdam, Netherlands). In: Atmospheric pollution; Proceedings of the Twelfth International Colloquium, Paris, France, May 5-7, 1976. Amsterdam, Elsevier Scientific Publishing Co., 1976, p. 589-601.

The dust pollution aspects of dewatering coal transported in a coal slurry pipeline were studied by simulating (in the laboratory) the various emissions at a terminal and calculating dispersion and fall-out. Calculations were based on an existing heavy-gas dispersion model, modified to take any particle fall-out into account. The results of the study indicate that pipeline grade coal handling terminal need not be a source of significant airborne pollution, if appropriate handling techniques are applied. V.P.

A78-12999 **Air pollution control and clean energy.** Edited by C. Rai (Wyoming, University, Laramie, Wyo.) and L. A. Spielman (Delaware, University, Newark, Del.). *AIChE Symposium Series,* vol. 72, no. 156, 1976. 464 p.

Several topics relevant to air pollution control and clean energy are discussed. Sulfur oxides are studied with attention to sulfur oxide control at nonferrous smelters and clean energy from fossil fuels. Particulates are examined from the viewpoint of health aspects, sampling and characterization, optical properties and remote sensing, and gas cleaning and pollution control. Other subjects include air pollution from stationary sources, catalysis in environmental and energy problems, and atmospheric transport and transformation. Also considered are assessment and control of combustion related air pollutants, economic evaluation and comparison of pollution control equipment, and pollution control related to biological systems. M.L.

A78-13072 # **GSSPS - Taking a new approach to the space solar power station.** L. J. Cantafio, V. A. Chobotov, and M. G. Wolfe (Aerospace Corp., El Segundo, Calif.). *Astronautics and Aeronautics,* vol. 15, Nov. 1977, p. 36-43. 13 refs.

Using a solar conversion efficiency of 11.3% and a concentration ratio of 2.3, it has been estimated that a photovoltaic system requires a 5- by 13-km solar array to deliver 5000 MW of rectified power to the ground. Innovative approaches are necessary to solve the problems associated with the deployment, assembly, stabilization, and control of such large flexible structures. The design approach examined in the present paper is the gravitationally stabilized solid-state satellite solar power station (GSSPS). Its solar array is separated into small segments joined together in a linear array, along a power-carrying cable oriented along the local vertical, with the earth-pointing power-transmitting antenna at the lower end of the array. The characteristics and the advantages and disadvantages of a 5000-MW system with 24 pairs of 385- by 2000-m solar panels attached to a 72-km long 2-m-diam circular waveguide are discussed. V.P.

A78-13150 **Principles of nuclear district heating.** L. A. Melent'ev (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *(Teploenergetika,* Nov. 1976, p. 6-9.) *Thermal Engineering,* vol. 23, Nov. 1977, p. 1-4. Translation.

The economic and engineering aspects of the utilization of nuclear reactor fuel are studied. It is shown that optimal utilization of such fuel in the heat and energy balance of the USSR is possible only if it finds widespread use both for power and heat supply. Some aspects of the selection and production of turbines for central-heating atomic power plants, including selection of the optimal heating coefficient and steam and hot-water parameters, are examined. V.P.

A78-13153 **Some results of investigations on the U-25 pilot plant to attain its design parameters.** V. A. Kirillin and A. E. Sheindlin. *(Teploenergetika,* Dec. 1976, p. 2-7.) *Thermal Engineering,* vol. 23, Dec. 1977, p. 1-7. 9 refs. Translation.

The work described was pertormed over a period of several years to improve the parameters of the U-25 energy converter employing a 25-MW MHD-generator. The major topics discussed include refinement of the hardware, the technological processes, and the operation of thermally stressed combustion chambers and of mixing systems for ionizing additions. Attention is given to studies of MHD-channel operation and to problems involved in the conversion of direct to alternating current. V.P.

A78-13154 **Some results of investigation of pressure fluctuations in a condensing injector.** E. E. Shpil'rain, A. F. Gandel'sman, A. P. Sevast'ianov, I. V. An, S. I. Vainshtein, V. A. Riabtsev, M. Sh. Rozenblat, and A. E. Frish (IVTAN; L'vovskii Politekhnicheskii Institut, Lvov, Ukrainian SSR; Moskovskii Energeticheskii Institut, Moscow, USSR). *(Teploenergetika,* Dec. 1976, p. 7-10.) *Thermal Engineering,* vol. 23, Dec. 1977, p. 8-11. 12 refs. Translation.

The operation of a condensation injector as an accelerator for the liquid-metal cycle of an MHD generator was studied experimentally with emphasis on the stability and efficiency of the device. It is found that the Mach number attains its maximum value in the injector-throat cross section with the lowest static pressure. Measurements of the pressure pulsations showed that in this cross section, the amplitude of the shock front vibrations passes through a minimum and the shock becomes less stable. The results of the experiment indicate that application of spectral analysis to the study of pressure pulsations in the diffusor of condensation injector yields reliable information on the internal processes occurring in the injector. V.P.

A78-13155 **Variation in excess oxidant factor in combustion products of MHD generator.** M. S. Pinkhasik, V. D. Mironov, Iu. A. Zakharko, and A. I. Plavinskii (IVTAN; Vsesoiuznyi Teplofizicheskii Institut, USSR). *(Teploenergetika,* Dec. 1976, p. 10-14.) *Thermal Engineering,* vol. 23, Dec. 1977, p. 12-16. 6 refs. Translation.

The determination of the excess oxidant ratio is of importance for the optimization of the operation of an MHD-generator and its combustion chamber (plasma generator). In the present paper, it is shown experimentally that an electrochemical gas analyzer can be use successfully to measure excess oxidant ratios smaller than unity. An expression is derived which relates the emf of an electrochemical gas analyzer to the excess oxidant ratio (smaller than unity) in the case of a 40% oxygen enrichment of the oxidant and the presence of ionizing additions. V.P.

A78-13156 **Experimental investigation of pulsating modes of combustion in the combustion chambers of the U-25 plant.** N. A. Balashov, L. Z. Dreizin, N. A. Miniaev, A. F. Perekal'skii, M. S. Pinkhasik, N. P. Privalov, and V. N. Sukhov (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *(Teploenergetika,* Dec. 1976, p. 14-17.) *Thermal Engineering,* vol. 23, Dec. 1977, p. 17-20. 5 refs. Translation.

The mode shapes of pulsating combustion were studied in combustion chambers of two types, using the U-25 (thermal-to-electric) energy converter both with an MHD-generator in the presence of a magnetic field and with a channel-simulating gas duct, without a magnetic field. Use was made of LKh-613-type piezoelectric sensors attached to the combustion chamber walls and the fuel-supply system. Diagrams of the pressure pulsations in the nozzle, combustion chamber, and the gas duct in the presence of longitudinal instability are given and discussed. V.P.

A78-13157 **Thermal testing of the GT-35 gas turbine plant in the steam turbine-gas turbine plant with a high-head steam generator.** G. G. Ol'khovskii, L. B. Povolotskii, M. P. Kaplan, A. O. Bumarskov, A. I. Belov, L. I. Chernomordik, and P. I. Korzh (Khar'kovskii Turbogeneratornyi Zavod, Kharkov, Ukrainian SSR; Vsesoiuznyi Teplofizicheskii Institut, USSR). *(Teploenergetika,* Dec. 1976, p. 51-55.) *Thermal Engineering,* vol. 23, Dec. 1977, p. 42-45. Translation.

The gas turbine of the PGU-200 power plant can be drived either by combustion or with steam generated in a boiler. The tests described in the present paper were carried out at loads of up to 35 MW. At maximal loads, the rate of airflow through the compressor was between 220 and 240 kg/sec; the pressure behind the compressor was 0.67 to 0.72 MPa, and the mean temperature in front of the turbine was 700 to 735 C. These parameters satisfy the required operating conditions of the high-pressure boiler and the installation itself. The indices of the major turbine elements were compatible with the design values: a compressor efficiency of 86 to 87%; a turbine efficiency of 87 to 88%; and a throughput of 1.00 to 1.01. Recalculated to autonomous operation and standard external conditions, the turbine power was 30.5 to 31.5 MW and the efficiency was 23.3 to 23.7%. V.P.

A78-13169 **Influence of combustion chamber geometry on toxic compound emissions.** A. V. Ivliev, Iu. A. Knysh, and V. P. Lukachev. *(Aviatsionnaia Tekhnika,* vol. 20, no. 1, 1977, p. 60-65.) *Soviet Aeronautics,* vol. 20, no. 1, 1977, p. 44-48. 5 refs. Translation.

Experiments were conducted investigating the influence of modifications in combustion chambers of gas turbine engines on completeness of combustion and the emission of toxic gases. The characteristics of the toxic exhaust gases of the NK-12CT gas turbine engine with two types of fuel sprayers were determined for the case of methane combustion. It is shown that by replacing fluidic-gas sprayers with centrifugal sprayers, it is possible to reduce the emission of nitrogen oxides by 40-50%. B.J.

A78-13342 **Bioconversion of solar energy to methane.** J. D. Keenan (Pennsylvania, University, Philadelphia, Pa.). *Energy* (UK), vol. 2, Dec. 1977, p. 365-373. 29 refs.

The purpose of this paper is to report the results of an investigation of the energy conversion efficiency of an aquatic based fuel-from-biomass system. The bases of the system are the biochemical conversions of solar energy to algal biomass to methane which is, in turn, used as auxiliary fuel for a fossil-fuel-fired steam-electric power plant. The alga used in the research was Anabaena flos-aque, a blue-green alga possessing many of the characteristics desired in an energy crop. The results of the research indicate that renewable methane can significantly reduce the imported fossil fuel requirement of the power station; that an overall efficiency of the conversion of solar energy to methane of one percent is attainable; and that energy inputs account for 12% of the methane fuel value. (Author)

A78-13343 **Prospects for geothermal energy applications and utilization in Canada.** I. I. Glass (Toronto, University, Toronto, Canada). *Energy* (UK), vol. 2, Dec. 1977, p. 407-428. 94 refs. Research supported by the Science Research Council of Canada and Japan Society for the Promotion of Science.

The article discusses potential utilization of geothermal energy in Canada. Attention is given to various sources of geothermal energy, including dry and wet-steam resevoirs for electric power generation and industrial application, and hot dry-rock fields. Various methods for fracturing hot dry-rock are described, such as (1) hydraulic and (2) nuclear and chemical-explosive fracturing. The economics of a geothermal energy system are reviewed, noting estimated costs from three different sources. The environmental effects of geothermal electric-power generation are outlined, along with the prospects for developing such systems in Canada. S.C.S.

A78-13344 **The shrouded aerogenerator.** O. Igra (Negev, University, Beersheba, Israel). *Energy* (UK), vol. 2, Dec. 1977, p. 429-439. 15 refs. Research supported by the United States-Israel Binational Science Foundation.

Experimental studies have been performed on a shrouded aerogenerator. The device tested will produce about twice the output power obtainable from an ideal wind turbine working under the same freestream conditions but without a duct. The aerogenerator does not require a driving mechanism that will keep it parallel to the free-stream direction. A simple, two-stage turbine with fixed blade geometry will provide the expected power output over a fairly wide range of free-stream velocities and rotational speeds. (Author)

A78-13345 **Mobilization and impacts of bio-gas technologies.** J. K. Parikh and K. S. Parikh (International Institute for Applied Systems Analysis, Laxenburg, Austria). *(Bundesministerium für Forschung und Technologie and United Nations Institute for Training and Research, Seminar on Microbial Energy Conversion, Göttingen, West Germany, Oct. 1976.) Energy* (UK), vol. 2, Dec. 1977, p. 441-455. 12 refs.

The article discusses the use of bio-gas plants for the efficient utilization of local resources for energy and fertilizer requirements. The technology is considered applicable to rural environments as it does not require great investments or highly-skilled labor. India is used as an example of a potential area for introduction of the technique. Single-family bio-gas plants are described, noting economic parameters and the predicted impact of large-scale adoption. Plans for village level plants are presented with regard to operating schemes, guidelines for pricing policy, cost-benefit analyses, and the potential impact of large-scale adoption. Bio-gas plants are also discussed in terms of slum sanitation and the prospects for developing such plants in other countries. S.C.S.

A78-13346 **Volcanoes as a source of geothermal energy.** W. M. Heffington, J. M. Kline, and J. W. Rottman (California, University, La Jolla, Calif.). *Energy* (UK), vol. 2, Dec. 1977, p. 457-459. 15 refs.

The thermal energy available from high-temperature magma is calculated to be 8 x 10 to the 14th kcal/cu km and an upper bound for volcanic energy of 3 x 10 to the 18th kcal/volcano is determined. Approximately one-third of the energy may be obtained between about 750 and 1150 C (i.e. above the solidification temperature of the magma), while the remaining two-thirds is available from magma in the solid state between ambient and around 750 C. Gas dissolved in the magma possesses about 4% of the thermal energy and a large portion of that energy is potentially available as high-temperature steam. After removal of water, the gas remaining is a low-Btu gas with a heat of combustion of about 0.3 kcal/l. Utilization of both the thermal and combustion energy is the subject of current research projects. (Author)

A78-13421 **Means of transport and the energy consumed by them (Die Verkehrsträger und ihr Energieverbrauch).** K. Bauermeister (Deutsche Bundesbahn, Frankfurt am Main, West Germany). *Zeitschrift für Eisenbahnwesen und Verkehrstechnik - Glasers Annalen,* vol. 101, Aug.-Sept. 1977, p. 282-291. 17 refs. In German.

The general energy situation in the Federal Republic of Germany is considered, taking into account changes concerning the relative importance of various means of transportation employed for transporting the energy carriers to the place at which they are used, and the relative amounts of energy consumed by these means of transportation. Aspects of energy transformation, including the efficiency of this transformation and approaches for increasing this efficiency, are investigated along with questions regarding the specific energy consumption. The effect of various factors on the specific energy consumption in the case of electric-traction railroad systems in West Germany is discussed. Attention is given to the primary energy consumption of trucks, inland shipping, pipelines, and air traffic. Possibilities for decreasing the specific primary-energy consumption are also examined. G.R.

A78-13422 **The technical evaluation of transport drive systems (Zur technischen Bewertung von Transportantriebssystemen).** H. Rose (Hochschule für Verkehrswesen, Dresden, East Germany). *Zeitschrift für Eisenbahnwesen und Verkehrstechnik - Glasers Annalen,* vol. 101, Aug.-Sept. 1977, p. 292-302. 13 refs. In German.

A description is presented of the objectives and results of investigations conducted by Gärtner (1973) and Wenkel (1974). Approaches for the complex technical evaluation of transport drive systems are considered, taking into account the determination of a complex technical evaluation parameter, the mean energy transformation value, and the number of the machines which are to be employed in the principal elements of the drive system. The specific, predominantly technical, evaluation of transport drive systems with a hybrid drive element is discussed. The values of the evaluation criteria as a function of a drive-system performance parameter are shown in a graph. G.R.

A78-13447 **Modeling the effect of atmospheric carbon dioxide on the global radiative heat balance.** R. J. Mulholland, C. M. Gowdy (Oklahoma State University, Stillwater, Okla.), and C. L. Cole (Northeastern Oklahoma State University, Tahleguah, Okla.). *IEEE Transactions on Systems, Man, and Cybernetics,* vol. SMC-7, Nov. 1977, p. 803-805. 13 refs. NSF Grants No. ENG-75-05341; No. SMI-76-02784.

The effect of fossil fuel combustion on the average temperature of the earth is studied by computer simulation. Based upon projected fuel usage patterns, a 6 K temperature rise is predicted within the next 200 years. In order to avoid possible catastrophic climatic changes, a hard constraint is computed for the maximum rate of fossil fuel consumption. (Author)

A78-13449 **An off-peak energy storage concept for electric utilities. II - The water battery concept.** J. E. Clifford, E. W. Brooman (Battelle Columbus Laboratories, Columbus, Ohio), V. T. Sulzberger, and Y. Z. El-Badry (Public Service Electric and Gas Co., Newark, N.J.). *Applied Energy,* vol. 3, Oct. 1977, p. 233-255. 7 refs. Research supported by the Battelle Memorial Institute and Public Service Electric and Gas Co.

A conceptual design for a 10 MW water battery installation is presented. General design approaches and cost estimates are developed for the basic water battery module, the energy storage subsystem (which consists of the compressors and storage vessels for the hydrogen and oxygen), and the power conditioning subsystem (which controls and regulates direct current to the water battery and alternating current to the grid). Factors considered include optimum system operating efficiency, projected battery life, reliability, maintenance, materials availability (the battery uses substantial but recoverable amounts of platinum and palladium), and environmental impact in terms of pollutants and physical size. M.L.

A78-13451 **A procedure for comparing the economy of different electrical space heating systems (Ein Verfahren zum Vergleich der Wirtschaftlichkeit verschiedener elektrischer Raumheizungssysteme).** D. Pevetz and W. Fiala (Wien, Technische Hochschule, Vienna, Austria). *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau,* vol. 35, Sept. 1977, p. A268-A271. In German.

The heating systems considered are related to electrical direct heating, the employment of heat storage devices for a utilization of lower electrical energy rates at night, an electrical heating of the floor area, and the use of heat pumps. The total yearly expenses for electrical heating installations are examined, taking into account capital costs, financing possibilities, and the various types of operational costs. Financial calculations for determining the economics of a heating system are also discussed and the calculation of the capital values at the time zero for two heating systems of the same type is considered. G.R.

A78-13452 **Heat pump application in houses.** S. J. Leach (Building Research Establishment, Garston, England). *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau,* vol. 35, Sept. 1977, p. A277-A283.

A description is presented of the possible uses of heat pumps for space and water heating applications in houses in the UK. In the UK the only heat pumps sold of a size suitable for domestic heating applications are compression cycle electrically driven devices. The feasibility of a use of other types of heat pumps is briefly considered, taking into account a Diesel-engine driven compression cycle pump, a gas engine driven heat pump operating with substitute natural gas (SNG), and an absorption cycle heat pump using SNG. Research conducted at a British building research establishment is discussed, giving attention to low energy experimental houses, a room unit heat pump, heat pumps used for waste water heat recovery, and aspects of heat pump testing. G.R.

A78-13453 **Air source heat pumps (Wärmepumpen für Aussenluft).** K. Vielhaber (Robert Bosch GmbH, Wernau, West Germany). *(Tagung über Nichtkonventionelle Energieträger, Essen, West Germany, Mar. 22, 1977.) Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau,* vol. 35, Sept. 1977, p. A283-A286. In German.

The design of an air-to-water pump in Central Europe is considered and the influence of the heat source air on the heating efficiency of the heat pump is investigated. Suitable defrosting procedures are discussed together with approaches for reducing operational noise. Attention is given to the piping arrangement in an air-to-water heat pump, an example for the appropriate installation of an air-to-water heat pump, the characteristics of an air-to-water heat pump, the temperature spread at the evaporator of an air-to-water heat pump, noise-level measurements on an air-to-water heat pump, and houses with air-to-water heat pumps. G.R.

A78-13454 **The BBC solar house - Design and operating experience (Das BBC-Solarhaus - Aufbau und Betriebserfahrungen).** B. Ziegenbein (Brown, Bovery et Cie AG, Heidelberg, West Germany). *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau,* vol. 35, Sept. 1977, p. A294-A297. In German.

A solar house was built in spring 1976 in Walldorf, near Heidelberg, West Germany. The solar house represents the typical characteristics of a modern one-family house with respect to appearance, living space, window area, and energy requirements. Two thirds of the yearly energy requirements are to be satisfied with the aid of solar energy. A bivalent heating system used contains, in addition to the solar installations, also a supplementary conventional heating system. The development of a cost-optimal design for collector area and storage volume is considered. Attention is given to an employment of low temperature levels in the solar installation for low-loss heat storage, the use of a heat pump, the control of the heating system, the study of latent-heat energy storage systems, air-conditioning with the aid of solar energy, and considerations concerning the design of the heat exchangers. G.R.

A78-13455 **Solar energy installations in Germany (Ausgeführte Solaranlagen in Deutschland).** A. Urbanek. *Elektrowärme International, Edition A - Elektrowärme im Technischen Ausbau,* vol. 35, Sept. 1977, p. A297-A301. 12 refs. In German.

About 250 solar systems for providing hot water and for heating swimming pools and buildings have been installed in West Germany during 1976. The number of installed solar systems in Germany at the end of 1977 will be about 5000. Solar heating procedures used in the case of large public swimming pools are discussed along with the approaches employed for providing hot water. Attention is given to a use of combined systems, the employment of heat pumps, the use of low-temperature solar systems for floor heating applications, and a house in which about 80% of the heat requirements are provided by solar energy. G.R.

A78-13464 **Nuclear fusion by means of a laser (La fusion nucléaire par laser).** C. Jablon (CNRS, Paris; Paris XI, Université, Orsay, Essonne, France). *La Recherche,* vol. 8, Nov. 1977, p. 925-935. 5 refs. In French.

An overview of nuclear fusion is offered with attention directed to the use of lasers to achieve the input of energy required to initiate fusion. The use of computers is considered with reference to the analysis of reactions occurring in highly compressed plasmas. Potential energy output is discussed, propagation of shock waves is portrayed, and a survey of U.S. and European research is presented. M.L.

A78-13468 **Global equilibrium between energy requirements and resources on the horizon of the year .-,00. I - Evolution and regionalization of the problem (L'équil'bre mondial entre besoins et ressources d'énergie à l'horizon 2000. I - Evolution et régionalisation du problème).** J.-R. Frisch. *Revue de l'Energie,* vol. 28, Oct. 1977, p. 444-459. In French.

As a basis for evaluation of world energy requirements and resources predicted for the year 2000, a system of regionalization has been developed, identifying three primary areas (western countries, eastern countries, and the Third World) and seven localized zones (North America, Western Europe, other western countries, the U.S.S.R., Eastern Europe, China, and the rest of the Third World). Various resources, including carbon, petroleum, natural gas, hydraulic energy, and nuclear energy, are discussed in terms of estimated global and regional needs. The article contains appendices showing global and regional energy consumption for 1950, 1974, and the predicted requirements for the year 2000. S.C.S.

A78-13469 **Energy economy in the investment policy of French companies. I - The industrial attitude (Les économies d'énergie dans la politique d'investissement de l'entreprise française. I - Le comportement des industriels).** M. Castagné and J.-J. Picard (Lorraine, Institut National Polytechnique, Nancy, France). *Revue de l'Energie,* vol. 28, Oct. 1977, p. 473-477. In French.

Five industrial sectors have been determined as the major consumers of energy: the steel, chemical, construction materials, paper and metallurgy industries. Potential methods for economizing energy in these industries are suggested, including those requiring little or no investment, and those requiring substantial capital investment. The 1973 energy crisis is reviewed in terms of the industrial reaction, classified into major factors such as politico-commercial, manpower, and environmental issues. The reaction of industry to the national policy formulated in answer to the energy crisis is discussed. This policy is based on three principal suggestions: (1) reinforcement of standards in construction aimed at eliminating excess energy waste, (2) national subsidizing, and (3) renewed research in the area of energy conservation. S.C.S.

A78-13624 **U.S. energy conversion research needs.** G. P. Cooper. *Mechanical Engineering,* vol. 99, Nov. 1977, p. 22, 23, 25-28. 38 refs.

Six energy systems, considered likely to be the major energy sources for the next 25 years, are analyzed with attention to weaknesses in their technology and to the R & D goals that should be pursued. The six systems are nuclear breeder systems, direct burning and carbonization of coal while in compliance with environmental protection controls, synthetic high-Btu (pipeline quality) gas production, synthesis of low-Btu gas from coal and residual oil, synthetic liquid fuel production, and utilization of energy in waste materials. The amount of energy that can be obtained from different processes is considered. M.L.

A78-13625 **Energy - Fluid fuels from solids.** D. F. Othmer (New York, Polytechnic Institute, Brooklyn, N.Y.). *Mechanical Engineering,* vol. 99, Nov. 1977, p. 29-35.

A survey of processes that produce gas or liquid fuels from solid fuels is presented. Approaches considered include gasification of coal, liquid fuels from coal, and oil and gas from oil shales. Additional sources considered include tar sands and bio-solids or biomass. The costs of various processes are examined. Overall, it is thought that more than $1 trillion will be required to build energy plants in the U.S. alone in the near future. M.L.

A78-13663 # **Determination of design and operational criteria for offshore facilities.** F. W. Rose (Continental Oil Co., Houston, Tex.). In: Satellite applications to marine technology; Conference, New Orleans, La., November 15-17, 1977, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p. 122-125. (AIAA 77-1577)

Environmental data acquisition has become an important factor for the oil and gas industries in terms of offshore exploration, development, and production. Oceanographic-meteorological data requirements and measurement techniques are discussed, noting both real time and historical requirements. The application of satellite remote sensing to offshore design and operational criteria determination is suggested. It is proposed that an operational remote sensing satellite system employing a few conventional measurement stations for ground truth verification may provide global oceanographic-meteorological climatology monitoring which would facilitate more precise forecasting capability. S.C.S.

A78-13666 * # **Applications of Seasat to the offshore oil, gas and mining industries.** A. G. Mourad and A. C. Robinson (Battelle Columbus Laboratories, Columbus, Oh.o). In: Satellite applications to marine technology; Conference, New Orleans, La., November 15-17, 1977, Collection of Technical Papers.
New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p. 149-156. 12 refs. Contract No. NASw-2800. (AIAA 77-1583)

The NASA satellite Seasat-A (to be launched in 1978) has applications to the offshore oil, gas, and mining industries including: (1) improvements in weather and wave forecasting, (2) studies of past wind and wave statistics for planning design requirements, and (3) monitoring ice formation, breakup, and movement in arctic regions. The primary geographic areas which will be monitored by Seasa A include: the Beaufort Sea, the Labrador Sea, the Gulf of Mexico, the U.S. east coast, West Africa, Equatorial East Pacific, the Gulf of Alaska, and the North Sea. Seasat-A instrumentation used in ocean monitoring consists of a radar altimeter, a radar scatterometer, a synthetic aperture radar, a microwave radiometer, and a visible and infrared radiometer. The future outlook of the Seasat program is planned in three phases: measurement feasibility demonstration (1978-1980), data accessibility/utility demonstration (1980-1983), and operational system demonstration (1983-1985). S.C.S.

A78-13681 # **Future onshore and offshore exploration by remote sensing from space.** F. B. Henderson, III (Geosat Committee, Inc., San Francisco, Calif.). In: Satellite applications to marine technology; Conference, New Orleans, La., November 15-17, 1977, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p. 264-275. (AIAA 77-1550)

Geological remote sensing from satellites is discussed in terms of its advantages such as synoptic perspective, global coverage, regional mapping, and improved efficiency. The limitations of such programs are identified, including insufficient resolution, limited stereoscopic capability, and restricted number of available spectral bands. Future additions to geological remote sensing programs are expected to consist of a Stereosat system, the inclusion of the 2.2 micron band, a large format camera, and synthetic aperture and side looking radars. Other satellite systems under development by NASA include Lageos, Seasat-A and B, SIR A and B, Heat Capacity Mapping Missions, Magsat, SMIRR, and a Global Positioning Satellite. S.C.S.

A78-13684 # **Positioning and navigation by satellite.** T. A. Stansell, Jr. (Magnavox Government and Industrial Electronics Co., Advanced Products Div., Torrance, Calif.). In: Satellite applications to marine technology; Conference, New Orleans, La., November 15-17, 1977, Collection of Technical Papers. Conference sponsored by AIAA, AMS, AGU, IEEE, MTS, and SEG. New York, American Institute of Aeronautics and Astronautics, Inc., 1977. 12 p. 9 refs. (AIAA 77-1553)

It has been suggested that navigation satellites may be applicable for marine operations such as offshore oil and gas surveys. Most marine navigational accuracy requirements are from 1-2 nautical miles for open ocean passage, and from 3-10 meters for specialized operations such as channel navigation and final position determination of drill rigs. The satellite navigation system Navstar (or GPS, Global Positioning System) may be appropriate for such operations. Each satellite would be equipped with a memory system, a control computer, an atomic frequency standard, two L-band transmitters and antennas, and command and control receiving equipment. Transit, the only operating satellite navigation system, is discussed in terms of its potential use on integrated navigation systems for offshore operations and fixed scale surveys. The MX 111 Marisat Communication Terminal is also briefly noted. S.C.S.

A78-13785 **Selective absorption of solar energy in ultrafine chromium particles.** C. G. Granqvist and G. A. Niklasson (Chalmers Tekniska Hogskola, Goteborg, Sweden). *Applied Physics Letters,* vol. 31, Nov. 15, 1977, p. 665, 666. 16 refs. Research supported by the Statens Naturvetenskapliga Forskiningsrad.

Ultrafine chromium particles prepared by evaporation in argon + air are found to be highly absorbing over the solar spectrum and highly transparent in the infrared. Such spectral selectivity is the distinctive feature of a coating in an efficient photothermal converter for solar energy. Optical transmittance through coatings with mass density less than or approximately equal to 0.5 g/sq m agrees well with calculations based on the Maxwell-Garnett theory, whereas coatings with larger mass density exhibit a transmittance too low to be directly reconciled with this theory. (Author)

A78-13797 **Enhancement of MIS solar-cell 'efficiency' by peripheral collection.** R. B. Godfrey and M. A. Green (New South Wales, University, Kensington, Australia). *Applied Physics Letters,* vol. 31, Nov. 15, 1977, p. 705-707. 7 refs. Research supported by the Radio Research Board, Sydney County Council, and Australian Research Grants Committee.

It is shown that peripheral collection in silicon devices yields greater short-circuit current in small-area MIS and Schottky solar cells. Very small cells, those with areas of less than 0.02 cm sq, may have their short-circuit currents boosted over 80%. Larger cells, those with areas over 1 cm sq, usually show an increase of under 10%. These findings show that the total front surface area of a cell is an important factor in predicting efficiency measurements. S.C.S.

A78-13800 **The sunny side of energy.** *Energy Developments,* vol. 1, Oct. 1977, p. 7-10.

A description is presented of developments related to a conversion of solar heat to mechanical and electrical power. A 10 kW solar generator (electric) system developed by a German company is based on the operation of a cold vapor turbine with the low-temperature heat (90 to 140 C) of solar collectors. The generator has been installed in Cairo (Egypt) for a study under realistic conditions. Other developments reported make use of parabolic cylindrical collectors for concentrating the incident solar radiation onto a focus line containing an absorber tube. It is believed that in countries with suitable meteorological conditions solar energy plants will be able in 10 to 20 years to generate electrical power at competitive prices, if appropriate series-production techniques are developed. G.R.

A78-13847 # **Optimal design methodology for a wind power system.** R. W. Langham and L. Frair (Virginia Polytechnic Institute and State University, Blacksburg, Va.). *Operations Research Society of America and Institute of Management Sciences, Joint National Meeting, San Francisco, Calif., May 9-11, 1977, Paper.* 27 p. 9 refs.

Design criteria for a wind generator system located in an arbitrary wind regime are developed, and a mathematical model for optimal design is tested. Costs associated with the rotor blade, tower and generator are included in the design criteria. An empirical relationship connecting wind speed to altitude, and a discrete approximation of wind energy are discussed in evolving a solution technique for the mathematical design model. Computational results are presented for a 2500-KW generator system located in Oklahoma City. J.M.B.

A78-13851 # **Estimating the potential of a solar-to-thermal collector industry.** J. S. Aronofsky and H. A. Blum (Southern Methodist University, Dallas, Tex.). *Operations Research Society of America and Institute of Management Sciences, Joint National Meeting, San Francisco, Calif., May 9-11, 1977, Paper.* 20 p. 15 refs.

The objective of this study was to develop and utilize an approach for estimating the future impact of an emerging industry which will provide solar-to-thermal convertors. Results indicate that by 1985 the price for thermal solar energy collectors could range from $1 to $5 per square foot and thereby become competitive in selected markets with crude oil or coal. The method of analysis is based on 'rapid' growth in the installation of units, increased market potential as the delivery temperature increases, and the applicability of 'experience curves' in estimating future collector costs. (Author)

A78-13857 **Hall effect on an rf induction discharge.** A. P. Zhilinskii, B. V. Kuteev, and A. S. Smirnov (Leningradskii Politekhnicheskii Institut, Leningrad, USSR). *(Pis'ma v Zhurnal Tekhnicheskoi Fiziki,* vol. 3, Mar. 26, 1977, p. 258-261.) *Soviet Technical Physics Letters,* vol. 3, Mar. 1977, p. 102, 103. Translation.

The paper considers the development of an efficient MHD generator with nonequilibrium conductivity which uses inductive HF discharges. Experiments were conducted to study the Hall effect for this type of discharge in argon at pressures of 15 and 32 torr with an additive of cesium. It is shown that an inductive-discharge plasma has high stability with respect to the development of different kinds of plasma oscillations for the case of MHD generator-plasma parameters. B.J.

A78-13905 **Silicon films as selective absorbers for solar energy conversion.** D. E. Ackley and J. Tauc (Brown University, Providence, R.I.). *Applied Optics,* vol. 16, Nov. 1977, p. 2806-2809. 12 refs. NSF-supported research.

For high-temperature photothermal solar energy conversion systems, silicon layers deposited on highly reflecting metals have been proposed to form absorber-reflector tandems that absorb large fractions of the incident solar energy while reducing the thermal emission from the system. In the present study, the optical constant below the fundamental absorption edge (up to 5 microns) of silicon single crystals and sputtered amorphous silicon film at temperatures up to 800 C are determined. The photothermal efficiencies of silicon/metal selective absorbers for thermal solar energy conversion are calculated. V.P.

A78-13907 **Infrared spectral emittance profiles of spectrally selective solar absorbing layers at elevated temperatures.** D. E. Soule and D. W. Smith (Western Illinois University, Macomb, Ill.). *(Optical Society of America, Topical Meeting on Optical Phenomena in Infrared Materials, Annapolis, Md., Dec. 1-3, 1976.) Applied Optics,* vol. 16, Nov. 1977, p. 2818-2821. 10 refs. Research supported by the Western Illinois University and Argonne National Laboratory.

A study was made to characterize parametrically the spectrally selective absorptance profiles of typical interference, bulk absorption, and mixed-type absorbing layers for solar-thermal conversion at temperatures to 500 C. A five parameter empirical Fermi function was used to model the spectral absorptance converted from the measured spectral reflectance. An alternative method using the Fermi model is presented for defining the IR spectral emittance profile, as scaled to the measured hemispherical total emittance. (Author)

A78-13908 **Structural composition and optical properties of solar blacks - Gold black.** P. O'Neill, C. Doland, and A. Ignatiev (Houston, University, Houston, Tex.). *Applied Optics,* vol. 16, Nov. 1977, p. 2822-2826. 11 refs. Research sponsored by the University of Houston and ERDA.

Specimens of gold black (a test solar black system) were produced under controlled laboratory conditions so as to study the dependence of their optical properties on the particlelike nature of the material. A theoretical model incorporating the particulate nature of the gold black films has been applied to describe their optical properties. The electron collision frequency calculated within the framework of the model is significantly larger than that predicted from the particle size effects, and the interband contribution to the absorption coefficient is noticeably smaller for the small (40-85 A) gold particles than for bulk gold. The dependence of the absorption coefficient on particle size has also been determined. (Author)

A78-13984 **Solar panels BPX47A for terrestrial applications.** I. C. Franx (Philips' Gloeilampenfabrieken, ELCOMA Div., Eindhoven, Netherlands). *(Annual Seminex Technical Seminar and Exhibition, London, England, Apr. 18-22, 1977.) Microelectronics and Reliability,* vol. 16, no. 4, 1977, p. 309-317.

The design features and operation of a solar panel composed of 34 series-connected silicon diodes and intended for direct conversion of solar radiation into electrical energy are described. The panel is designed to meet stringent requirements imposed by humid, arid, tropical, subtropical, continental, and Arctic climates. Data on solar radiation for a large number of earth locations are discussed in terms of seasonal variations and costs. The necessity of providing for a charge regulator due to an energy excess in summer is stressed. S.D.

A78-13989 # **The energy problem of the North (Problemy energetiki Severa).** I. R. Stepanov. Leningrad, Izdatel'stvo Nauka, 1976. 132 p. 130 refs. In Russian.

The influence of the specific climatic, economic, and geographic features on power generation and engineering in northern regions of the globe is examined. The natural energy resources of Sibiria, Alaska, northern Canada and Scandinavia are reviewed. Particular attention is given to the northern regions of the USSR, their industrialization, technological evolution, and the associated changes in heat and power requirements. A survey of power plants particularly well suited for use in northern regions includes mobile diesel power plants, mobile gas turbine power plants, underground nuclear power plants, and power plants employing the combined gas turbine/steam cycle. Some aspects of the development of wind-driven and tidal power plants are discussed. V.P.

A78-14025 **Materials and energy from the sun.** M. Calvin (California, University, Berkeley, Calif.). *Sunworld,* Aug. 1977, p. 2-6.

Attention is given to using the green plant as a solar energy collector device noting various types of plants having such potential. A Brazilian project producing ethanol from sugar cane is discussed along with the hydrocarbon storage capacities of such rubber-producing plants as Hevea brasiliensis and guayule. Latex-producing plants (including Euphorbia tirucalli, Asclepias, and Euphorbia trigona) are described in terms of their possible cultivation under arid or semiarid conditions. Methods for latex hydrocarbon analysis are presented along with the preliminary results of an experimental planting project. Practical approaches for the use of hydrocarbon as a crude oil are identified, including refining processes and the utilization of the plants as both collectors of sunlight and producers of compounds. S.C.S.

A78-14072 **The engineering properties of Texas lignite and associated rocks in relation to the stability of an in situ gasification chamber.** T. W. Thompson, J. J. Menezes, and K. E. Gray (Texas, University, Austin, Tex.). *In Situ,* vol. 1, no. 2, 1977, p. 171-190. 8 refs. Research supported by the Texas Utilities Co., Atlantic Richfield Co., Continental Oil Co., Dow Chemical Co., Du Pont de Nemours and Co., Inc., Mobil Oil Corp., Shell Development Co., and NSF.

A78-14077 * **The impact of H2S emissions on future geothermal power generation - The Geysers region, California.** L. P. Leibowitz (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *IEEE, ASME, and ASCE, Joint Power Generation Conference, Los Angeles, Calif., Sept. 18-21, 1977, IEEE Paper A 77 816-2.* 9 p. 15 refs. Members, $2.50; nonmembers, $3.00. Research sponsored by the California Energy Resources Conservation and Development Commission and ERDA.

The future potential for geothermal power generation in the Geysers region of California is as much as 10 times the current 502 MW(e) capacity. However, environmental factors such as H2S emissions and institutional considerations may play the primary role in determining the rate and ultimate level of development. In this paper a scenario of future geothermal generation capacity and H2S emissions in the Geysers region is presented. Problem areas associated with H2S emissions, H2S abatement processes, plant operations, and government agency resources are described. The impact of H2S emissions on future development and the views of effected organizations are discussed. Potential actions needed to remove these constraints are summarized. (Author)

A78-14091 **Solar energy economizes on heat pump current (Sonnenenergie spart Wärmepumpen-Strom).** A. Urbanek. *Sonnenenergie,* vol. 2, Mar.-Apr. 1977, p. 14, 16, 17. In German.

A house heating system, in operation since July 1976, is described. Solar energy collected by 45 sq m of roof collectors is used to operate a groundwater heat pump as well as to provide heat to a 6.8 cu m reservoir and a warm water floor heating system. Cooling of the cellar is also achieved. Parameters of the system components are reported. The economics of the system are considered, and it is hoped that the use of solar energy to supply current for the heat pump, besides significantly reducing costs, will provide an alternative to oil heating. M.L.

A78-14092 **Standard and solar energy exchange-heat water installation (Standard-Solaranlage für Brauchwasser).** J. Miller. *Sonnenenergie,* vol. 2, Mar.-Apr. 1977, p. 18, 19. In German.

A solar energy system which is able to provide up to 65% of the hot water required by a household is described. The installation involves 5 collectors of 1.35 sq m each and a 380 l storage tank. A diagram of the system is provided and the components identified. The system functions by heat exchange between the water in the reservoir system and water in the domestic heating system. Among topics discussed are the warm water requirement, the utilization of available solar energy, the need to heat water to a higher temperature than that obtained by the heat-exchange process, and the ability of the system to withstand extreme temperatures. M.L.

A78-14093 **Solar heating for 10,000 Deutsche Marks (Sonnenheizung für 10,000 DM).** R. Brunner. *Sonnenenergie,* vol. 2, Mar.-Apr. 1977, p. 20, 22. In German.

A solar energy system which provides most of the heat required by half of a double-house is described. The reduction in heating oil consumed and the economics of the system are considered with attention to the heat requirement. The system provides heat for warm water floor heating and a swimming pool, and its cost is estimated to be about 10,000 Deutsche Marks plus an additional 1400 DM for installation. M.L.

A78-14094 **Construction physics for solar houses (Zur Bauphysik für Sonnenhäuser).** G. Waldherr. *Sonnenenergie,* vol. 2, July-Aug. 1977, p. 4, 6, 8. In German.

An investigation is conducted regarding the thermal insulation provided by an external wall with optimum characteristics, taking into account aspects of construction physics and climatic considerations. Conditions for solar houses with low-temperature heating systems are considered. Suitable characteristics for external wall constructions reported by Hebgen and Heck (1973) are examined and approaches for a selection of suitable building materials are discussed. The implementation of the considered methods for optimum external wall design is illustrated with the aid of examples including three specific cases. G.R.

A78-14095 **Interaction between collector and consumer (Koppelung von Kollektor und Verbraucher).** K. Schwarz. *Sonnenenergie,* vol. 2, July-Aug. 1977, p. 9, 10, 13. In German.

An investigation is conducted concerning the system design and the operational conditions which will provide an optimum efficiency for a solar heating system, taking into account the employment of flat-plate solar energy collectors. It is found that in the considered case an optimum amount of thermal energy is obtained if the collectors transmit their heat energy under the most effective heat exchange conditions at the lowest practical temperature level to the subsystem in which the energy is consumed. Approaches for implementing these conditions are discussed. Attention is given to aspects of collector operating conditions, suitable hot-water supply systems, space heating with the aid of a solar heating system, and installations which utilize thermal energy obtained from different sources. G.R.

A78-14096 **The first 'solar hotel' in Germany (Das erste 'Sonnenhotel' in Deutschland).** R. Laroche. *Sonnenenergie,* vol. 2, July-Aug. 1977, p. 17-19. In German.

On June 9, 1977, the first hotel which is heated by means of solar energy was opened in Germany. The solar installation consists of solar-energy collectors with an area of 118 sq m and four heat pumps for warm-water floor heating and the hot-water supply. The currently largest solar-energy storage system with the capacity for storing 360 cu m of water in a concrete container is located under the hotel building. G.R.

A78-14097 **The Tritherm House of Bosch-Junkers in Wernau (Das Tritherm-Haus von Bosch-Junkers in Wernau).** A. Urbanek. *Sonnenenergie,* vol. 2, July-Aug. 1977, p. 20-22. In German.

The Tritherm House was built as an experimental installation for the study of a system which employs solar collectors, a heat pump, and an auxiliary heating device, for space heating and the provision of warm water. The Tritherm House is a one-family house with a living-space area of 174 sq m. The solar heating system includes 25 solar-energy collectors with a total area of 40 sq m. Space heating in connection with the investigations can be provided with the aid of a radiator-heating system and a low-temperature warm-water floor heating system. The employment of a heat pump makes it possible to discharge the solar heat-storage system to a lower temperature and to utilize in the case of diffuse solar radiation even thermal collector energy at lukewarm temperature levels. Attention is given to conventional and latent heat storage, the heat exchangers, the operational conditions, control techniques, and yearly operating costs. G.R.

A78-14098 **The sun satisfies two thirds of the heat requirements (Sonne deckt zwei Drittel des Wärmebedarfs).** B. Ziegenbein. *Sonnenenergie,* vol. 2, July-Aug. 1977, p. 25, 26. In German.

The solar energy system for the considered experimental solar house had been designed with the objective to provide two thirds of the energy for heating needed in the house. The results obtained during one year of system operation have demonstrated that this objective can be achieved under the climatic conditions of West Germany. The solar system includes 65 collectors with an effective absorbing area of 71.5 sq m, a heat exchanger, and two-thermal-energy storage tanks, each with a volume of 4 cu m. A heat pump with a power rating of 1.87 kW is also employed. G.R

A78-14099 **A prefabricated-house series with solar technology (Fertighaus-Serie mit Solartechnik).** H. Baltrusch and H.-J. Döhren. *Sonnenenergie,* vol. 2, July-Aug. 1977, p. 27, 28. In German.

The heating system used in the considered prefabricated house utilizes direct and indirect solar radiation. The heating system represents a combination of flat-plate solar energy collectors with a total area of 12 sq m, a heat pump, a warm-water supply device with a volume of 200 l, and an auxiliary oil-heating system. The pump satisfies 85% of the heat requirements in winter. The remaining 15% of the heat are supplied by means of the solar energy collectors. During the time from March to October warm water and the thermal energy for the floor-heating system are entirely provided by the solar collectors. The oil-heating system is used as a stand-by to provide additional heat during periods of pronounced cold weather. G.R.

A78-14101 **The outlook for wind energy (Chancen der Windenergie).** U. Hütter. *Sonnenenergie,* vol. 2, May-June 1977, p. 3-8. 11 refs. In German.

The prospects of using wind energy in West Germany are examined. Winds are most favorable in coastal regions and in a few mountainous areas. Windmill blade characteristics and their relation to energy output are considered. It is noted that 5500 3-MW units would have supplied 16% of West Germany's energy requirements in 1973, or all the energy used in the northern part of the country. The performance of different windmill designs are described, and costs associated with a windmill energy system are estimated. The problem of uneven delivery of energy is examined with attention to the possible desirability of trading off performance for dependability. M.L.

A78-14102 **Investigation of wind energy (Windenergieforschung).** A. Ziegler (Bundesministerium für Forschung und Technologie, Bonn, West Germany). *Sonnenenergie,* vol. 2, May-June 1977, p. 8-10, 12. In German.

Technical concepts for wind energy production, including the Honnef, Darrieus, mantle turbine, and Hütter, are compared, and their potential contribution to energy production is estimated. Research problems in the development of wind energy utilization are identified, and West German research projects are surveyed. Some goals for future projects are suggested. Data on the prevalence of wind velocities at different heights are presented, and the need for more meteorological data is noted. M.L.

A78-14103 **Wind energy techniques of the past and present (Wind energietechnik einst und heute).** U. Stampa. *Sonnenenergie,* vol. 2, May-June 1977, p. 12-15. In German.

The characteristics of several types of windmills used in the past are surveyed with attention to some facets of the history of research on windmill design. Analogies with aircraft construction are considered, and procedures for generating current are examined. Requirements for and approaches to economic and reliable power generation are summarized. M.L.

A78-14104 **Basic physical factors in the calculation of flat-plate collectors. VI (Physikalische Grundlagen zur Berechnung von Flachkollektoren. VI).** U. Bossel. *Sonnenenergie,* vol. 2, May-June 1977, p. 18-21, 24. In German.

The parameters of a 1500 m by 1000 m flat-plate collector are defined, and the influences of ambient factors on the functioning of the collector are analyzed. Effects of the absorption layer, irradiation and surrounding temperature, wind velocity, and the selectivity on the efficiency are calculated. Data are presented for a number of conditions. The effects of overheating are also studied. M.L.

A78-14105 **A heating oil tank as a solar energy reservoir (Heizöltank als Solarspeicher).** K. Uiblacker. *Sonnenenergie,* vol. 2, May-June 1977, p. 22. In German.

It is pointed out that the cost of solar energy installations would be reduced if already existing heating oil tanks could be used as heat reservoirs. The safety of using tanks for this purpose is examined with attention to the flashpoint, the burning temperature, oil water content and impurities, and preliminary heating. It is concluded that the solar energy-induced heating of oil stored in a tank would not cause a hazard, and would actually improve the ability of the oil-burning furnace to provide heat during the winter. M.L.

A78-14130 # **The use of MHD generators in the nuclear energy field (Primenenie magnitogidrodinamicheskikh generatorov v iadernoi energetike).** V. A. Kirillin and A. E. Sheindlin. *Akademiia Nauk SSSR, Izvestiia, Energetika i Transport,* Sept.-Oct. 1977, p. 32-40. 13 refs. In Russian.

The paper examines the prospects of combining MHD generators with nuclear reactors of different types in the USSR. Attention is given to the possibilities of the following combinations: (1) a fast-neutron liquid-metal reactor with a liquid-metal MHD generator, (2) a high-temperature fission-fusion reactor with a nonequilibrium-plasma MHD generator, and (3) a gas-phase fission reactor with an MHD generator using uranium hexafluoride plasma. The feasibility of combining closed-cycle MHD generators with nuclear reactors is assessed. B.J.

A78-14131 # **Achievements of scientific and technological progress in the development of transport and its energetics in the USSR (Uspekhi nauchno-tekhnicheskogo progressa v razvitii transporta i ego energetiki v SSSR).** D. P. Velikanov. *Akademiia Nauk SSSR, Izvestiia, Energetika i Transport,* Sept.-Oct. 1977, p. 72-78. In Russian.

The development of the following types of cargo and passenger transport in the USSR in the period 1950-1975 is reviewed: rail, sea, river, air, automobile and urban rapid transit. Attention is given to energy supplies for each type of transport along with technical progress in the development of each type. The pipelining of natural gas and petroleum products is also discussed. B.J.

A78-14155 **Electric utility applications of fabric filters.** E. R. Frederick (Air Pollution Control Association, Pittsburgh, Pa.). *Air Pollution Control Association Journal,* vol. 27, Nov. 1977, p. 1086-1089.

The use of baghouses as a practical and economical means for controlling emissions from the burning of low sulfur coals is discussed. Data on the effect, in terms of compartmentation, of cleaning on fan power and cloth ratio are presented, as are operating data on baghouse pressure drop and information on bag failures. When alkaline reagents (i.e., nahcolite) are available, some power plants are also considering a process for dry scrubbing SO2 from the flue gas. By introducing such reagents with the emission ahead of the fabric collector, both particulates and SO2 are removed. Experience with baghouses at two power plants is reported, and the capitalized cost of pressure drop and bag replacement penalties versus cloth ratio is considered. M.L.

A78-14161 **Pollution abatement energy usage of gas treating and processing plants.** I. L. Bilsky and S. N. Spaw (Texas Air Control Board, Austin, Tex.). *Air Pollution Control Association Journal,* vol. 27, Nov. 1977, p. 1117-1119. 7 refs.

A78-14170 **Keeping oil out of the marine environment.** *Environmental Science and Technology,* vol. 11, Nov. 1977, p. 1046, 1047.

A procedure for reducing the marine oil pollution caused by tankers is described. Crude oil from the cargo is applied under pressure to the tank walls, structure, and tank bottom to remove oil residues. The resulting tank washings (all crude oil) are pumped ashore along with the rest of the cargo. This procedure is a modification of the load-on-top procedure, in which sea water (subsequently pumped into the sea) is used to wash oil residues from tank walls. The disadvantages of using sea water are that some of the oil is discharged into the sea with the water, while other oil residues, insoluble in sea water, form a sludge in the tanker. M.L.

A78-14175 # **Electromechanics in space (Elektromekhanika v kosmose).** A. G. Iosif'ian. Moscow, Izdatel'stvo Znanie (Novoe v Zhizni, Nauke, Tekhnike, Seriia Kosmonavtika, Astronomiia, No. 3), 1977. 64 p. 6 refs. In Russian.

The electromechanics of satellite structures are discussed with attention to the component sensitivity of electromechanical systems, the electromechanics of control elements, the electromechanics of the thermoregulation system, and the transformation of solar energy into electrical energy. The Lunokhod, the Viking, and space observatories are considered in the framework of space station electromechanics. The role of electromechanics in space navigation is described, and proposed future space electromechanics projects are surveyed. M.L.

A78-14218 **Experimental determination of alkali impurity release from various dolomites.** L. N. Yannopoulos, J. L. Toth, and A. Pebler (Westinghouse Research and Development Center, Pittsburgh, Pa.). *Combustion and Flame,* vol. 30, no. 1, 1977, p. 61-69. 5 refs. ERDA-sponsored research.

A study was made of the release of volatile alkali compounds from dolomites, which will be used to desulfurize coal gas in a proposed fluidized bed coal gasification/combined cycle power plant. The study employed a flame emission photometric technique to monitor sodium and potassium compound emissions from five types of dolomite at temperatures between 700 and 900 C. Wide variations in emission rates were noted for the different types of dolomite. In general, alkali release rates were found to depend on temperature, the chemical nature of the vapor sources and calcination of the dolomite. The relevance of these findings for predicting corrosion of gas turbine components is also discussed. J.M.B.

A78-14274 **Two-dimensional analysis of a diagonal-type nonequilibrium plasma MHD generator.** M. Ishikawa, J. Umoto, and T. Hara (Kyoto University, Kyoto, Japan). *Electrical Engineering in Japan,* vol. 96, Nov.-Dec. 1976, p. 19-36. 17 refs. Translation.

A numerical analysis is presented for the two-dimensional potential, current and electron temperature distributions in a diagonal-type nonequilibrium-plasma MHD generator. Initially the current distribution is studied for constant values of electrical conductivity and Hall parameter; subsequently the current, potential and electron temperature distributions are derived for the case where electrical conductivity and Hall parameters are varied in space. The relationship between the current distribution and the load rate and electrode gradient coefficient is also discussed. J.M.B.

A78-14285 **Saving raw materials or saving energy in aircraft construction (Economie de matière ou économie d'énergie en construction aéronautique).** C. Acker (Société Nationale Industrielle Aérospatiale, Direction Industrielle, Paris, France). *Revue Française de Mécanique,* 1st Quarter, 1977, p. 15-19. In French.

The paper is concerned with the economic cost of the large amounts of scrap that are formed during the manufacture of aircraft whose light weight results from the use of alloys. An energy analysis is presented; this study shows that the apparent waste is justified in terms of the high amount of energy saved by flying a lighter plane. Factors which could change this analysis - such as a modification of material recycling costs or the increased use of nonmetallic materials - are considered. M.L.

A78-14399 # **Current progress in materials development for coal conversion.** C. H. Samans and W. R. Hulsizer (International Nickel Co., Inc., New York, N.Y.). *ASME, Transactions, Series H - Journal of Engineering Materials and Technology,* vol. 99, Oct. 1977, p. 372-378.

A coal gasification materials program directed at developing engineering data on materials is described. Included are initial results on materials exposed in 6.9 MPa simulated gasifier atmospheres at 755 K, 1089 K, and 1255 K; a 1 MPa simulated regenerator atmosphere at 1285 K; and in pressurized aqueous environments simulating gasifier quench towers. Erosion/corrosion tests, scheduled to begin in the near future, are also described. Comparison of simulated exposure results with data from early interrupted exposures in two operating pilot plants are reported indicating reasonable agreement except for a few pilot plant specimens which appeared to deteriorate rapidly because of operating conditions not thought previously to be corrosive. (Author)

A78-14420 **Forty-nine theses on energy policy (49 Thesen zur Energiepolitik).** H. Michaelis. *Energiewirtschaftliche Tagesfragen,* vol. 27, Oct. 1977, p. 671, 672, 674, 676. In German.

The author lays down forty-nine propositions in the form of necessities, goals, forecasts, and guidelines regarding economic growth and energy consumption, energy policy and primary energy sources, nuclear energy, power plant licensing procedures, governmental regulation, international accommodation of energy policy, and long-term problems as they relate to the Federal Republic of Germany. Failure to develop nuclear energy to an output of 30,000 MW is seen as highly unfavorable to West German economy. The roles of alternative energies are not seen to become significant before the turn of the century. P.T.H.

A78-14421 **Tritherm heating (Die Tritherm-Heizung).** A. Kehl and F. Scharf. *Energiewirtschaftliche Tagesfragen,* vol. 27, Oct. 1977, p. 677, 678, 680 (5 ff.). 9 refs. In German.

Tritherm heating consists of a synthesis of solar heating, heat pump heating, and fossil fuel heating. This paper reports some experimenting with various combinations of operating modes of the three components on a demonstration house. The operation of the system was also simulated on computer for a cold, cloudless February day, and the time history of the temperature at the collector, heat storage unit, outside air, and the heating return circuit was calculated. P.T.H.

A78-14497 **The thermodynamics of a fuel cell aggregate involving thermal-catalytic methanol decomposition (Zur Thermodynamik eines Brennstoffzellen-Aggregats mit thermisch-katalytischer Methanolspaltung).** H. D. Baehr and E. F. Schmidt (Bundeswehr, Hochschule, Hamburg, West Germany). *Brennstoff-Wärme-Kraft,* vol. 29, Oct. 1977, p. 393-400. 20 refs. In German.

A description is presented of fuel cells on a methanol basis, taking into account approaches which make it possible to avoid a costly purification of the crude gas. The thermal decomposition of methanol as a means for obtaining crude gas for fuel cell operation is considered, taking into account experiments conducted with an electrically heated tube reactor. The experimental data are found to agree very well with the results of thermodynamic calculations. Attention is given to thermodynamic relations concerning the methanol decomposition process, the composition of the gas obtained as a result of this process, the efficiency of the fuel cell, and the efficiency of hydrogen generation. G.R.

A78-14498 **Pulverized coal-pressure gasification with air as a topping stage for the combined gas/steam turbine process (Kohlenstaub-Druckvergasung mit Luft als Vorschaltstufe vor dem kombinierten Gas-/Dampfturbinen-Prozess).** H. Kleinhückelkotten (Bergbau-Forschung GmbH, Essen, West Germany). *Brennstoff-Wärme-Kraft,* vol. 29, Oct. 1977, p. 410-418. 16 refs. In German.

The employment of the considered process, which involves the use of pulverized coal, makes it possible to avoid the drawbacks of fixed-bed gasification. All types of coal can be gasified without additional equipment. There are no disturbing by-products, such as tar, oil, phenols, or ammonia. The use of pulverized coal has, however, also disadvantages which are related to energetic considerations. It is found that even under optimum conditions which might be difficult to implement the thermal efficiency of the entire process is 39.2% with respect to the calorific value of the coal. This value is about 1.1% lower than the efficiency of a comparable process using Lurgi-pressure gasification. G.R.

A78-14539 **Koppers-Totzek economics and inflation.** D. M. Mitsak, H. J. Michaels, and J. F. Kamody (Koppers Co., Inc., Pittsburgh, Pa.). *Energy Communications,* vol. 3, no. 5, 1977, p. 475-510.

The Koppers-Totzek entrained slagging gasification process is based on a rapid partial oxidation of pulverized coal. A process description is provided, taking into account the performance of a four-headed gasifier which is capable of processing up to 850 tons of coal per day. Attention is given to the effect of financial variables on the cost of the gas and the effects of price inflation and escalation on fuel costs. G.R.

A78-14540 **Assessing near-term technologies for solar heating and air-conditioning systems.** G. Marcus, D. Spalding, and B. Gershan (Analytic Services, Inc., Falls Church, Va.). *Energy Communications,* vol. 3, no. 5, 1977, p. 511-537. 27 refs.

This study addresses the development and application of a methodology intended to aid decision-making on the allocation of R&D efforts for performance improvements in solar heating and cooling systems. The work described examines major technologies applicable to near-term solar systems with flat plate collectors. Physical models are applied to estimate improvements in system performance for different technology developments. Available projections of system costs are then used to evaluate the relative cost-effectiveness of the performance improvement for each technology option. A principle conclusion of the study is that development and application of new technologies to improve system performance has limited potential for reducing the total cost of near-term solar heating and cooling systems. (Author)

A78-14649 **Superconducting magnetic energy storage.** M. Masuda and T. Shintomi (National Laboratory for High Energy Physics, Oho, Ibaraki, Japan). *Cryogenics,* vol. 17, Nov. 1977, p. 607-612. 15 refs.

The uses of superconducting magnetic energy storage (SMES) for large particle accelerators and for peak shaving in a power network are discussed. The circuitry, thyristor converter, and efficiency of SMES are described, and equations for calculating the power loss of SMES are presented. A model of SMES is examined, and the possibilities of SMES replacing water pumped storage of energy for peak shaving are analyzed. M.L.

A78-14688 **Hydrocarbons via photosynthesis.** M. Calvin (California, University, Berkeley, Calif.). *International Journal of Energy Research,* vol. 1, Oct.-Dec. 1977, p. 299-327. 12 refs. ERDA-sponsored research.

Photosynthesis is examined as a possible annually renewable resource for material and energy. The production of fermentation alcohol from sugar cane as a major component of materials for chemical feedstocks is examined as well as the direct photosynthetic production of hydrocarbon from known plant sources. Experiments are underway to analyse the hydrocarbons from Euphorbias, Asclepias and other hydrocarbon-containing plants with a view toward determining their various chemical components. In addition, experimental plantings of plants of this type have begun to obtain data on which species would be the most successful. Work is also underway on the development of chemical process techniques for the extraction of plant materials after harvesting. In addition, efforts are underway to construct synthetic systems on the basis of our knowledge of the natural photosynthetic processes. These systems could be used to produce fuel, fertilizer and power. As a result of studies of the natural quantum conversion process in green plants, we can envisage several photoelectron transfer processes, some of which have already been demonstrated in synthetic systems. Methods of constructing systems of this type and the principles of their use are described. (Author)

A78-14689 **Analysis and optimization of solar hot water systems.** R. Bruno, W. Hermann, H. Hörster, R. Kersten, and F. Mahdjuri (Philips GmbH, Forschungslaboratorium, Aachen, West Germany). *International Journal of Energy Research,* vol. 1, Oct.-Dec. 1977, p. 329-340. 10 refs. Research supported by the Bundesministerium für Forschung und Technologie.

Use of a simplified method has been made to calculate the time-dependent thermal performance of various solar domestic hot water systems. To establish the value of solar hot water systems under given economic considerations a thermal analysis was carried out on three basic energy system designs, operating at several locations in the Federal Republic of Germany (F.R.G.) with various solar collectors. It is found that systems design can result in variations up to a factor of two in the per cent solar output. The location and year of operation in the F.R.G. result in variations up to 15 per cent in the solar output. A sensitivity study was also done with respect to all solar collector, systems and user parameters. From this it was found that the dominant effects on the systems performance were due to the collector-dependent parameters. (Author)

A78-14690 **Critical paths to coal utilization.** G. R. Hill (Electric Power Research Institute, Palo Alto, Calif.). *International Journal of Energy Research,* vol. 1, Oct.-Dec. 1977, p. 341-349. 21 refs.

The present dilemma of energy producers, converters, and policy decision makers is presented. The consequences of environmental control regulations, coupled with the need for conservation and energy, and of energy resources on the increased utilization of coal, are discussed. Several recent technical accomplishments which make possible increased utilization of coal for power generation are described. Groundwork is laid for discussion of the technical development which must occur if the United States is to retain its energy viability. (Author)

A78-14691 **Properties of some salt hydrates for latent heat storage.** K. Gawron and J. Schröder (Philips GmbH, Forschungslaboratorium, Aachen, West Germany). *International Journal of Energy Research,* vol. 1, Oct.-Dec. 1977, p. 351-363. 10 refs. Research sponsored by the Commission of the European Communities.

The melting points, densities, and caloric data for a number of salt hydrates which might be suitable for latent heat storage applications are considered. Attention is given to chemical properties and corrosion, problems related to supercooling and approaches for overcoming these problems, thermal contact and change of volume with phase transition, the cost of the storage media, and an energy system for heating and cooling. G.R.

A78-14692 **Short communication on the optimum orientation of solar collectors - An alternative approach.** R. Wilson, J. T. McMullan, R. Morgan, and R. B. Murray (Ulster, New University, Coleraine, Northern Ireland). *International Journal of Energy Research,* vol. 1, Oct.-Dec. 1977, p. 365-368.

An investigation is conducted concerning an approach which provides an alternative to the use of a simple atmospheric model for the investigation of the optimum orientation of solar collectors in the northern British Isles described by Hughes et al. (1977). It is found that the new approach is much more suited to extension than the earlier model. It is possible to assign different extinction rates to different cloud types, allowing for their structure and thickness. G.R.

A78-14745 **Influence of junction roughness on solar-cell characteristics.** G. de Mey, B. Jacobs, and F. Fransen (Gent, Rijksuniversiteit, Ghent, Belgium). *Electronics Letters,* vol. 13, Oct. 27, 1977, p. 657, 658.

Most theoretical investigations of solar cells use a 1-dimensional model for the calculation of the minority-carrier concentration and the characteristics. However, if the surface of the junction is no longer flat, a more-dimensional analysis will be necessary. A numerical 2-dimensional analysis based on an integral-equation technique is presented to solve the problem. (Author)

A78-14787 # **Industrial use of geological remote sensing from space.** F. B. Henderson, III (Geosat Committee, Inc., San Francisco, Calif.). In: International Symposium on Remote Sensing of Environment, 11th, Ann Arbor, Mich., April 25-29, 1977, Proceedings. Volume 1. Ann Arbor, Mich., Environmental Research Institute of Michigan, 1977, p. 183-187.

The utilization of satellite remote sensing of geological resources by the oil, gas and mineral industries is discussed. It is noted that present and planned NASA systems, as well as geologically dedicated supplemental systems, can materially improve the process of making requisite maps for geological industries efficiently and economically. B.J.

A78-14805 * # **Energy and remote sensing.** R. A. Summers (ERDA, Washington, D.C.), W. L. Smith (Michigan, Environmental Research Institute, Washington, D.C.), and N. M. Short (NASA, Goddard Space Flight Center, Greenbelt, Md.). In: International Symposium on Remote Sensing of Environment, 11th, Ann Arbor, Mich., April 25-29, 1977, Proceedings. Volume 1. Ann Arbor, Mich., Environmental Research Institute of Michigan, 1977, p. 467-481. 27 refs.

Exploration for uranium, thorium, oil, gas and geothermal activity through remote sensing techniques is considered; satellite monitoring of coal-derived CO2 in the atmosphere, and the remote assessment of strip mining and land restoration are also mentioned. Reference is made to color ratio composites based on Landsat data, which may aid in the detection of uranium deposits, and to computer-enhanced black and white airborne scanning imagery, which may locate geothermal anomalies. Other applications of remote sensing to energy resources management, including mapping of transportation networks and power plant siting, are discussed. J.M.B.

A78-14815 # **Landsat detection of hydrothermal alteration in the Nogal Canyon Cauldron, New Mexico.** R. K. Vincent (GeoSpectra Corp., Ann Arbor, Mich.) and G. Rouse (Earth Sciences, Inc., Golden, Colo.). In: International Symposium on Remote Sensing of Environment, 11th, Ann Arbor, Mich., April 25-29, 1977, Proceedings. Volume 1. Ann Arbor, Mich., Environmental Research Institute of Michigan, 1977, p. 579-590.

The use of Landsat imagery to detect zones of hydrothermal alteration in cauldrons, calderas and other volcanic features is discussed. In particular, an iron-oxide anomaly detected in a Cenozoic cauldron in New Mexico was found to correlate with a hydrothermal alteration. However, further analysis of Landsat imagery indicated that on a purely spectral basis the secondary iron oxides of the hydrothermal alteration could usually not be distinguished from unimportant primary ferric oxides. It is suggested that spectral data and geologic information employed in coordination may provide a means of identifying some hydrothermal activity. J.M.B.

A78-14853 # **Application of airborne infrared technology to monitor building heat loss.** F. J. Tanis and R. E. Sampson (Michigan, Environmental Research Institute, Ann Arbor, Mich.). In: International Symposium on Remote Sensing of Environment, 11th, Ann Arbor, Mich., April 25-29, 1977, Proceedings. Volume 2. Ann Arbor, Mich., Environmental Research Institute of Michigan, 1977, p. 1001-1013.

During the 1975-76 winter heating season ERIM conducted studies to test the application of airborne infrared technology to the requirements for energy conservation in buildings. Quantitative airborne data of the City of Ypsilanti, Michigan were collected and processed to identify roof temperatures. A thermal scanner was flown at an altitude of 1,200 feet with two thermal bands 8.2-9.3 microns and 10.4-12.5 microns recorded by an analog system.

Calibration was achieved by standard hot and cold plates. Using a thermal model to interpret ceiling insulation status, environmental factors were found to influence the relation between roof temperature and insulation. These include interior and sky temperatures, roofing materials, and the pitch and orientation of the roof. A follow-up mail survey established the ability to identify insulated and uninsulated houses from the airborne infrared data. (Author)

A78-14957 # **Wind shear downwind of large surface roughness elements.** J. V. Ramsdell (Battelle Pacific Northwest Laboratory, Richland, Wash.). In: Conference on Aerospace and Aeronautical Meteorology, 7th, and Symposium on Remote Sensing from Satellites, Melbourne, Fla., November 16-19, 1976, Preprints. Boston, Mass., American Meteorological Society, 1977, p. 22-27. U.S. Department of Transportation Contract No. FA72WAI-263; Contract No. E(45-1)-1830.

Data on fluctuations of the vertical and lateral shears of the longitudinal wind component near the central business district of Seattle, Washington have been analyzed to determine shear characteristics downwind of large surface roughness elements. The frequency distribution and time scales of the shear fluctuations have been evaluated, and, when possible, the results have been compared with results from Cape Kennedy. It is found that vertical and lateral shear fluctuations downstream of large roughness elements can be described by a Pearson Type IV distribution. Parameters of the distribution can be predicted by simple relationships involving the mean wind speed and several easily determined physical variables. B.J.

A78-15020 **Helicopters and energy savings (Les hélicoptères et les économies d'énergie).** G. Petit (Société Nationale Industrielle Aérospatiale, Division Hélicoptères, Paris, France). *(Congrès International Aéronautique, 13th, Paris, France, June 2, 3, 1977.) L'Aéronautique et l'Astronautique,* no. 66, 1977, p. 3-20. In French.

The article discusses various means to economize helicopter fuel consumption noting possible modifications in engine specific fuel consumption, rotor aerodynamic quality, parasitic drag of the fuselage, helicopter empty weight, and flight path optimization. It is felt that within the next decade there may be a significant decrease in fuel consumption in relation to payload through improvements in specific fuel consumption (30 percent reduction predicted) and in structural characteristics (15 percent reduction predicted). It is suggested that the tilting rotor convertible helicopter may prove to be an important new design effecting further reductions in fuel consumption. S.C.S.

A78-15021 **Future fuels for aviation (Les futurs combustibles pour l'aviation).** M. Barrère (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(Congrès International Aéronautique, 13th, Paris, France, June 2, 3, 1977.) L'Aéronautique et l'Astronautique,* no. 66, 1977, p. 21-31. In French.

A review is presented of global energy consumption in terms of the percentages of various sources utilized. Fuel characteristics currently required by aircraft engines are discussed noting their precise physical and chemical effects on engine operation. Suggestions are made with regard to the development of policies for both fuel consumption reduction and the development of new fuel sources, such as (1) economic analyses of fuels currently used and their projected availability, (2) the potential combination of oil-derived and synthetic fuels, and (3) the creation of wholly synthetic fuels, perhaps based on methane and hydrogen. S.C.S.

A78-15053 # **Forced convection heat transfer at an inclined and yawed square plate - Application to solar collectors.** E. M. Sparrow and K. K. Tien (Minnesota, University, Minneapolis, Minn.). *ASME, Transactions, Series C - Journal of Heat Transfer,* vol. 99, Nov. 1977, p. 507-512. 7 refs. NSF Grant No. ENG-75-03221.

Mass transfer experiments were carried out on a square flat plate at angle of attack and yaw by the naphthalene sublimation technique, and the results were presented in terms of heat transfer parameters by means of the analogy between heat and mass transfer. The experiments were conducted over a wide range of angles of attack and yaw, and covered the Reynolds number range from about 20,000 to 100,000. Strong three-dimensional effects were responsible for the fact that the j-factor was insensitive to angle of attack and angle of yaw. The j-factor could therefore be simply correlated with Reynolds number: $j = 0.931$ divided by the square root of the Reynolds number. When applied to a calculation of the heat transfer coefficient for wind-related heat losses from the upper cover plate of a solar collector, this correlation yields a significantly different value for the heat transfer coefficient than the current standard computational equation. P.T.H.

A78-15057 # **Heat transfer from a horizontal plate facing upward to superposed liquid-layers with change of phase.** Y. Shimada, Y. H. Mori, and K. Komotori (Keio University, Yokohama, Japan). *(American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Dec. 5-10, 1976, Paper 76-WA/HT-1.) ASME, Transactions, Series C - Journal of Heat Transfer,* vol. 99, Nov. 1977, p. 568-573. 11 refs. Research supported by the Saneyoshi Foundation.

This paper presents an experimental examination of a novel technique to improve the convection heat transfer to a liquid whose boiling point is higher than the temperature of the heated surface. A layer of an immiscible, denser, and more volatile 'secondary liquid' is placed between the heated surface and the layer of the 'primary liquid' which is to be heated. The secondary-liquid boils on the heated surface, and its vapor condenses in the upper primary-liquid layer. The rate of such a heat transfer exceeds by far that of natural convection heat transfer to the single primary-liquid layer with an increase of the surface temperature, and becomes approximately equal to that of boiling heat transfer to the single secondary-liquid layer. (Author)

A78-15079 # **Downhole measurements of thermal conductivity in geothermal reservoirs.** H. D. Murphy and R. G. Lawton (California, University, Los Alamos, N. Mex.). *(American Society of Mechanical Engineers, Energy Technology Conference and Exhibition, Houston, Tex., Sept. 18-22, 1977, Paper 77-Pet-23.) ASME, Transactions, Series J - Journal of Pressure Vessel Technology,* vol. 99, Nov. 1977, p. 607-611. 17 refs. ERDA-sponsored research.

The line source method of determining thermal conductivity is extended to include the transient effect associated with the fluid in flowing geothermal wells. The general equations describing transient heat flow are utilized. Approximate solutions are derived and compared to the exact solution of the general equations. The proposed method is operationally simple since the heater, and the associated problems of obtaining adequate thermal contact between the heater and the sides of the borehole are eliminated. Using this method downhole measurements were obtained and favorably compared with laboratory measurements on characterized core specimens taken from wells in a hot dry rock geothermal reservoir. (Author)

A78-15080 # **Geothermal energy - Heat extraction from hot dry rock masses.** S. Nemat-Nasser (Northwestern University, Evanston, Ill.). *(American Society of Mechanical Engineers, Energy Technology Conference and Exhibition, Houston, Tex., Sept. 18-22, 1977, Paper 77-Pet-41.) ASME, Transactions, Series J - Journal of Pressure Vessel Technology,* vol. 99, Nov. 1977, p. 612, 613. NSF Grant No. AER-75-00187.

A brief analysis is presented of the basic technical problems in the area of heat extraction from hot dry rock masses. The problems include: (1) initiation and extension of cracks in hot dry rock by hydraulic fracture, (2) circulation of water through the crack and up to the ground surface, and (3) thermally induced secondary cracking and its effect on water flow and heat exchange. Field equations for the fluid flow and heat transfer over the thickness of the crack are integrated to obtain a two-dimensional set of equations. The derivation leads to the basic equations of mass, momentum and energy. B.J.

A78-15081 # **Seals for geothermal roller drill bits.** R. R. Hendrickson, C. Carwile, L. Matson, and R. W. Winzenried (Terra Tek, Inc., Salt Lake City, Utah). *(American Society of Mechanical Engineers, Energy Technology Conference and Exhibition, Houston, Tex., Sept. 18-22, 1977, Paper 77-Pet-53.) ASME, Transactions, Series J - Journal of Pressure Vessel Technology,* vol. 99, Nov. 1977, p. 614-618. 5 refs.

A significant factor contributing to short bit life and attendant high costs for geothermal drilling is the lack of seals for elevated temperatures. To assist development of a high-temperature seal, a test facility was constructed to simulate the seal environment in a roller bit during geothermal drilling. Although none of the tested elastomers appear suitable for compression seals above 200 C, extensive testing was performed to determine their exact limits. Several new heterogeneous seal designs were found usable to higher temperatures. (Author)

A78-15082 # **Geothermal drill bit improvement - Specific application to the Geysers.** R. R. Nielsen (Terra Tek, Inc., Salt Lake City, Utah), C. Carwile (ERDA, Washington, D.C.), and L. M. Barker. *(American Society of Mechanical Engineers, Energy Technology Conference and Exhibition, Houston, Tex., Sept. 18-22, 1977, Paper 77-Pet-67.) ASME, Transactions, Series J - Journal of Pressure Vessel Technology,* vol. 99, Nov. 1977, p. 619-623. 5 refs.

The paper describes a research and development program intended to design, build and test an improved geothermal drill bit. The program was organized as follows: (1) determine the failure mode for drill bits used in geothermal drilling, (2) make the necessary changes to improve the performance of the bit for geothermal applications, (3) design and build a laboratory test apparatus to test both full-scale prototype bits and conventional models currently in use in geothermal applications, (4) test the proposed drill bit design in the laboratory and make the necessary refinements to optimize its performance for geothermal conditions, and (5) field test the bit to verify actual improvement. B.J.

A78-15083 # **Stress response investigations related to in-situ gasification of coal.** S. H. Advani, L. Z. Shuck, and K. Y. Lee (West Virginia University, Morgantown, W. Va.). *(American Society of Mechanical Engineers, Energy Technology Conference and Exhibition, Houston, Tex., Sept. 18-22, 1977, Paper 77-Pet-25.) ASME, Transactions, Series J - Journal of Pressure Vessel Technology,* vol. 99, Nov. 1977, p. 627-633. 15 refs. Contract No. E(40-1)-5088.

The paper presents temperature, stress and fracture evaluations associated with underground coal gasification along with considerations pertaining to in-situ coal fracture permeability evaluation. The temperature response computed via a finite difference technique is used to determine the temperature-dependent material properties. Corresponding roof and coal seam stresses, determined from a finite element code, are given. Thermal and in-situ load stress intensity factors and related stresses are identified for the interpretation of gasification burn configurations, channel response and thermal cracking. B.J.

A78-15101 **Stoichiometric calculations concerning the Fischer-Tropsch synthesis (Stöchiometrische Berechnungen zur Fischer-Tropsch-Synthese).** O. Roelen. *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoffchemie,* vol. 30, Oct. 1977, p. 456-461. 12 refs. In German.

The basic chemical equation used for the calculations considers methane separately in addition to the other hydrocarbons formed as a result of the reaction between CO and molecular hydrogen. The evaluation of the basic equation is discussed, taking into account approaches for the accurate determination of the residual volume of the emitted gas to increase the reliability of the computational results. Attention is given to the characteristic parameters, the process efficiency, a method for the evaluation of the gas analyses, the theoretical maximum yield, approaches for verifying the correctness of the calculations, and effects of the operating conditions on the process characteristics. G.R.

A78-15115 # **Onset of oscillation of a gas-column in a tube due to the existence of heat-conduction field - A problem of generating mechanical energy from heat.** Y. Katto (Tokyo, University, Tokyo, Japan) and A. Sajiki. *JSME, Bulletin,* vol. 20, Sept. 1977, p. 1161-1168.

The oscillation of a gas-column, which occurs when a heater is held in a tube, being open at both ends and having a steady inner flow of gas, has been studied experimentally in order to clarify the fundamental natures of the limiting condition for the onset of oscillation. At the present stage, various experimental results obtained cannot yet be interpreted systematically on the basis of theoretical study, but it has been shown that the limiting condition exists in a clear form for the onset of oscillation, suggesting a possible means which enables to develop quantitative study on the thermal onset of oscillation. This type of oscillation occurs when a cooler as well as a heater is held in a tube with no inner flow, yielding a conclusion that there is a common feature in some fundamental respects with the case of having an inner flow. (Author)

A78-15155 **Probe-tube microphone for pressure-fluctuation measurements in harsh environments.** J. P. Barton, J. K. Koester, and M. Mitchner (Stanford University, Stanford, Calif.). *Acoustical Society of America, Journal,* vol. 62, Nov. 1977, p. 1312-1314. NSF Grant No. AER-72-03487; Contract No. E(49-18)-1227; Grant No. EX-76-C-01-2341.

A probe-tube microphone has been developed for use in the harsh experimental environment involved in studying small-scale pressure fluctuations in combustion magnetohydrodynamics. A smooth frequency response is obtained by a theoretically derived method of impedance matching where an acoustical resistance is placed midway within the length of the tube. The use of such probe-tube microphones under experimental conditions has proven very satisfactory. (Author)

A78-15354 **Metallographic analysis of a steel plate which failed in service in a coal gasifier.** J. R. Fischer (Rockwell International Corp., Los Angeles, Calif.), R. J. De Angelis, O. J. Hahn, and P. P. Gillis (Kentucky, University, Lexington, Ky.). *Engineering Fracture Mechanics,* vol. 9, no. 4, 1977, p. 833-837. Research sponsored by the University of Kentucky.

A material sample containing a portion of the crack that caused failure of the inner shell of a coal gasifier was examined metallographically and compared with a sample of the same material far from the region of failure. Corrosion pitting was observed on the base metal but seemed to have had no catastrophic effect. However, limited observations indicated that corrosion pitting of weld filler metal produced the failure. (Author)

A78-15400 **Alternative hydrocarbon fuels for aviation.** W. G. Dukek (Exxon Research and Engineering Co., Linden, N.J.) and J. P. Longwell (MIT, Cambridge, Mass.). *Exxon Air World,* vol. 29, no. 4, 1977, p. 92-96. 9 refs.

Alternative liquid jet fuels for aviation are discussed along with short- and long-range product quality problems of aircraft fuels. Studies have shown that wide-cut fuels containing blends of heavier diesel and burner fuel fractions with kerosene would represent a less energy intensive course to follow than hydrocracking heavy gas oils (with higher aromatic contents) to make specification jet fuel. The experience which the airlines are presently acquiring on higher aromatic jet fuel may be a prelude to the future era of flying on alternative fuels of all types. To plan for the future, consideration should be given to designing a new series of aircraft with the built-in capability of utilizing liquid fuels of a wide range of properties, so that the aircraft would operate on conventional jet fuel, diesel fuel, domestic heating oil or even high aromatic coal liquids. S.D.

A78-15407 **Solar energy and economic considerations.** J. F. Miller (Singer Co., Auburn, N.Y.). *ASHRAE Journal*, vol. 19, Nov. 1977, p. 40-42.

The article discusses the economic considerations surrounding various solar energy projects, and notes that solar supplements for closed-loop heat pump systems are often necessary. Attention is given to (1) geographical factors important in a solar energy project's success, (2) the possibility of a night set-back system to reduce annual energy consumption, and (3) the selection of an optimum solar array. S.C.S.

A78-15408 **Solar energy and large building HVAC systems - Are they compatible.** M. Meckler (Energy Group, Inc., Los Angeles, Calif.). *ASHRAE Journal*, vol. 19, Nov. 1977, p. 43-50. 17 refs.

The article discusses the potential applications of solar heating and cooling systems to large buildings. It is suggested that a reversible heat engine or approximating Rankine cycle expander driving a heat pump may be an important factor in economizing fuel consumption. A Rankine cycle engine is described in detail with attention to maximizing overall Rankine cycle availability. The Solar Powered Heat Reclamation Air Conditioning System (SPHRACS) is described along with the single duct reheat system, ceiling induction, Rankine heat flow paths, and the Rankine drive train. S.C.S.

A78-15409 **Solar absorption system for space cooling and heating.** I. Shwarts and A. Shitzer (Technion - Israel Institute of Technology, Haifa, Israel). *ASHRAE Journal*, vol. 19, Nov. 1977, p. 51-54. 8 refs. Research supported by the Ministry of Industry and Commerce of Israel.

Consideration is given to using solar absorption systems for space cooling and as heat pumps for space heating with attention to typical Israeli climatic conditions. Two working mixtures for continuous absorption systems are discussed: NH3-H2O and H2O-LiBr. The results have indicated that the H2O-LiBr heat pump system is a potential year-round air conditioning system which may provide significant energy savings, perhaps up to 70%. S.C.S.

A78-15410 **Seasonal solar collector performance with maximum storage.** P. J. Lunde (Center for the Environment and Man, Inc., Hartford, Conn.). *ASHRAE Journal*, vol. 19, Nov. 1977, p. 55-59.

An integrated form of the basic solar collector heat balance equations is derived which permits use of average temperature and radiation data to determine seasonal performance when the average storage temperature is known. For the limiting case of infinite storage and hence constant storage temperature, a typical collector performance is presented graphically for a variety of collector operating conditions. (Author)

A78-15411 **Self-supporting active solar energy system.** R. Zakhariya (Johnson Controls, Milwaukee, Wis.). *ASHRAE Journal*, vol. 19, Nov. 1977, p. 60-63.

The article discusses a self-supporting active solar energy system with attention to heat collection, power generation, forced circulation subsystems, and distribution. The system is described in terms of four possible states: (1) sun available and heated fluid in demand, (2) sun available and heated fluid not in demand, (3) sun not available and heated fluid not in demand, and (4) sun not available and heated fluid in demand. The method's advantages over presently available active solar energy systems are reviewed, and the results of testing are presented. S.C.S.

A78-15423 # **Film reflectors in space (Plenochnye otrazhateli v kosmose).** A. V. Luk'ianov. Moscow, Izdatel'stvo Moskovskogo Universiteta, 1977. 70 p. 98 refs. In Russian.

The prospects for using large-scale film reflectors and collectors are discussed. Attention is given to studies of superlight rotating reflectors, noting their construction, orientation, and motion control. It is suggested that such reflectors may be used in climate and weather control, orbiting solar power stations, and as solar sails. S.C.S.

A78-15783 **Specific output of windmills - A discovery.** E. L. Harder. *IEEE, Proceedings*, vol. 65, Nov. 1977, p. 1623-1625. 6 refs.

Because the wind varies widely from point to point on the earth it has generally been assumed that the specific output of a wind turbine generator, the kilowatthours generated in a year per kilowatt of rating, could only be determined from the particular wind pattern involved. However, it was discovered empirically that the specific output of windmills is practically independent of their location on the earth, or of the mean annual wind velocity. It depends instead on the ratio of the rated speed, the wind speed at which full rating is realized, to the mean annual wind velocity. This is demonstrated by data from many designs and wind-power sites. The resulting curve of specific output versus rated speed/mean annual wind velocity, together with the fundamental formula for power extracted from the wind by a windmill constitutes a useful approximate design and optimizing method. (Author)

A78-15788 **Direct conversion of CO2 laser energy to high-voltage electrical energy using a laser-produced plasma.** W. T. Silfvast and L. H. Szeto (Bell Telephone Laboratories, Inc., Holmdel, N.J.). *Applied Physics Letters*, vol. 31, Dec. 1, 1977, p. 726-728.

High-voltage high-current pulses of electrical energy (700 V, 14 A, 10 kW) are generated with efficiencies greater than 0.1% for a duration of 30 nsec when a 3-4-J CO2 TEA laser is focused on a copper cathode in a special vacuum cell designed to collect the ejected high-energy electrons. Potential applications as a high-voltage source and as a detector are discussed. (Author)

A78-15827 **Ash fouling in the combustion of low rank Western U.S. coals.** E. A. Sondreal, P. H. Tufte, and W. Beckering (ERDA, Grand Forks, N. Dak.). *Combustion Science and Technology*, vol. 16, no. 3-6, 1977, p. 95-110. 44 refs.

A survey of the various aspects of the problem of ash fouling of heat transfer surfaces in boilers fired on low-rank Western U.S. coals is presented. The discussion covers design improvements on boilers for fouling coals, correlations of ash fouling rates with coal parameters, research on ash fouling conducted at the Grand Forks Energy Research Center, studies of the mineral content in Western U.S. coals, and some proposed ash fouling mechanisms. Some findings regarding remedial measures to reduce ash fouling are reported. P.T.H.

A78-15828 **Physical mechanisms governing the oxidation of volatile fuel nitrogen in pulverized coal flames.** J. O. L. Wendt and D. W. Pershing (Arizona, University, Tucson, Ariz.). *Combustion Science and Technology*, vol. 16, no. 3-6, 1977, p. 111-121. 15 refs. NSF Grant No. AER-75-03964; Contract No. E(49-18)-1817.

The problem of volatile fuel nitrogen oxidation in pulverized coal flames is examined from the viewpoint of physical rather than chemical mechanisms. Of particular concern is the role of local oxygen concentration, and the control of local oxygen by adjustment of air/fuel mixing schedules and/or particle time/temperature histories. Data from practical pulverized fuel combustion configurations are reviewed, and the relationships between local oxygen content and NO(x) emissions are discussed. Physical phenomena which control the micro mixing of volatile nitrogeneous species and oxygen are delineated and modeled, and new data on self-sustaining pulverized coal flames are used to relate these fundamental aspects of single coal particle behavior to practical systems. Combustor data on the effect of aerodynamic changes and process changes on conversion of fuel nitrogen demonstrate the overriding importance of local oxygen concentration in determining NO(x) emissions. P.T.H.

A78-15829 **The microstructure of pulverized coal-air flames. I - Stabilization on small burners and direct sampling techniques.** T. A. Milne and J. E. Beachey (Midwest Research Institute, Kansas City, Mo.). *Combustion Science and Technology*, vol. 16, no. 3-6, 1977, p. 123-138. 56 refs. Research supported by the U.S. Bureau of Mines.

The successful stabilization of unaugmented, laminar, premixed, flat flames of coal dust-air on 6.3-cm diameter burners is described. The method of feeding the coal and achieving a uniform dust dispersion is presented and the behavior of the flame is discussed, including its thermal interaction with the burner grid. Procedures and apparatus for the direct sampling, through sonic orifices, of both gaseous species and particulates are presented. Emphasis is placed on the use of direct, molecular beam, mass spectrometry to provide broad detection capability, rapid quenching, and high spatial resolution. The initial, bright reaction zone of rich flames of pulverized Pittsburgh Seam coal in air can be probed with a spatial resolution of the order of a millimeter and time resolution of the order of milliseconds. (Author)

A78-15831 **Studies on coal reactivity - Kinetics of lignite pyrolysis in nitrogen at 808 C.** N. Ya Nsakala, R. H. Essenhigh, and P. L. Walker, Jr. (Pennsylvania State University, University Park, Pa.). *Combustion Science and Technology,* vol. 16, no. 3-6, 1977, p. 153-163. 26 refs. Contract No. E(49-18)-2030.

Pyrolysis of lignites under isothermal conditions at 808 C in nitrogen has provided evidence for a two-component model of coal constitution. Two-stage pyrolysis for pyrolysis times exceeding 0.2 sec was consistent with a two-component model. Component I decomposition was found to be particle size dependent down to particle size of 58 microns. Component II decomposition appears to be independent of size up to 180 microns, which is in the region normally assumed to be rate-limited by diffusional escape. P.T.H.

A78-15832 **Flame stabilization of low volatile fuels.** J. G. Cogoli, D. Gray, and R. H. Essenhigh (Pennsylvania State University, University Park, Pa.). *Combustion Science and Technology,* vol. 16, no. 3-6, 1977, p. 165-176. 18 refs. Research supported by the Cooperative Combustion Laboratory Fund, Middle Atlantic Power Research Committee, and ERDA.

Four chars and two anthracite samples were burned in a furnace that produced an essentially one-dimensional flame in a study intended to yield data on flame stabilization behavior of low volatile fuels, flame shattering, and the effect of the terminal boundary condition on flame behavior. High reactivity samples included bituminous coal and two chars, so that volatile content in itself does not determine reactivity. Internal pore structure does determine resultant reactivity. Particle size can be increasingly important for low-reactivity fuels as any internal surface becomes decreasingly accessible. Ignition distance was found to be approximately proportional to inlet velocity, yielding approximately constant ignition times for small ignition time. No evidence for particle shattering was found. Ignition times for the low reactivity fuel are substantially greater than the predictions of simple radiation theory, while for high-reactivity fuel the agreement between theory and the data is good. P.T.H.

A78-15834 **The physical transformation of the mineral matter in pulverized coal under simulated combustion conditions.** A. F. Sarofim, J. B. Howard, and A. S. Padia (MIT, Cambridge, Mass.). *Combustion Science and Technology,* vol. 16, no. 3-6, 1977, p. 187-204. 28 refs. Contract No. E(49-18)-1209.

The physical transformation of the mineral matter in coal has been studied in a laboratory furnace using size-graded, pulverized samples of a lignite and a bituminous coal. The mineral matter is originally distributed in micron-size inclusions in the coal particles. The paper illustrates how the final particle size distribution of the ash produced at combustion temperatures of 1250 to 1830 K is determined by a combination of agglomeration of fused mineral matter, cenosphere formation due to gas evolution, and vaporization and recondensation of volatile constituents. (Author)

A78-15835 **Coal pyrolysis at fire-level heat flux.** C. K. Lee, J. M. Singer, and R. F. Chaiken (U.S. Bureau of Mines, Pittsburgh Mining and Safety Research Center, Pittsburgh, Pa.). *Combustion Science and Technology,* vol. 16, no. 3-6, 1977, p. 205-213. 15 refs.

Pyrolysis of Pittsburgh Seam coal at fire-level surface heat fluxes of 0.76 and 2.0 cal/sq cm-sec was investigated by means of measurements of mass-loss rate, density, temperature and internal gas pressure of pyrolyzing coal, and thermal properties of coal and coke. Local and overall heats of pyrolysis were determined from these measurements at 2.0 cal/sq cm-sec. It was found that as coal pyrolyzes, a surface coke layer grows behind a low-density plastic zone that propagates into the virgin coal. The plastic zone is characterized by initial endothermic decomposition of virgin coal into a metaplast of liquid and gas, and subsequent exothermic polymerization of these products to form coke. Exothermic reactions also occur in the surface coke layer. The sequential pyrolysis reactions were identified with respect to various density zones in the reacting coal. (Author)

A78-15836 **Fluidized-bed combustion technology - A review.** C. S. R. Rao (Mitre Corp., McLean, Va.). *Combustion Science and Technology,* vol. 16, no. 3-6, 1977, p. 215-227. 35 refs.

The state of fluidized-bed combustion technology is briefly reviewed, the discussion covering only the combustion related processes in the normal mode of operation. The basic concept of an atmospheric fluidized bed combustion power plant and of the pressurized type of installation is exhibited. The scope and principal results of studies on the main mechanisms in the fluidized-bed combustion process are examined. These cover the fluidization phenomenon and attempts at predicting minimum fluidization velocity and particle terminal velocity; the problem of combustion efficiency and emissions such as SO2, NO(x), and particulates; and the dependence of heat transfer rate on combustion parameters. P.T.H.

A78-15847 **Limits on the yield of photochemical solar energy conversion.** R. T. Ross and T.-L. Hsiao (Ohio State University, Columbus, Ohio). *Journal of Applied Physics,* vol. 48, Nov. 1977, p. 4783-4785. 8 refs. NSF Grants No. BMS-72-02298; No. PCM-76-11655.

Entropy and unavoidable irreversibility place a limit on the efficiency of photochemical solar energy conversion which is substantially lower than that placed by the first law of thermodynamics alone. Shockley and Queisser's (1961) 'detailed balance limit' on the efficiency of p-n-junction photovoltaic devices is a special case of this general thermodynamic limit on the efficiency of all quantum-utilizing solar energy converters. For a single photochemical system operating at 20 C in sunlight not attenuated by the atmosphere, this efficiency cannot exceed 29%. Under the same conditions, the efficiency of a solar converter composed of two photochemical systems can reach 41%. (Author)

A78-15850 **A simple measurement of absolute solar-cell efficiency.** J. L. Shay, S. Wagner, R. W. Epworth (Bell Telephone Laboratories, Inc., Holmdel, N.J.) K. J. Bachmann, and E. Buehler (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). *Journal of Applied Physics,* vol. 48, Nov. 1977, p. 4853-4855.

A simple technique is described for precise and reproducible measurement of absolute solar-cell efficiencies in the laboratory. This technique involves indirect measurement of the short-circuit current density by first measuring the wavelength dependence of the absolute quantum efficiency and then folding these data with a standard defined solar spectrum stored in a minicomputer. The technique has been used to monitor progress in the development of both single-crystal and thin-film InP/CdS solar cells. As examples, current-voltage characteristics and spectral dependences of absolute quantum efficiencies are evaluated for uncoated and SiO-coated single-crystal InP/CdS solar cells measured in the dark and under simulated AM2 illumination. Solar efficiencies of 12.8% and 15.0%, respectively, are determined for the uncoated and SiO-coated single-crystal cells. The absolute-quantum-efficiency spectra of an uncoated single-crystal cell and two uncoated thin-film cells are compared, standard AM1 and AM0 solar spectra are folded with the quantum-efficiency spectrum for the SiO-coated single crystal, and efficiencies of 14.2% (AM1) and 12.0% (AM0) are obtained for this cell. F.G.M.

A78-15930 **Systems analysis of space manufacturing from nonterrestrial materials.** G. W. Driggers (Science Applications, Inc., Huntsville, Ala.). *International Astronautical Federation, International Astronautical Congress, 28th, Prague, Czechoslovakia, Sept. 25-Oct. 1, 1977, Paper 77-72.* 34 p. 16 refs.

The components of a general system for obtaining nonterrestrial material and processing it to a finished product are described conceptually. A chemical process system for lunar materials is schematically portrayed, and parameters of the system are estimated. Scenarios for the implementation of the manufacturing facility and production of the early solar power satellites are discussed. Preliminary analysis suggests that large quantities of solar power can be supplied to the earth at less than $1000 per kilowatt of installed ground capacity. M.L.

A78-15951 **Combustion.** I. Glassman (Princeton University, Princeton, N.J.). New York, Academic Press, Inc., 1977. 289 p. 142 refs. $19.50.

Aspects of chemical thermodynamics are considered along with questions of chemical kinetics, the explosive and general oxidation characteristics of fuels, and flame phenomena in premixed combustible gases, taking into account the criterion for explosion, explosion limits and oxidation characteristics of hydrogen, the explosion limits and oxidation characteristics of carbon monoxide, the laminar flame speed, the stability limits of laminar flames, turbulent flames, the stirred reactor theory, and high flame stabilization in high velocity streams. Attention is also given to detonation, diffusion flames, ignition, environmental combustion considerations, and the combustion of coal. G.R.

A78-16048 **Use of solar energy for direct and two-step water decomposition cycles.** E. Bilgen (Ecole Polytechnique, Montreal, Canada), M. Ducarroir, M. Foex, F. Sibieude (CNRS, Laboratoire des Ultra-Réfractaires, Odeillo, Pyrénées-Orientales, France), and F. Trombe (CNRS, Laboratoire de l'Energie Solaire, Odeillo, Pyrénées-Orientales, France). *(Energy Research and Development Administration and University of Miami, World Hydrogen Energy Conference, 1st, Miami Beach, Fla., Mar. 1-3, 1976.) International Journal of Hydrogen Energy,* vol. 2, Oct. 27, 1977, p. 251-257. Research supported by the National Research Council of Canada.

The feasibility of using concentrated solar energy at high temperatures to decompose water is experimentally demonstrated. Preliminary studies show that direct decomposition of water at 2000-2500 C is possible and that the main development should be directed toward reactor design and the separation of product gases. On the other hand, it is shown that two-step thermochemical cycles for hydrogen production are feasible when the reactions are carried out at appropriate high temperatures in a solar furnace. The thermal decomposition of zinc oxide, suitable for such a two-step cycle, is studied in detail. (Author)

A78-16049 **High temperature, stable, spectrally selective solar absorbers for thermochemical hydrogen production.** H. S. Gurev, R. E. Hahn, and K. D. Masterson (Arizona, University, Tucson, Ariz.). *International Journal of Hydrogen Energy,* vol. 2, Oct. 27, 1977, p. 259-267. 17 refs. NSF Grant No. AER-72-03566-A02.

The thermochemical reduction of water by reactions similar to the Mark I process requires a processing temperature of 730 C. The efficient utilization of solar photothermal energy conversion in distributed collector systems to attain this temperature will require the use of suitable spectrally selective surfaces which are stable at the operating temperature. A coating system with demonstrated high-temperature capability has been developed. A silicon thin-film absorber is deposited by chemical vapor deposition (CVD) on a silver thin-film reflector. This optical stack is fabricated at temperatures in excess of 800 C, and the CVD technology is amenable to large-scale production in a flow-through system. At 500 C the present Si-Ag system has typical solar absorptance and total normal emittance values of 0.75 and 0.06, respectively. Samples were fabricated which maintained their high spectral selectivity after 2000 thermal cycles between 150 C and 450 C, and after 100 h at 600 C. Further process studies now underway indicate that the solar absorptance can be improved to better than 0.85 by employing a Si-Ge multilayer absorber and that the operating range of the stacks can potentially be raised to the 800-900-C range by employing a refractory-metal thin-film reflector. (Author)

A78-16050 **Combustion improvement in a hydrogen fueled engine.** S. Furuhama (Musashi Institute of Technology, Tokyo, Japan), K. Yamane (Nissan Motor Co., Ltd., Tokyo, Japan), and I. Yamaguchi (Japan Automobile Research Institute, Ibaraki, Japan). *International Journal of Hydrogen Energy,* vol. 2, Oct. 27, 1977, p. 329-340. 5 refs.

Experimental testing of hydrogen-fueled engines has verified that hydrogen can be used safely and easily and is a promising fuel for automobiles. However, there are problems with abnormal combustion and NO(x) formation. This paper discusses the phenomenon of abnormal combustion and presents a correlation between the abnormal combustion and NO(x) formation. Elimination of these problems was accomplished after several engine modifications and by an experimentally-developed 'combined combustion process'. The characteristics of a hydrogen-oxygen engine with a hydrogen-rich fuel mixture were also studied. This engine was found to have an unexpectedly narrower range of operation than a hydrogen-air engine. (Author)

A78-16053 **Generation of electricity from the wind.** D. F. Warne and P. G. Calnan (Electrical Research Association, Ltd., Leatherhead, Surrey, England). *IEE Reviews,* vol. 124, Nov. 1977, p. 963-985. 121 refs.

The paper outlines the present status of wind power, its technology, and potential in various applications with special emphasis on electricity generation. Topics reviewed include the availability of wind energy, fundamental wind-turbine theory, design options, practical plant achievements, major projects in progress in various countries, and wind-power economics. Wind-turbine performance prediction is discussed relative to simple momentum theory, types of wind turbine, lift and drag in airfoil sections, and operation of high-speed vertical-axis turbines. Possible applications of wind-driven plants are assessed, and potential contributions to future energy needs are projected. S.D.

A78-16093 **Collection properties of generalized light concentrators.** R. E. Jones, Jr. (Lakehead University, Thunder Bay, Ontario, Canada). *Optical Society of America, Journal,* vol. 67, Nov. 1977, p. 1594-1598. 5 refs.

The collection properties of generalized nonimaging radiation concentrators are evaluated for the case of geometrical optics. The second law of thermodynamics is used to study the optical properties of general three-dimensional concentrators. For cylindrical concentrators a relation is determined for the concentration and angular acceptance. Such relations are shown to reduce to those previously known for the case of ideal concentrators. S.C.S.

A78-16128 # **Semiconductor materials for photovoltaic conversion (Materiali semiconduttori per la conversione fotovoltaica).** C. Canali and M. Prudenziati (Modena, Università, Modena, Italy). *Alta Frequenza,* vol. 46, Oct. 1977, p. 435-448. 34 refs. In Italian.

The physical principles of photovoltaic conversion are reviewed, and the structural and material properties influencing the conversion efficiencies of several semiconductor materials used in solar cells are discussed. The optimal cell thickness is determined theoretically; the value of antireflective coatings and concentrators is also mentioned. The preparation of silicon films through edge-defined fed-growth or through deposition of thin layers is considered, and the production of gallium arsenide and cadmium sulfide photovoltaic cells is treated. Special reference is made to the feasibility of photovoltaic conversion systems for Italy. J.M.B.

A78-16275 **Solar energy: Fundamentals in building design.** B. N. Anderson (Total Environmental Action, Inc., Harrisville, N.H.). New York, McGraw Hill Book Co., 380 p. 390 refs. $21.50.

The emphasis in this book is on the design of buildings from the viewpoint of their being able to operate as an efficient solar energy installation. The three principles of this design are that (1) the building must be a solar collector, (2) it must be a solar storehouse, and (3) it must be a good heat trap. The design features of a variety of components and systems for solar utilization in buildings are explained. Attention is given to solar hot water systems, flat plate collectors, other collector types, solar heat storage, solar cooling, and retrofitting of buildings. Vital information is given on heat theory and insolation, sol-air temperature, solar heat gain through windows, heat pump principles, degree days and design temperatures, insulating values of building materials, and emittances and absorptances of materials. P.T.H.

A78-16276 **The prospects for photovoltaic conversion.** W. D. Johnston, Jr. (Bell Telephone Laboratories, Inc., Holmdel, N.J.). *American Scientist,* vol. 65, Nov.-Dec. 1977, p. 729-736. 20 refs.

An investigation is conducted concerning the possibility that photovoltaic conversion devices can make a significant contribution to the energy economy. Such devices are currently extensively used to provide electric power in the case of space applications. A widespread use of photovoltaic power for terrestrial applications, however, is currently not practical because of economic constraints. The principles of photovoltaic conversion and the approaches presently employed to implement these principles are considered as a basis for an evaluation of the possibilities for achieving the cost reductions required to make photovoltaic power economically competitive. Attention is given to various types of silicon-based solar cells, cadmium sulfide/copper sulfide cells, gallium arsenide cells, the employment of solar-energy concentrators, cadmium sulfide/indium phosphide cells, and liquid/solid cells. It is concluded that solar cells could meet about 30% of total electric needs. The time-scale of 30 to 50 years envisioned for the realization of this potential appears realistic. G.R.

A78-16337 # **Combustion processes in in situ coal gasification: Phenomena, conceptual models and research status. I - Overview and continuum wave descriptions.** R. C. Corlett (Washington, University, Seattle, Wash.) and C. F. Brandenburg (ERDA, Laramie Energy Research Center, Laramie, Wyo.). *Combustion Institute, Spring Meeting, University of Washington, Seattle, Wash., Apr. 18, 19, 1977, Paper 77-3.* 23 p. 17 refs.

This paper categorizes combustion problems of in situ coal gasification, reviews research progress to date, and suggests directions for future work. Permeation as opposed to borehole concepts are emphasized. The present manuscript consists of an overview and a presentation of continuum wave descriptions of reverse and forward combustion. A fully analytic, albeit simplified, treatment of wave propagation rate and salient structure characteristics is set forth. The main features of previously published numerical models are retained and quantitatively predictable. (Author)

A78-16338 # **Quenching of nitric-oxide formation in methane-air flames by secondary-air injection.** R. L. Gay, W. S. Young, and E. L. Knuth (California, University, Los Angeles, Calif.). *Combustion Institute, Spring Meeting, University of Washington, Seattle, Wash., Apr. 18, 19, 1977, Paper.* 46 p. 37 refs. Research supported by the American Gas Association.

In the experiments described, a porous-plug burner and a molecular-beam mass-spectrometer sampling system were used to study the quenching of nitric oxide formation in a premixed one-atmosphere methane-air flame by secondary air injection. With secondary-air mole fractions of 10 to 16 percent, and with injection at an axial location corresponding to a reaction flow time of 0.01 sec, it proved possible to quench NO formation at 50% of the concentration realized without secondary air injection. In the region of maximum NO quenching, the corresponding temperature reduction was about 20%. Heat transfer considerations predict a small loss in efficiency with secondary-air injection. V.P.

A78-16339 # **Pollutant measurements in a methanol furnace.** W. L. Grosshandler (Washington State University, Pullman, Wash.) and R. F. Sawyer (California, University, Berkeley, Calif.). *Combustion Institute, Spring Meeting, University of Washington, Seattle, Wash., Apr. 18, 19, 1977, Paper 77-8.* 33 p. 10 refs.

An experimental facility has been built to study the combustion of methanol and a slurry of methanol plus 5.3% coal in an environment similar to industrial and utility boilers. Temperature and major products of combustion have been mapped throughout the 20 cm diameter by 1 m long water-cooled furnace. Formaldehyde levels have been investigated and quantitative measurements of nitric oxide and total oxidizable nitrogen have been made. The major effect of the coal is to increase exhaust particulate levels and increase NO from about 20 ppm to 100 ppm, representing conversion of about 40% of the coal bound nitrogen. (Author)

A78-16340 # **Modelling and experimentation of sample probe effects on pollutant gases drawn from flame zones.** J. C. Kramlich and P. C. Malte (Washington State University, Pullman, Wash.). *Combustion Institute, Spring Meeting, University of Washington, Seattle, Wash., Apr. 18, 19, 1977, Paper 77-6.* 45 p. 24 refs. Research sponsored by the Washington State University; NSF Grant No. ENG-73-20136-A02; Contract No. E(49-18)-2252.

A computer model of chemical kinetics within a quartz gas sampling probe for NO(x) and CO from fuel-lean carbon monoxide/air and methane/air combustion has been developed. Both gas-phase and surface chemical reactions are considered. Heat transfer and flow considerations establish the longitudinal temperature profile. The kinetic model is a one-dimensional plug-flow reactor with assigned temperature in which the probe gases kinetically relax and cool simultaneously. Verifying experiments have been conducted through sampling from a jet-stirred reactor. The project results show: (1) In the early, hot portion of the probe, any NO2 is almost entirely converted to NO by O and H atoms. (2) As the probe gases cool, NO is partially converted to NO2 by HO2, which itself is formed by radical relaxation effects. (3) To a degree CO is converted to CO2 by OH in the probe. This is a continuation of CO combustion within the hot portion of the probe. (Author)

A78-16348 # **Pollutant measurements in laboratory pulverized coal combustor and gasifier.** D. P. Rees, L. D. Smoot (Brigham Young University, Provo, Utah), and N. S. Harding. *Combustion Institute, Spring Meeting, University of Washington, Seattle, Wash., Apr. 18, 19, 1977, Paper.* 20 p. 12 refs. Research supported by the Electric Power Research Institute; Contract No. E(49-18)-1767.

Two recently constructed facilities that use pulverized coal are described, and a planned procedure for studying sulfur and nitrogen pollutant formation is explained. The similar facilities are a high pressure entrained gasifier and an atmospheric pressure combustor. In the future, amounts of nitrogen and sulfur in the char and selected compounds containing these elements in the gas phase will be measured at various axial and radial positions inside the furnace. Preliminary data on the char collected from a single probe at a single axial location during coal combustion are presented and discussed. Methods of sampling and analysis are considered. M.L.

A78-16353 **The development and prospects of power transistors used for the conversion of energy (Evolution et perspectives des transistors de puissance utilisés en conversion d'énergie).** R. Gicquel (Thomson-CSF, Division Sescosem, Aix-en-Provence, France). *L'Onde Electrique,* vol. 57, Nov. 1977, p. 672-678. In French.

The European market for power transistors used in such products as televisions and automobile lights is reviewed; quality control measures adopted in manufacturing the transistors are considered. In particular, attention is given to the stability of the electrical characteristics of the transistors, thermal fatigue resistance, mechanical properties of the silicon-case interconnections, and the capability of avoiding the avalanche effect. Research programs which have bearing on the development of advanced power transistors, including studies dealing with masking and diffusion processes, and the physical chemistry of resins and oxides, are also mentioned. J.M.B.

A78-16473 **French policy in the area of the campaign against atmospheric pollution (La politique française dans le domaine de la lutte contre la pollution atmosphérique).** J.-M. Biren (Ministère de la Culture et de l'Environnement, Service des Problémes de l'Atmosphére, Paris, France). *(International Union of Air Pollution Prevention Associations, International Clean Air Congress, 4th, Tokyo, Japan, May 16-20, 1977.) Pollution Atmosphérique,* vol. 19, July-Sept. 1977, p. 285-290. In French.

Policies adopted by the French Ministry for the Environment, aimed at controlling atmospheric concentrations of sulfur dioxide, particulate matter, smoke, nitrogen oxides, carbon monoxide, fluorine, lead and hydrocarbons, are reviewed. The environmental protection campaign includes programs for reestablishing air quality in polluted areas, the operation of surveillance and monitoring networks, and the development of research programs. Research designed to study the effects of atmospheric pollutants on humans, vegetation and materials is mentioned. In addition, a proposed national data bank for air quality information is described. J.M.B.

A78-16475 **Combustion treatment of smoke and odors of industrial origin - Energy recovery (Traitement par combustion des fumées et odeurs d'origine industrielle - Récupération d'énergie).** Y. Strehl and P. Millard (Gaz de France, Paris, France). *Pollution Atmosphérique,* vol. 19, July-Sept. 1977, p. 301-316. In French.

The incineration of hydrocarbon and hydrocarbon derivative emissions as a means of controlling atmospheric pollution is discussed. Principles of both thermal and catalytic incineration are reviewed, and the use of heat exchangers to conserve energy in the combustion system is considered. An application of effluents incineration and energy recovery to an automobile painting facility is described. Costs of typical thermal and catalytic incineration systems are also assessed. J.M.B.

A78-16507 # **The significance of an arc shaped dark patch on the Nimbus III /HRIR/ imagery of India.** V. M. D. Kulkarni (K. J. Somaiya College of Science, Bombay, India). *International Society for Photogrammetry, International Congress for Photogrammetry, 13th, Helsinki, Finland, July 11-23, 1976, Paper.* 7 p. 13 refs. Research supported by K. J. Somaiya College of Science, Indian Space Research Organization, and Ministry of Education and Social Welfare of India.

Night-time infrared imagery obtained from the U.S. weather satellite Nimbus-III was employed to study a geothermal field in western India. An arc-shaped dark area in the satellite imagery appeared to be the surface expression of a fault lying at some depth; along the curve of this fault line is found a series of hot springs. Results of the study suggested that a combination of thermal, photographic and gamma radiation surveys of the fault region may provide criteria for predicting crustal movements and volcanic disturbances. J.M.B.

A78-16633 **Use of the gravity field to shape large linear solar concentrators with fixed focal axis.** G. Salvini (Roma, Università, Rome, Italy) and R. Visentin (Calabria, Università, Cosenza, Italy). *Nuovo Cimento, Lettere,* vol. 20, Nov. 5, 1977, p. 367-370. 6 refs.

Large linear parabolic concentrators with sizes of 25 to 50 sq m per linear meter and concentration ratios of 30 to 50 are considered. It is proposed that interactions of such massive systems with strong winds and other unfavorable weather conditions be avoided by folding up a system rather than strengthening it against the effects of these phenomena. The proper use of gravity to realize and control the proper profile of an East-West linear parabolic concentrator is discussed in terms of the mechanical properties of cables and strips. It is found that the sun can be tracked with an almost unchanged weight distribution and with a fixed position of the concentrator's focal axis simply by moving the end points of the concentrator. Diurnal and seasonal adjustments are briefly examined. F.G.M.

A78-16635 **Non-electrical uses of geothermal energy.** E. Barbier and M. Fanelli (CNR, Istituto Internazionale per le Ricerche Geotermiche, Pisa, Italy). *Progress in Energy and Combustion Science,* vol. 3, no. 2, 1977, p. 73-103. 48 refs.

Exploration techniques, extraction, and uses of low-enthalpy geothermal fluids in different countries for nonelectric applications in the temperature range 50-160 C are outlined. At present the nonelectric applications utilize either hot water or water-steam mixtures. Attention is directed at the use of geothermal energy in agriculture, aquaculture, climate control, balneology, district heating and cooling, and various industrial applications. The consumption of geothermal energy for nonelectric applications throughout the world is about 6200 MW. Elimination of pollution by proper disposal of waste fluids is also examined. S.D.

A78-16637 **Synthetic fuels and combustion.** J. P. Longwell (Exxon Research and Engineering Co., Linden, N.J.). *Progress in Energy and Combustion Science,* vol. 3, no. 2, 1977, p. 127-138. 22 refs.

The term synthetic fuels is used in the energy industry to mean fossil fuels produced from sources other than petroleum. The large coal resources and their extensive occurrence throughout the world suggest that coal liquefaction will in time be the major source of liquid fuels. Emphasis is placed on conversion of coal to liquid fuels for transportation use. Transportation fuel requirements and solution to combustion problems in automative systems are discussed. Future work should focus on improvement in the ability of aircraft engines to burn highly aromatic fuels with a wide boiling range and on research into the chemistry of soot formation and burnout along with the mechanics of reactive flows involving high-molecular-weight liquids and vapors and soot. S.D.

A78-16698 * # **Learning to build large structures in space.** T. Hagler (NASA, Office of Space Flight, Washington, D.C.), H. G. Patterson (NASA, Johnson Space Center, Houston, Tex.), and C. A. Nathan (Grumman Aerospace Corp., Bethpage, N.Y.). *Astronautics and Aeronautics,* vol. 15, Dec. 1977, p. 51-57.

The paper examines some of the key technologies and forms of construction know-how that will have to be developed and tested for eventual application to building large structures in space. Construction of a shuttle-tended space construction/demonstration platform would comprehensively demonstrate large structure technology, develop construction capability, and furnish a construction platform for a variety of operational large structures. Completion of this platform would lead to demonstrations of the Satellite Power System (SPS) concept, including microwave transmission, fabrication of 20-m-deep beams, conductor installation, rotary joint installation, and solar blanket installation. P.T.H.

A78-16769 **Economics and projections for geothermal development in the Northwest.** G. M. Simmons (Idaho, University, Moscow, Idaho). *Geothermal Energy,* vol. 5, Dec. 1977, p. 8, 9, 11-13 (13 ff.). 23 refs. Research supported by the Pacific Northwest Regional Commission.

The Northwestern states (Washington, Oregon, Idaho) possess a considerable potential for geothermal development. Since most of the known geothermal sources are of moderate temperature, utilization will be primarily non-electric. This paper reviews the present status of the region's geothermal development and attempts to assess the long range impact that this important energy source might have on the Northwest. (Author)

A78-16814 # **Analysis of the seeded combustion gas boundary layer near a cold electrode.** K. Okazaki, Y. Mori, K. Ohtake, and K. Hijikata (Tokyo Institute of Technology, Tokyo, Japan). *AIAA Journal,* vol. 15, Dec. 1977, p. 1778-1784. 11 refs.

The boundary layer of potassium-seeded combustion gas over a cold electrode in the diffusive current mode without arcs is studied theoretically and experimentally. The theoretical analysis features charge separation between electrons and ions, electron thermal nonequilibrium, finite ionization rate, and no assumption of a thin sheath layer adjoining the electrode surface. The case where the current is produced by an applied external electric field without a magnetic field is studied, and the boundary layer around the anode is examined. For the laminar boundary layer, numerical results show that the region of electron-ion charge separation extends much wider than the Debye length from the surface and that both electron thermal and ionization nonequilibria are considerable near the electrode even in the seeded combustion gas; the calculated performance of the electrode voltage drop and current density agrees fairly well with experimental results. For the turbulent boundary layer under the condition of practical MHD generator operation, numerical calculations indicate that the charge-separation region is limited to the extent of several Debye lengths from the surface and that the electron number density is very close to that obtained by the Saha equation for the electron temperature. (Author)

A78-16826 **Solar cells for terrestrial applications.** H. J. Hovel (IBM Corp., Yorktown Heights, N.Y.). *Solar Energy,* vol. 19, no. 6, 1977, p. 605-615. 138 refs.

A review is presented of the status of solar cell research at the end of 1976. Efforts concerning silicon solar cells are related to a decrease in the cost of silicon, the reduction of the cost of fabricating cells, and an improvement in conversion efficiency. Work related to CdS solar cells had mainly the objective to increase efficiency from 8 to 10 percent or more. A description is provided of new types of CdS devices which may overcome some of the stability problems of conventional Cu2S-CdS cells and which may turn out to be more efficient in the long run. Attention is also given to advances related to the development of concentrator solar cells, possibilities concerning an employment of thin film solar cells, and approaches for overcoming certain difficulties with respect to the design of solar cell arrays. A simple diagram of a residential photovoltaic system is presented. The output of the solar cell array is fed directly into an inverter, which performs the functions of maximum power point tracking, dc to ac inversion, and voltage regulation. G.R.

A78-16827 **Underground longterm storage of solar energy - An overview.** B. Givoni (Negev University, Beersheba, Israel). *Solar Energy,* vol. 19, no. 6, 1977, p. 617-623. 8 refs.

A system which could economically store solar energy, collected during the summer, for utilization during the winter would make a vital contribution toward an extended use of solar heating systems. Suitable approaches for designing such thermal storage systems by making use of underground facilities are examined. Heat transfer media considered include water, air, and steam. Options investigated are related to a use of large insulated water tanks, the employment of small uninsulated water tanks surrounded by earth, a utilization of uninsulated space filled with rocks, and a usage of dry ground. Attention is also given to possibilities offered by wet ground, thermal storage in wet ground located in dry surroundings, the use of deep aquifers, the employment of near-surface aquifers, and the utilization of eutectic salts. An approach is described for storing solar energy, at high temperatures over long periods in an underground thermal storage. G.R.

A78-16828 **Solar energy and Congress.** W. L. R. Rice (ERDA, Office of Congressional Relations, Washington, D.C.). *Solar Energy,* vol. 19, no. 6, 1977, p. 631-641. 39 refs.

The background of the U.S. solar energy program is examined. It is pointed out that during the period from 1950 to 1970 federal support of solar energy research and development averaged about $100,000 per year. In fiscal year 1971, $1 million were allocated to research project grants for solar energy terrestrial applications. Federal funding of solar energy has subsequently risen to an annual rate of $115 million for 1976. Aspects of program planning and budgeting are considered and questions related to the congressional funding of solar research are examined, taking into account the budget process, precedents for ERDA budget reporting, the evolution of the fiscal year 1977 solar budget, budget projections, and a program assessment. Attention is also given to congressional oversight hearings, legislative proposals, the value of internal budget data, and congressional actions. G.R.

A78-16829 **Technical and socio-economic aspects of solar energy and rural development in developing countries.** R. Ramakumar (Oklahoma State University, Stillwater, Okla.). *Solar Energy,* vol. 19, no. 6, 1977, p. 643-649. 21 refs. ERDA-supported research; NSF Grant No. AER-75-00647.

A78-16830 **Use of transition metal compounds to sensitize a photochemical energy storage reaction.** C. Kutal, D. P. Schwendiman, and P. Grutsch (Georgia, University, Athens, Ga.). *Solar Energy,* vol. 19, no. 6, 1977, p. 651-655. 22 refs. NSF Grant No. MPS-75-13752; Contract No. E(38-1)-893.

A solar energy storage system based upon the valence isomerization of norbornadiene to quadricyclene possesses several attractive features, including high specific energy storage capacity, kinetic stability of the energy rich photo-product in the absence of suitable catalysts, and relatively inexpensive reactants. An inherent difficulty with the system is the lack of absorption of solar energy by norbornadiene. Attempts to overcome this shortcoming have focused upon the use of transition metal compounds to sensitize the desired energy storage step. Results to date indicate that complexation of norbornadiene to the metal provides a potentially useful route to sensitization. Several copper(I) compounds have thus far been found to be effective. The factors which affect the ability of a transition metal compound to function as a sensitizer via a complexation mechanism are discussed. (Author)

A78-16831 **Experimental study on house cooling and heating with solar energy using flat plate collector.** N. Nakahara, Y. Miyakawa, and M. Yamamoto (Ohbayashi-Gumi, Ltd., Tokyo, Japan). *Solar Energy,* vol. 19, no. 6, 1977, p. 657-662.

A78-16832 **Lightweight thermal storage for solar heated buildings.** T. E. Johnson (MIT, Cambridge, Mass.). *Solar Energy,* vol. 19, no. 6, 1977, p. 669-675. 14 refs. NSF Grant No. GI-41306.

A new building element is introduced that greatly improves the thermal and architectural performance of passively heated structures. Insolated ceiling tiles charged with thin layers of phase change material are used to stabilize room temperatures and store large quantities of heat without using weighty materials which are expensive to support in multiple story structures. Experimental and analytical results are presented which detail the tile performance. (Author)

A78-16833 **Proposal for the production and seasonal storage of hot water to heat a city.** G. Cavalleri (Centro Informazioni Studi ed Esperienze; Milano, Università, Milan, Italy) and G. Foligno (Ditta Ingeniera F. Poggi, Milan, Italy). *Solar Energy,* vol. 19, no. 6, 1977, p. 677-683. 6 refs.

A project is considered for heating a large city of the size of Milan, Italy, with about 1.5 million inhabitants, by means of solar energy. The use of natural or artificial lakes for storing thermal energy until the time of its use in winter or parts of the spring or autumn is considered. Solar collectors with an area of about 15 sq km can be placed in the vicinity of the lake. Lake and solar collectors are to be located in a mountainous region to exploit the low cost of the land and the higher intensity of the solar radiation. Attention is given to the thermal insulation of the lake surface, the transportation of hot water to the city by an aqueduct, the design of solar collectors for the large-volume heating of water to 98 C, and the efficiency of the solar collectors. In an economic evaluation of the project, it is found that the cost of heat provided by the considered system would be about one half of the cost of conventional heating using fuel oil. G.R.

A78-16834 **Prediction of average collector efficiency from climatic data.** P. J. Lunde (Center for the Environment and Man, Inc., Hartford, Conn.). *Solar Energy,* vol. 19, no. 6, 1977, p. 685-689.

A78-16835 **Technoeconomic aspects of central photovoltaic power plants.** J. O. Bradley and D. R. Costello (Midwest Research Institute, Kansas City, Mo.). *(International Solar Energy Society and Solar Energy Society of Canada, Joint Conference on Sharing the Sun: Solar Technology in the Seventies, Winnipeg, Canada, Aug. 15-20, 1976.) Solar Energy,* vol. 19, no. 6, 1977, p. 701-709.

The economic feasibility of central photovoltaic power plants is investigated from the perspective of an electric power utility company. The maximum acceptable price of the system is established, as a function of conventional fuel costs. Factors which would enhance the economic attractiveness of the system are analyzed. These factors include: increases in conventional fuel costs, decreases in photovoltaic system costs and subsidies to attract utility companies. (Author)

A78-16836 **Optimal proportioning of an insulated earth cylinder for storage of solar heat.** R. L. Nicholls (Delaware, University, Newark, Del.). *Solar Energy,* vol. 19, no. 6, 1977, p. 711-714. 11 refs.

A78-16837 **Thermomigration of silicon wafers in a solar furnace.** H. E. Cline and T. R. Anthony (GE Research and Development Center, Schenectady, N.Y.). *Solar Energy,* vol. 19, no. 6, 1977, p. 715-719. 9 refs.

A 5.5 m, 8.7 kW solar furnace was designed and constructed to process silicon wafers by thermomigration. Under the intense heat, 160 W/sq cm, of the solar furnace, a grid of aluminum wires was migrated through the wafer in 5 min. Helium gas was used to cool the wafer and produce a thermal gradient of 400 C/cm. The heat transfer and efficiency of the system are discussed. (Author)

A78-16838 **A method of testing for rating thermal storage devices based on thermal performance.** J. E. Hill, G. E. Kelly, and B. A. Peavy (National Bureau of Standards, Washington, D.C.). *Solar Energy,* vol. 19, no. 6, 1977, p. 721-732. 41 refs. NSF-ERDA-supported research.

This paper describes a proposed test method for determining the 'effective capacity' and heat loss characteristics of thermal storage devices. The prescribed series of tests should provide useful data for the rating of thermal storage devices based on thermal performance. The apparatuses and major components used in the tests have been prescribed so a liquid or air can be used as the transfer fluid. The series of tests to be conducted consist of one steady-state test to determine the heat loss characteristics and eight transient tests to determine the 'effective capacity' for both heat storage and heat removal. During the transient tests, the entering fluid temperature is changed in a step-wise manner and amount of energy either stored or removed over a specified test time is determined. Sample experimental data are given in the paper to demonstrate the concept of the transient tests. (Author)

A78-16840 **Optimal sizing of solar heating components by equating marginal costs of suboptimal investment paths.** R. L. Nicholls (Delaware, University, Newark, Del.). *Solar Energy,* vol. 19, no. 6, 1977, p. 747-750. 10 refs.

The considered method for an optimum sizing of building insulation and solar system components makes it possible to minimize the sum of first and operating costs in the case of a building heated with fuel and with solar energy. Optimum investment levels concerning each of the system components are computed in one iteration on the basis of the given input data. This procedure differs from a previously used method which employs an iterative process to arrive at an optimal solution. Essential steps of the new method are related to an identification of the optimal investment path among the insulation components, the identification of the optimal investment path among the solar heat collector and storage components, and the equating of the marginal costs of these items to the marginal fuel cost in order to obtain optimal investments in all components. The described solution technique is illustrated with the aid of an example. The example is concerned with a system which includes a flat plate solar collector and an earth heat storage unit. G.R.

A78-16842 **Stochastic modeling and forecasting of solar radiation data.** T. N. Goh and K.-J. Tan (University of Singapore, Singapore). *Solar Energy,* vol. 19, no. 6, 1977, p. 755-757. 11 refs.

Modeling of solar radiation data is an essential step in the design and performance prediction of solar energy conversion systems. This paper considers the requirements for solar radiation models from a forecast information user's point of view, and proposes a new modeling approach in which stochastic time series modeling methodology is used to fully extract the statistical properties of solar radiation data and present them in a form suitable for forecasting. This is followed by an illustrative example and a discussion on the potential application of the methodology in solar energy research. (Author)

A78-16843 **Shadows' effect in a large scale solar power plant.** O. Barra, M. Conti, E. Santamata, R. Scarmozzino, and R. Visentin (Calabria, Università, Cosenza, Italy). *Solar Energy,* vol. 19, no. 6, 1977, p. 759-762.

An investigation is conducted concerning the effect of shadows which are projected on the surface of a collector in a concentrating cylindrical-parabolic collector system. The investigation makes use of an analytical-numerical method. The optimum cutting angle for different geometries of the solar plant is numerically evaluated. Values of the optimum cut angle of cylindrical-parabolic tracking collectors as a function of the ratio between spacing and height are presented in a graph. It is concluded that the ratio between the spacing and the height of the collectors at intermediate latitudes should be larger than 2.5 to avoid excessive shadowing effects in a large-scale solar plant. G.R.

A78-16848 **Paratransit prospects - Filling a gap.** R. A. Keith and R. E. Skinner. *High Speed Ground Transportation Journal,* vol. 11, Fall 1977, p. 245-259.

Urban travel habits in the United States will change in the next decade in response to energy, environmental, and economic problems and may create a wider gap between what the automobile does well and what conventional public transportation does well. Paratransit can limit the gap and could be serving more passengers than conventional transit in the 1990's. Paratransit is shared riding. It consists of many forms of service between conventional, scheduled, fixed-route public transit, and the private use of the automobile. A mode may have a paid (i.e., professional) driver, as in public transit, or consist of organized groups using privately-owned vehicles, such as a carpool. Specific forms include taxi, jitney, dial-a-ride, subscription van/subscription bus, carpool/vanpool, and a variety of human service programs. Disappointments with early dial-a-ride experiments should not confuse the appraisal of paratransit prospects. Paratransit usage has the potential for a passenger-growth factor of 4 while conventional transit has a factor near 2, in the next 20 years. (Author)

A78-16852 # **Implementation of extreme-purity specifications in the case of solar generators, taking into account, as an example, the satellites GEOS and ISEE-B (Verwirklichung extremer Reinheitsanforderungen an Solargeneratoren am Beispiel von Satelliten GEOS und ISEE-B).** U. Himstedt and G. Pohl (Telefunken AG, Frankfurt am Main, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über wissenschaftliche Satelliten, Cologne, West Germany, Nov. 24, 1977, Paper.* 24 p. In German.

The satellites GEOS and ISEE-B are to be used for scientific objectives involving the measurement of static and quasi-static electric and magnetic fields. The solar generator needed in connection with the conduction of the considered measurements has to satisfy extreme requirements regarding the electric, magnetic, and chemical purity. The specifications are much more exacting than those which had to be met in the case of other satellites. The design characteristics and technological approaches used to satisfy these requirements are discussed, taking into account the effect of the electrostatic and magnetic specifications. Chemical-purity requirements made it necessary to employ for the construction of the solar generator adhesives with special low-level degassing characteristics. Attention is given to the approaches used for the electrostatic shielding of the generator, the use of a transparent conductive coating on the solar cell cover, a novel approach used for providing the electrical connections for the conductive coating, the mechanical design of the generator, the selection of silicone adhesives, and the results obtained in computer-aided analyses. G.R.

A78-16901 **Fiber-composite systems for energy-storage flywheels.** L. S. Penn and E. S. Jessop (California, University, Lawrence Livermore Laboratory, Livermore, Calif.). In: Diversity - Technology explosion; Proceedings of the Twenty-second National Symposium and Exhibition, San Diego, Calif., April 26-28, 1977. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1977, p. 442-453. 8 refs. Contract No. W-7405-eng-48.

A study of four fiber-composite systems for use in energy-storage flywheels (Kevlar 49/epoxy, Kevlar 29/epoxy, S2-glass/epoxy, and E-glass/epoxy) has been completed. The overall goals were to compare the performance of the four materials and to obtain a relationship between results of conventional materials tests and spin tests. For each material, tensile tests of epoxy-coated strands, hydroburst tests of NOL rings, and hydroburst and spin tests of thin-rim composite rotors about 406 mm in diameter were performed. The results of the rotor and NOL ring hydroburst tests were the same as the results of the spin tests. Thus, for the thin-rim rotor design, hydroburst tests of the rotor or of the NOL ring can be used to predict spin performance. In terms of energy density, Kevlar 49/epoxy ranked highest, but in terms of energy density per unit cost, E-glass/epoxy was best. (Author)

A78-16902 **Heat pipe materials unique requirements for coal gasification processes.** G. J. Ewell and A. Basiulis (Hughes Aircraft Co., Culver City, Calif.). In: Diversity - Technology explosion; Proceedings of the Twenty-second National Symposium and Exhibition, San Diego, Calif., April 26-28, 1977. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1977, p. 454-465. 8 refs.

Heat pipes are very suitable for an employment as heat exchangers in coal gasification processes. The use of heat pipe thermal recovery units in a system for the removal of sulfur from low-BTU gas is described. The heat pipe units are employed in two stages. In the first stage, the hot gases are cooled to 400 F for the sulfur scrubbing process. In the second stage, the sulfur-free gases are reheated again prior to their use in a gas turbine. Requirements concerning the materials employed for heat pipe construction are considered, taking into account the basic heat pipe design, heat pipe internal compatibility requirements, external compatibility requirements with respect to a resistance to corrosion, and erosion and scaling phenomena. Suitable materials for heat pipe construction are listed in a table, giving attention to the temperature ranges from 1000-1800 F and from 200 to 1000 F. G.R.

A78-16923 * # **New batteries and their impact on electric vehicles.** H. J. Schwartz (NASA, Lewis Research Center, Cleveland, Ohio). *Electric Vehicle Council, International Electric Vehicle Exposition and Conference, 1st, Chicago, Ill., Apr. 26-29, 1977, Paper.* 15 p. 18 refs.

The paper is concerned with the development of electric vehicles and electric vehicle batteries. The present and predicted performance levels of some battery systems such as lead-acid, nickel-iron, nickel-zinc, and zinc-chlorine are considered, as are the characteristics that an electric vehicle must possess in order to appeal to customers. The implications of battery improvements for manufacturers of electric vehicles are discussed. Lack of knowledge of passenger range requirements for electric vehicles is noted. M.L.

A78-16926 # **Fiat electric city car prototype.** G. Brusaglino (Fiat S.p.A., Turin, Italy). *Electric Vehicle Council, International Electric Vehicle Exposition and Conference, 1st, Chicago, Ill., Apr. 26-29, 1977, Paper 7755.* 24 p.

Characteristics and on-the-road tests are discussed for a prototype two-passenger electric car designed for urban operation over level or hilly routes. The electric propulsion system of the vehicle consists of a separately excited dc motor fed by a double transistor chopper controlling both armature and field circuits; the propulsion system is capable of delivering 10 kW of continuous power and a three-minute peak output of 15 kW. The field control area for the electric motor is considered in relation to the structural design of the propulsion unit. A nickel-zinc storage battery is used as the on-board storage device. J.M.B.

A78-16927 # **An electrifying experience - Electric vehicles in the Postal Service.** D. P. Crane (U.S. Postal Service, Office of Fleet Management, Washington, D.C.). *Electric Vehicle Council, International Electric Vehicle Exposition and Conference, 1st, Chicago, Ill., Apr. 26-29, 1977, Paper 7750.* 8 p.

Experience in specifying, purchasing, and operating postal electric trucks and vans is reviewed, starting with unsuccessful tests in the early 1960s and their resumption within the framework of a testing project in 1969. Particular attention is given to cost effectiveness, reliability, and the mechanical, electrical, and recharging problems encountered in the project. Satisfactory results obtained to date with AM General vehicles and in particular with vehicles manufactured in England by Harbilt Electric Trucks and Vehicles are noted, along with recent progress that has been made in batteries, enabling the Postal Service to raise requirements to a top speed of 40 to 50 mph and to accelerations of 0 to 15 mph in 4 sec, 0 to 20 mph in 6 sec, and 0 to 30 mph in 30 sec. V.P.

A78-16928 # **Electric levitated inter-city vehicles.** K. Glatzel and M. v. Sarnowski (Dornier System GmbH, Friedrichshafen, West Germany). *Electric Vehicle Council, International Electric Vehicle Exposition and Conference, 1st, Chicago, Ill., Apr. 26-29, 1977, Paper 7782.* 22 p.

The paper reviews the West German Maglev program on the research and development of levitated vehicles for high-speed intercity transportation. Attention is focused on the design features and capabilities of four types of vehicle: the Transrapid 04, a linear high-speed test stand, and two types of electrodynamic levitated test carrier with a linear induction motor and a linear electric motor respectively. Further research will deal with the development of three types of vehicles: a vehicle with electromagnetic levitation and short-primary LIM, a vehicle with electromagnetic levitation and iron core short-secondary linear synchronous motor, and a vehicle with electrodynamic levitation and air core short-secondary linear synchronous motor. Specification data are presented to show that

Maglev vehicles exhibit quite satisfactory values on the basis of primary energy consumption. S.D.

A78-16930 # **Electrifying the Burlington Northern Railroad.** E. R. Craven (Burlington Northern RR, St. Paul, Minn.). *Electric Vehicle Council, International Electric Vehicle Exposition and Conference, 1st, Chicago, Ill., Apr. 26-29, 1977, Paper 7780.* 17 p.

The conversion from diesel power to railroad electrification is discussed. Since several fuels can be used to produce electricity, electrification would provide more flexibility than the current reliance on diesel fuel as well as help conserve oil resources. It is thought that benefits of electrification include reduced locomotive maintenance costs, longer life (electric 30 years - diesel 15 years), increased reliability of service, some increase in line capacity, overload capability for acceleration, more tractive effort, and more stable long-term energy costs. Disadvantages include the all or nothing decision requirement, since small-scale electrification is considered prohibitively expensive. The possibility of interference to signaling and communications is also examined. M.L.

A78-16931 # **Electric vehicles in the Bell System.** J. McDougall (American Telephone and Telegraph Co., Basking Ridge, N.J.). *Electric Vehicle Council, International Electric Vehicle Exposition and Conference, 1st, Chicago, Ill., Apr. 26-29, 1977, Paper 7752.* 27 p.

A program to develop 4000-lb battery-powered vans suitable for use by the telephone company is described. Current phone company electric vehicles are inventoried, and the operation of prototype vehicles is evaluated. Points of concern include the heater, security, service, driver acceptance, decreased friction, and standardization. Van requirements are stated. Development through three phases corresponding to use of contemporary lead acid batteries, improved lead acid batteries, and high energy batteries is planned. Limited use is foreseen for state of the art electric vehicles, which include vehicles lighter and heavier than vans. M.L.

A78-16933 # **The electric locomotive opportunity in the United States.** M. D. Meeker (General Electric Co., Erie, Pa.). *Electric Vehicle Council, International Electric Vehicle Exposition and Conference, 1st, Chicago, Ill., Apr. 26-29, 1977, Paper 7781.* 15 p.

The currently available equipment, performance, and experience necessary to ensure successful electrification of any main line are reviewed. One of the electrification projects examined is the electrification on the North-East corridor between New Haven, Connecticut, and Boston, Massachusetts. Another one, is the modernization of the existing electrification between New Haven and Washington, D.C., whose main objective is to reduce the travel time through operation at 125 mph. Some economically promising solutions are examined. The application of currently available technology to the implementation of cost effective electric railroad operation is exemplified by a 15-mile coal-haul railroad operating at 25,000 V, 60 Hz alternating current, and by a 78-mile railroad in Arizona, operating at 50,000 V, 60 Hz. V.P.

A78-16934 # **The Copper Electric Town Car - Recent developments.** D. K. Miner (Copper Development Association, Inc., New York, N.Y.). *Electric Vehicle Council, International Electric Vehicle Exposition and Conference, 1st, Chicago, Ill., Apr. 26-29, 1977, Paper 7756.* 5 p.

Recent improvements in the design of the Copper Electric Town Car, a small two-passenger prototype automobile suitable for use in urban and metropolitan areas, is described with attention to speed control, regenerative braking, and batteries. The preferred electrical drive system involves a separately excited motor type with 1-speed, chain speed reduction and speed control managed by transistor chopper and voltage switching; a system with transistor armature chopper is to be evaluated. In the regenerative braking system, the controller adds the negative regenerative current to a fixed positive signal and modulates the sum to the driver's demand signal. Maximum regeneration is achieved by removing the foot from the accelerator pedal; this action approximates a gentle brake stop. Regenerative current is limited to 160 amps. The brake pedal has no connection with the regenerative system; normal friction braking is used to bring the car to a stop from speeds below 21 mph. The testing of special 21-plate batteries is described. The car can accelerate from 0 to 30 mph in 8.8 seconds. Ranges for three driving test conditions are reported. M.L.

A78-16935 # **Electric vehicle test and evaluation program of the U.S. Postal Service.** T. A. Norman (U.S. Postal Service, Washington, D.C.). *Electric Vehicle Council, International Electric Vehicle Exposition and Conference, 1st, Chicago, Ill., Apr. 26-29, 1977, Paper 7747.* 14 p.

The paper describes electric vehicle propulsion systems being evaluated as part of a program initiated to reduce the dependence on oil based fuels. Performance evaluation and testing showed that the nickel zinc battery, currently in the developmental stage, has the potential of significantly improving vehicle performance, but is inferior to the lead acid battery with respect to cycle life. The newly developed large lead acid batteries can fit within present DJ-5E (1/4-ton electric postal delivery vehicle), adding cost and weight, but improving vehicle performance. A flywheel system has the potential of significantly improving electric vehicle performance. The system, however, is still under development, and tests have not been carried out. V.P.

A78-16940 # **Electric utility fleet applications of electric vehicles.** D. J. Postle (Consumers Power Co., Jackson, Mich.). *Electric Vehicle Council, International Electric Vehicle Exposition and Conference, 1st, Chicago, Ill., Apr. 26-29, 1977, Paper 7751.* 5 p.

Performance requirements are developed for battery-powered electric vehicles applicable to mail delivery, personnel transportation, shuttle bus service, security patrols, pickup and delivery operations, or electric meter service. Specifications include a minimum daily range of 50 miles at an average speed of 30 to 45 mph over rolling terrain, with 150 to 200 stops and starts and a payload (including the driver) of at least 1000 pounds. Improvements in battery technology and maintenance characteristics of electric vehicles are also considered. J.M.B.

A78-16941 # **Environmental and energy considerations for electric vehicles in urban use.** H. W. Poston and J. Seliber (Chicago, Dept. of Environmental Control, Chicago, Ill.). *Electric Vehicle Council, International Electric Vehicle Exposition and Conference, 1st, Chicago, Ill., Apr. 26-29, 1977, Paper 7753.* 21 p. 10 refs.

In view of the present energy situation, and without banning the large sedan and station wagon, it seems reasonable for a motorist to use a low energy car for a trip to the store, the train, or to work. In the present paper, the electric passenger car in urban use is discussed as a means of providing mobility and such societal needs as safety, reduced operating expenses, reduced air pollution and noise, and low-energy consumption. Factors, such as weight, air and rolling resistance, efficiency of motor and transmission, and accessory power, all of which affect power demand from the batteries, are discussed. The feasibility of meeting the above requirements with a small electric car employing lead acid batteries is pointed out. V.P.

A78-17092 **Air pollution assessments of new fossil energy technologies.** K. L. Heitner (TRW, Inc., McLean, Va.). *Air Pollution Control Association, Journal,* vol. 27, Dec. 1977, p. 1173-1177. 14 refs.

The possible impact of an increased use of coal in electric power plants on air pollution is considered, taking into account a preliminary evaluation of coal burning technologies for baseload electric power generation. Attention is given to current emissions performance standards, future new source performance standards, air pollution assessments of alternate baseload electric power plant technologies, and assessments of alternate power plant types. It is concluded, that in the near-term the utilities will continue to build plants utilizing the baseline technology. In connection with evolutionary improvements in pollution control equipment, the utilities will eventually be able to meet more restrictive emission standards. G.R.

A78-17133 **Energy optimization of a cycled Tokamak.** P. S. Martini and R. J. Onega (Virginia Polytechnic Institute and State University, Blacksburg, Va.). *Nuclear Technology,* vol. 36, Dec. 1977, p. 285-293. 5 refs.

The accumulation of impurities in a controlled thermonuclear reactor makes steady-state operation unlikely. The energy output during the burn phase will depend on the ion temperatures and densities. A dynamic model of the burn cycle of a Tokamak is used to investigate the ion densities and temperatures as a function of time. The total energy output per cycle is investigated as a function of the ion feed rates, plasma current, and the divertor efficiency. The point-kinetics model of the plasma incorporates ion and energy balance equations and explicitly accounts for the impurity ion buildup. The D-D, D-T, and D-3He reactions are all considered in this model. The energy carried off by the neutrons in the D-D and D-T reactions is lost from the plasma. Impurities enter the plasma as a result of wall interactions with escaping ions and neutrons. The trapped-ion mode is used for calculating the confinement times. An equilibrium state vector was obtained using currently projected operating parameters. The total energy density for a burn cycle was found to be a monotonically increasing function of the source rates and the plasma current. The energy density was not substantially increased until the divertor efficiency was greater than approximately 60% when the other parameters were held constant. (Author)

A78-17143 **Coal desulfurization.** R. A. Meyers (TRW Systems Group, Redondo Beach, Calif.). Research supported by the U.S. Environmental Protection Agency. New York, Marcel Dekker, Inc., 1977. 265 p. 185 refs. $29.75.

A comprehensive review of methods for removal of sulfur from coal by chemical means is presented, with special emphasis on process engineering and economic viability. In many cases, published data are recalculated and reinterpreted, leading to conclusions that differ significantly from those cited in the source literature. The basic chemistry associated with various viable methods for coal desulfurization is outlined, with a detailed description of ferric sulfate leaching. Classification of desulfurization methods is based on mechanistic considerations and physical-chemical correlations such as oxidation-reduction potentials, reaction rate constants, solubilities, etc. Also examined are methods for removal of pyritic sulfur as well as processes for elimination of organic sulfur. S.D.

A78-17144 **Heavy oil gasification.** Edited by A. H. Pelofsky (Scientific Applications, Inc., East Brunswick, N.J.). New York, Marcel Dekker, Inc. (Energy, Power, and Environment. Volume 1), 1977. 171 p. $22.50.

Pyrolysis and partial oxidation processes are considered, taking into account cyclic pyrolysis processes, hydrogenolysis, gasification principles, shift conversion, methanation, the Shell gasification process, the Texaco gasification process, and the Ube process. Refinery type processes are considered, giving attention to ebulated bed hydroprocessing, the Universal Oil Products process for the production of synthetic gas, the Fluor Process for the production of synthetic gas, and the Kelogg heavy oil cracking process. Institute of Gas Technology oil gasification processes are also considered along with the Segas process, the production of synthetic gas from shale oil, a scheme to hydrogasify shale oil, and the direct gasification of oil shale. G.R.

A78-17190 # **Establishment of a space manufacturing facility.** G. W. Driggers (Science Applications, Inc., Huntsville, Ala.) and J. E. Newman. In: Space-based manufacturing from nonterrestrial materials. New York, American Institute of Aeronautics and Astronautics, Inc., 1977, p. 135-160. 11 refs.

The procedure for developing a Space Manufacturing Facility (SMF) for the production of five solar power satellites (of 10 GW each) on an annual basis is presented. A comparison is made between maintaining crews in large space stations and supporting them in township (O'Neill settlement) facilities. Various options for site selection are described and compared. The requirements for a proposed lunar facility are identified, noting habitat, farming, oxygen extraction, mining and conveying equipment, fiberglass refining and bagging, mass drivers, and nuclear power-plants. Composite schedules for the development of the manufacturing facility are reviewed, and cumulative costs are projected for the design, development, testing, evaluation, and launch operations. S.C.S.

A78-17261 **Underground gasification - An alternate way to exploit coal.** T. H. Maugh, II. *Science,* vol. 198, Dec. 16, 1977, p. 1132-1134.

Tests of underground coal gasification in North America, Europe and the Soviet Union are reviewed. Results of an underground coal gasification project operated by the Laramie Energy Research Center (LERC) in Wyoming suggest that the process can achieve overall energy recovery efficiency of 60 to 65% when applied to low-grade bituminous deposits in the Western U.S. The reverse combustion technique developed by LERC to connect adjacent injection and gas production wells has also been adopted for an experimental program in Belgium. Soviet coal gasification technology, which involves linkage of several wells through pneumatic fracturing of the coal, is considered, and its proposed application to Texas Gulf Coast lignite is discussed. J.M.B.

A78-17262 **Oil in the ocean - Circumstances control its impact.** R. A. Kerr. *Science,* vol. 198, Dec. 16, 1977, p. 1134-1136.

Microbial degradation, adsorption and other dispersion mechanisms which influence the impact of oil spills on coastal areas are discussed. A combination of gas chromatography and mass spectroscopy has been used to measure the petroleum compounds retained in marsh areas after spills; sediment sampling has provided histories of the annihilation and gradual restoration of marine life affected by heavy oil pollution. Controlled experiments to investigate the disruption of biological system by various concentrations of petroleum indicate that the long-term effects of oil spills may be in the sediments, rather than in the water. J.M.B.

A78-17263 **Submarine seepage of natural gas in Norton Sound, Alaska.** J. D. Cline (NOAA, Pacific Marine Environmental Laboratory, Seattle, Wash.) and M. L. Holmes (U.S. Geological Survey, Seattle, Wash.). *Science,* vol. 198, Dec. 16, 1977, p. 1149-1153. 39 refs. Research supported by the U.S. Bureau of Land Management.

Dissolved two- to four-carbon alkanes detected in the waters of Norton Sound 40 km south of Nome, Alaska are attributed to a hydrocarbon plume. The structural geology of the Norton Basin and dynamic modeling of the initial gas phase composition (probable methane/ethane and ethane/propane ratios of 24 and 1.7 respectively) provide evidence that the seep gas may be of thermochemical origin rather than of recent biogenic origin. J.M.B.

A78-17349 **Relative evaluation of competing processes - Energetic economy analysis of competing processes of coal and oil chemistry (Relative Bewertung konkurrierender Verfahren - Energetische Wirtschaftlichkeitsanalyse konkurrierender kohlechemischer und erdölchemischer Prozesse).** H. Gaensslen (Lurgi Mineralöltechnik GmbH, Frankfurt am Main, West Germany). *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie,* vol. 30, Nov. 1977, p. 508-510. In German.

The described method provides the information needed in economic investigations concerning a replacement of hydrocarbons by coal as raw material for the chemical industry. A procedure for obtaining estimates regarding the investment costs is discussed. The error for the obtained specific minimum-investment value can be as large as 20%. The specific production costs of a chemical organic product are considered. A formula is presented which can be used to calculate for given coal-energy costs the mineral-oil costs which make it possible to obtain a certain product at the same cost from both raw materials. It is assumed that the cost of oil and coal will change with time. An investigation is conducted concerning the time required until cost-equality is reached for processes based on coal and oil chemistry. The conditions are examined under which the coal-chemistry process can, within a certain time period, be competitive with the oil-based process. The application of the described method is illustrated with the aid of a concrete example. G.R.

A78-17350 **The draft of a law for changing energy-law regulations (Zum Entwurf eines Gesetzes zur Änderung energierechtlicher Vorschriften).** E. Tamchina. *Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie,* vol. 30, Nov. 1977, p. 527, 528. 24 refs. In German.

The draft of a bill before the legislative body of the federal government of West Germany provides essentially an extension beyond 1980 of an existing law dealing with the electric-power industry and supplements it. The basis for the bill is an agreement between the electric-power and the coal-mining industries. The agreement provides for the delivery of certain quantities of coal to the electric-power industry for the time from 1978 to 1987. The bill is to help to ensure a market for the products of the coal-mining industry which as a consequence of a slowdown in economic activities, has currently large reserves of unsold coal and coke products. The regulations contained in the considered bill and their economic significance are discussed in detail. G.R.

A78-17409 **Tutorial, test measurement accuracy.** R. B. Abernethy (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, Fla.). In: International Instrumentation Symposium, 23rd, Las Vegas, Nev., May 1-5, 1977, Proceedings. Symposium sponsored by the Instrument Society of America. Pittsburgh, Pa., Instrument Society of America (Fundamentals of Aerospace Instrumentation. Volume 9; Fundamentals of Test Measurement. Volume 4), 1977, p. 5-15. 11 refs.

The paper describes a standard method of treating measurement error or uncertainty for gas turbine engine performance parameters, such as thrust, airflow, and thrust specific fuel consumption. Statistical concepts and mathematical procedures are explained, and an uncertainty model is presented in mathematical, graphical, and block diagram form with a numerical example of model use. In the example, uncertainties are computed for net thrust, fuel flow, and thrust specific fuel consumption. M.L.

A78-17424 **Estimation of the characteristic time required for construction of energy delivery systems (Abschätzung charakteristischer Zeiten beim Ausbau von Energieversorgungssystemen).** J. Nitsch (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für technische Physik, Stuttgart, West Germany). *Brennstoff-Wärme-Kraft,* vol. 29, Nov. 1977, p. 439-444. 25 refs. In German.

The paper presents an analysis of time constants that indicate the time required to construct energy delivery systems. The analysis takes into account changes in the market demand for energy which would necessitate adaptations of original plans. The case of private household energy requirements is taken as an example, and it is shown that exact criteria for the building time can be ascertained by a precise analysis of customer and energy distribution infrastructures. The role of those forms of energy that use pipe-like delivery systems is examined, and factors which influence the substitution of one energy source for another are considered. M.L.

A78-17425 **Exergy of gas fuels and their combustion gases (Exergie der Gasbrennstoffe und ihre Verbrennungsgase).** V. Valent, B. Djordjevic, D. Radovanovic, and D. Malic (Beograd, Univerzitet, Belgrade, Yugoslavia). *Brennstoff-Wärme-Kraft,* vol. 29, Nov. 1977, p. 450, 451. 8 refs. In German.

The effect of gas composition on exergy was studied by measuring the exergy of 20 gas mixtures which contained some or all of the following: N2, CO, CO2, H2, O2, CH4, and C2H4. The effect of composition is explained in the framework of the Rant treatment of exergy. It was found that the composition could affect the exergy by as much as 10%. Data relating the effects of CO2 composition to fuel exergy for different conditions are presented. M.L.

A78-17451 **Ceramic microstructures '76: With emphasis on energy related applications; Proceedings of the Sixth International Materials Symposium, University of California, Berkeley, Calif., August 24-27, 1976.** Symposium sponsored by the Energy Research and Development Administration and University of California. Edited by R. M. Fulrath and J. A. Pask (California, University, Berkeley, Calif.). Boulder, Colo., Westview Press, Inc., 1977. 935 p. $46.50.

Ceramics for aerospace and energy-related applications are considered, with emphasis on the characterization of microstructures through use of such techniques as scanning electron microscopy and high-voltage transmission electron microscopy. Topics of the papers include the morphology of polycrystalline silicon carbide, quantitative microscopy techniques, sintered silicon carbide, X-ray diffraction set-point measurements in glass-ceramic-metal composites, directionally solidified ceramic eutectics, sodium ion diffusion in beta alumina, hot pressing of Si3Ni4, microstructures and macrostructures of MHD electrode-insulators, surface finish control of the strength of polycrystalline ceramics, and the production of wurtzite-type boron nitride. J.M.B.

A78-17464 **MHD electrode-insulator micro- and macrostructure.** J. L. Bates (Battelle Pacific Northwest Laboratories, Richland, Wash.), B. R. Rossing (Westinghouse Research Laboratories, Pittsburgh, Pa.), and H. K. Bowen (MIT, Cambridge, Mass.). In: Ceramic microstructures '76: With emphasis on energy related applications; Proceedings of the Sixth International Materials Symposium, Berkeley, Calif., August 24-27, 1976. Boulder, Colo., Westview Press, Inc., 1977, p. 731-752. 30 refs.

The development of MHD electrode modules for coal-fired and for clean fuel fired MHD channels has required the development of compatible materials for high current flux electrical conductors, high temperature insulators and current lead-outs. Large thermal gradients due to high heat fluxes (50-200 watts/sq cm), potassium seed condensation and subsequent reaction, and slag-seed interactions with the materials causes restructuring of the micro- and macrostructure. Results from current modules based on ZrO2-CeO2 and spinel (e.g., FeAl2O4-Fe3O4) electrodes; MgO, Al2O3 and MgAl2O4 insulators; and platinum or steel current-leadouts are discussed. (Author)

A78-17476 # **A parametric study of a heat exchanger designed for geothermal power plant application.** D. H. Kihara, H. C. Chai (Hawaii, University, Honolulu, Hawaii), and G. S. Shimozono. *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-1.* 12 p. 13 refs. Members, $1.50; nonmembers, $3.00. NSF Grant No. GI-38319.

The preliminary design of a vertical, counterflow, shell and tube heat exchanger for use in a Rankine cycle is presented. The heat exchanger is to be part of a representative geothermal power plant generating 10 Mw utilizing geothermal brine at 350 F with isobutane as the working fluid. The computational procedure for determining tube lengths, number of tubes, and pressure drops is outlined. Detailed in graphical form are results of a parametric study showing how these parameters are affected by changes in turbine inlet temperature, tube diameter, tube pitch, isobutane velocity, scale thickness, pinch temperature difference, and system pressure. (Author)

A78-17477 # **Evaluation and design considerations for liquid-liquid direct contact heat exchangers for geothermal applications.** H. R. Jacobs. *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-2.* 9 p. 29 refs. Members, $1.50; nonmembers, $3.00. Contract No. E(10-1)-1523.

Alternates to conventional heat exchangers are necessary for the design of many binary cycle Geothermal Power Plants. Direct Contact heat exchangers are proposed and various designs are considered for the important liquid-liquid regime which accounts for 40 percent of the duty for subcritical cycles. (Author)

A78-17478 # **Application of direct contact heat exchangers in geothermal systems.** I. Oliker (Burns and Roe, Inc., Paramus, N.J.). *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-3.* 7 p. 18 refs. Members, $1.50; nonmembers, $3.00.

Two applications of direct-contact heat exchangers (DCHs) used in geothermal systems are examined. The first type of DCH is applied to a binary cycle where a secondary fluid is vaporized in contact with the brine (direct contact evaporator). The second type of DCH is applied to a geothermal power plant operating on water vapor only (direct contact condenser); in this case the DCH serves as a direct contact condenser to provide the maximum condensation rate of the turbine exhaust steam in place of the barometric condenser. Experience in related fields is used to discuss heat transfer, scaling, corrosion and carryover problems related to DCH. It is shown that the water treatment techniques developed in related fields - such as power technology and water desalination - can be employed in DCHs in order to reduce these problems in geothermal applications. Design requirements are pointed out, such as providing effective drainage from a DCH to prevent sludge buildup, high heat transfer coefficients, and maximum steam condensation. S.D.

A78-17479 # **Testing of direct contact heat exchangers for geothermal brines.** W. B. Suratt and G. K. Hart (DSS Engineers, Inc., Fort Lauderdale, Fla.). *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-4.* 8 p. 12 refs. Members, $1.50; nonmembers, $3.00. Contract No. E(40-1)-4893.

A 350,000 Btu/hr test loop was built and operated to assess the feasibility of utilizing direct contact heat exchange between a secondary working fluid and brine from liquid dominated geothermal resources. Isobutane working fluid was continuously heated in a liquid-liquid preheater and then vaporized in a separate boiler by direct contact heat exchange with 325 F simulated brine. The preheater is an Elgin-type spray tower with isobutane as the dispersed phase. Axial mixing was the predominant influence on preheater heat transfer performance, limiting the number of heat transfer units attainable in a tower of given height, regardless of the magnitude of interfacial area or local drop heat transfer coefficients. An analysis based on the Letan-Kehat drop wake model for axial mixing is in good agreement with the experimental data obtained. The direct contact boiler generated isobutane vapor at a design saturation temperature of 220 F. In terms of volumetric heat transfer coefficients, boiling performance was far superior to liquid-liquid heat transfer in the preheater. (Author)

A78-17480 # **Operational limitations of direct contact boilers for geothermal applications.** H. R. Jacobs, S. B. Plass, R. Gregory (Utah, University, Salt Lake City, Utah), and A. C. Hansen. *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-5.* 8 p. 18 refs. Members, $1.50; nonmembers, $3.00. Contract No. E(10-1)-1523.

Direct contact heat transfer was proposed for geothermal binary cycles as a means of avoiding the fouling and corrosion problems inherent in the use of conventional tube and shell heat exchangers. The direct contact heat exchange necessary in subcritical binary cycles is divided into the boiling regime and the liquid-liquid heat transfer regime. This paper deals with the heat transfer within the boiling regime. Experiments are reported for a near scale heat exchanger utilizing R-113 as the working fluid. A non-dimensional correlation with the limited results of other investigators for isobutane and ethane as working fluid. (Author)

A78-17487 # **Heat transfer in solar energy storage.** S. W. Yuan, A. M. Bloom, and M. Nazli (George Washington University, Washington, D.C.). *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-38.* 11 p. 8 refs. Members, $1.50; nonmembers, $3.00.

An analysis of the heat transfer characteristics of a solar energy storage concept that uses unprepared earth as a storage medium is presented. Two methods of heating and extraction are considered. The first method uses a water pipe heat exchanger for both the heating and extraction phases. The second method uses a heat pipe during the heating phase and a water pipe during the extraction phase. The heat input to the earth storage is obtained by the operation of solar collectors. The solar collection process is activated during the day and is deactivated during the night. Solar energy is collected by this procedure throughout the entire year and stored in the earth reservoir. For space heating applications, house load data are applied to the earth storage during the winter months. It is demonstrated that year round solar collection and approximately 400,000 cu ft of earth storage is adequate to provide space heating for twelve average size houses in most areas of the United States. Furthermore, the use of a heat pipe on the heating phase may reduce the initial preparation time for the earth storage. (Author)

A78-17491 # **Effects of slagging in MHD generator ducts.** M. Martinez-Sanchez (MIT, Cambridge, Mass.) and I. Sadovnik (Avco Everett Research Laboratory, Inc., Everett, Mass.). *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-59.* 11 p. 10 refs. Members, $1.50; nonmembers, $3.00.

Consideration is given to various effects of the slag layers that form on the walls of coal-fired MHD generators, including fluid-dynamic, heat transfer, and electrical effects. Interactions of slag and plasma are derived; the results are representative of the effects of many slag types and amounts of runoff from the burner and wall temperature. The slag layer is described, noting the effects of variable properties, segmentation, electromagnetic dissipation, and forces. A quasi-one-dimensional model, accounting for finite segmentations and boundary layer effects, is used to represent the plasma flow. It is found that generator performance can be seriously hindered by current leakages through slags of high conductivity. For more resistive slags generator performance may be improved via better thermal insulation and reduced electrode voltage drops. S.C.S.

A78-17492 # **Analysis of a new concept for a high temperature direct coal-fired falling particle air pre-heater for MHD power generation.** R. L. Mussulman, R. O. Warrington, Jr. (Montana State University, Bozeman, Mont.), and R. L. Prill. *American Institute of Chemical Engineers and American Society of Mechanical Engineers,* *Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-60.* 6 p. 15 refs. Members, $1.50; nonmembers, $3.00.

A unique design for a falling liquid droplet heat exchanger is presented. The major problem associated with this type of heat exchanger, that of obtaining uniformly sized liquid droplets, has been solved by utilizing vibration-induced atomization of the liquid. With this method the drops are formed by disturbing a liquid capillary jet by either vibrating a distributor plate through which the liquid flows or by holding the plate stationary and producing the disturbances with external sound pressure waves. Specific use of this type of heat exchanger as a direct coal-fired air preheater for MHD power generation is examined. Digital solution of the governing equations has determined the effects of particle size and size distribution on the chamber size requirement. Comparisons with other MHD air preheater design concepts, including the cored brick, show that the present design has numerous advantages. (Author)

A78-17493 # **Specifics of heat exchanger design for a 2000-MWt dual cycle, MHD Topping-Steam Bottoming power plant.** R. L. Lawit, P. R. Sheth, and R. A. Stoudt (Gilbert/Commonwealth Engineers and Consultants, Reading, Pa.). *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-61.* 14 p. 14 refs. Members, $1.50; nonmembers, $3.00. Contract No. EX-76-C-01-2228.

An MHD topping cycle puts extreme demands and premiums on the design of heat exchangers. Efficient transfer of energy is essential at temperatures far above those in conventional plants. In addition, the atmosphere is highly corrosive and very erosive with condensation and precipitation of seed and slag under reducing and oxidizing conditions. Caustic seed, as well as high concentrations of alkali and sulfur create an extremely severe test on MHD heat exchanger metal. The paper describes heat exchanger design considerations for a 2000-MWt input MHD Topping-Steam Bottoming open cycle plant and is based on use of Sub-Bituminous Rosebud Montana Coal with maximum drying (94 percent by weight of the total moisture is removed). (Author)

A78-17494 # **Heat transfer problem associated with an MHD power generation system - An overview.** A. W. Postlethwaite and M. M. Sluyter (ERDA, MHD Div., Washington, D.C.). *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-62.* 10 p. 23 refs. Members, $1.50; nonmembers, $3.00.

Research in the field of MHD has advanced to the point where the development of an operational system is feasible. The primary system being considered by ERDA is an open-cycle MHD/steam cycle power loop. Critical thermal problems impact the system due to hot ionized plasma, seed injection, slag deposition and high temperature air heaters. MHD power generation has entered the development phase and commercial operation can be achieved by existing materials and techniques. (Author)

A78-17495 # **Effects of wall electrical conductance and induced magnetic field on MHD channel heat transfer with developing thermal and velocity fields.** E. A. Hsia (General Electric Co., Aircraft Engine Group, Evendale, Ohio). *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-63.* 10 p. 13 refs. Members, $1.50; nonmembers, $3.00.

Heat transfer of the interacted laminar magnetohydrodynamic flow in the entrance region of a channel with electrically conducting walls is investigated by the integral method. The flow is assumed to be incompressible, electrically conducting, and with constant properties. Both viscous dissipation and Joule heating are included in the present analysis. Influences of the wall conductivity, the Hartmann number and the nonuniform induced magnetic field on the developing temperature field and local heat transfer rates are investigated. The effect of wall conductivity is found to shorten the growth behavior of the temperature field in the entrance region. Numerical results included fluid temperature profiles, thermal boundary layer thickness, wall and free stream temperature differences and local Nusselt numbers. (Author)

A78-17496 # **A MHD simulation test facility for investigating the thermal properties of a slag/seed coated radiant boiler and superheater for a 2000 MWt MHD power plant.** D. L. Murphree, C. J. Bell, R. W. Cain, J. B. Nail, R. E. Powe, W. S. Shepard, and A. G. Wehr (Mississippi State University, Mississippi State, Miss.). *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-64.* 10 p. 9 refs. Members, $1.50; nonmembers, $3.00. Contract No. EX-76-C-01-2246.

A78-17497 # **Particulate deposition in direct fired MHD air preheaters.** C. K. Sande (Cordis Dow, Concord, Calif.), H. W. Townes, and T. C. Reihman (Montana State University, Bozeman, Mont.). *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-65.* 8 p. 13 refs. Members, $1.50; nonmembers, $3.00.

An analytical model for the deposition of particulates on a tube wall in turbulent flow was developed. The model considered as transport mechanisms the turbulent diffusion of the particles in the radial direction and the bulk transport by the mean flow in the axial direction. An approximation of the turbulent diffusion coefficients of the particulates was made and includes the effects of the energy density spectrum of the turbulent flow field and particle diameter as well as other parameters. The effect of tube wall roughness is also included in the model. Finite difference equations were developed and solved for several cases of interest using digital computation. Several examples are given based on the flow conditions expected in direct fired open cycle MHD air preheaters. (Author)

A78-17498 # **Advances in liquid fluidized-bed heat exchanger development.** E. S. Grimmett, A. F. Fanous, and C. A. Allen (Allied Chemical Corp., Idaho Falls, Idaho). *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-66.* 11 p. 17 refs. Members, $1.50; nonmembers, $3.00.

The paper reports the first heat transfer results from a horizontal liquid fluidized-bed heat exchanger. Geothermal water from Raft River Geothermal Wells provided the heat source. Treated water was the secondary fluid. Silica sand closely screened to 16 mesh was the bed material. The exchanger was 8 in. in diameter by 15 in. long. Heat transfer results are compared with values from a vertical heat exchanger experiment. A liquid fluidized-bed heat exchanger size and cost for the low pressure preheater portion of the 40-MW Raft River Thermal Loop is compared to the size and cost of a conventional tube and shell preheater. Even when designed for the Raft River geothermal water, which is low in dissolved solids, the liquid fluidized-bed heat exchanger is competitive in cost to the conventional unit. (Author)

A78-17501 # **An approach for determining the impact of peak coolant temperature on fusion reactor size and electricity costs.** D. A. Bowers (McDonnell Douglas Astronautics Co., St. Louis, Mo.). *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-73.* 7 p. 6 refs. Members, $1.50; nonmembers, $3.00. Research supported by the Electric Power Research Institute.

This paper addresses the impact of blanket coolant outlet temperature (peak coolant temperature) on controlled thermonuclear reactor size as measured by thermal power output and electrical power costs. The UWMAK-III reactor is used as a reference design for which the thermal conversion efficiency effects of peak coolant temperatures in the 500-1000 C range are assessed. Required reactor thermal power is seen to vary no more than 11% among the three reference peak coolant temperatures. The cost of electricity also shows a relative insensitivity to peak coolant temperature and indicates that a steam cycle conversion system is preferable to a high temperature closed cycle gas turbine system. (Author)

A78-17506 # **A numerical solution to the unsteady, quasi-three-dimensional, turbulent heat transfer problem in an MHD channel.** D. M. Markham, C. D. Maxwell, S. T. Demetriades, and D. A. Oliver (STD Research Corp., Arcadia, Calif.). *American Institute of Chemical Engineers and American Society of Mechanical Engineers, Heat Transfer Conference, Salt Lake City, Utah, Aug. 15-17, 1977, ASME Paper 77-HT-90.* 12 p. 19 refs. Members, $1.50; nonmembers, $3.00. Contract No. EX-76-C-01-2243.

A numerical solution is derived for the unsteady, quasi-three-dimensional turbulent-heat transfer problem in an MHD channel. The study yields the following conclusions: (1) heat transfer in an MHD channel is caused by core-to-wall temperature difference, MHD induced secondary flows convecting hot fluid around the channel, and Joule dissipation, (2) secondary flows account for the large nonuniformities in the heat flux distributions on the channel sidewalls, whereas other MHD effects cause nonuniformities found on the electrodes, (3) when compared to insulating sidewalls, conducting sidewalls cause a more uniform heat flux distribution on the electrodes and more severe nonuniformities on the sidewalls, (4) MHD flows may not be simply analyzed as they show a large departure from Reynolds analogy, (5) three-dimensional heat transfer effects are significant in an MHD channel, and (6) the model described is valid for distortions in the electrical conductivity field caused by local plasma heating. S.C.S.

A78-17520 **Optimum efficiency of photogalvanic cells for solar energy conversion.** W. J. Albery (Oxford University, Oxford, England) and M. D. Archer (Cambridge University, Cambridge, England). *Nature,* vol. 270, Dec. 1, 1977, p. 399-402. 7 refs.

The performance of photogalvanic cells for the direct conversion of solar energy to electrical energy depends on the cell, photochemistry, the homogeneous kinetics, the mass transport, the electrode kinetics and the load on the cell. The variation of the power output with the concentrations of the redox couples, their transport and kinetic parameters and the dimensions of the cell is found. The power conversion efficiency of the optimal cell could be as large as 18% but it is unlikely that all the necessary conditions can be met. A more realistic estimate of the maximum power conversion efficiency that could be achieved from a photogalvanic cell is between 5 and 9%. (Author)

A78-17551 **The University of Louisville Dual Solar Energy Research Center.** T. M. Murray and J. H. Calhoun (Louisville, University, Louisville, Ky.). In: Imaginative engineering thru education and experience; Proceedings of the Southeast Region 3 Conference, Williamsburg, Va., April 4-6, 1977. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 273-276.

The University of Louisville has constructed an astronomy observatory in Oldham County, Kentucky. The 1850 sq ft administration building for the observatory will also function as a solar energy proof-of-concept complex. Solar energy will be collected by two different types of water collectors of 500 sq ft each. The heated water will be stored in two 3000 gallon tanks in the building's basement. There are two related design concepts that make this project an interesting and innovative system. First, there will be multiple methods to control the components of the system to increase the system's overall efficiency. Second, these components will be under direct control of a microprocessor system. An absorption A/C system is scheduled to be added early in the summer of 1977. (Author)

A78-17552 * **Economical photovoltaic power generation with heat recovery.** G. Ascher (NASA, Goddard Space Flight Center, Greenbelt, Md.). In: Imaginative engineering thru education and experience; Proceedings of the Southeast Region 3 Conference, Williamsburg, Va., April 4-6, 1977. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 277-280.

Three designs for conversion of solar radiation to electricity and thermal energy are analyzed. The objective of these converters is to increase the electric and thermal output for each photovoltaic array so as to lower the cell cost relative to the amount of energy delivered. An analysis of the economical aspects of conversion by photovoltaic cells with heat recovery is carried out in terms of hypothetical examples. Thus, it is shown that the original cost of say $40,000 per generated kilowat can be reduced to $572.00 per kilowatt by increasing the original electric output of 1 kW to 10 kW in electricity and 60 kW in thermal energy. The newly derived specific cost is only 1.4 percent of the original one. It is expected that a cost reduction of roughly 2% of the present specific cost per kilowatt will greatly stimulate public acceptance of photovoltaic terrestrial conversion to electricity. V.P.

A78-17553 **An optical scanning technique for evaluating silicon solar cells.** T. C. Chandler, Jr., R. B. Hilborn, Jr., and J. W. Faust, Jr. (South Carolina, University, Columbia, S.C.). In: Imaginative engineering thru education and experience; Proceedings of the Southeast Region 3 Conference, Williamsburg, Va., April 4-6, 1977. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 281-284. 9 refs.

The present paper deals with silicon solar cells which operate by the photovoltaic effect common to p-n junctions. The theory is highly developed, but solar cell efficiencies, series resistance, and other parameters do not always agree with theoretical values, the discrepancies resulting from inhomogeneities in the diffused region of the cells. The relationship between the inhomogeneities and solar cell parameters is studied by evaluating the variations in surface concentration, making use of the bulk photovoltaic effect, and by using a specially adapted curve tracer to display the forward (illuminated) characteristic of the test cell. It is found that the bulk photovoltaic scanning technique has some disadvantages, including difficulties in interpreting the bulk emf vs lateral distance curve and also the associated resistivity profile for an n-type crystal. However, variations in resistivity profile large enough to degrade cell performance can be easily detected. V.P.

A78-17556 **The microprocessor controlled and instrumented solar energy project.** J. H. Calhoun and T. M. Murray, Jr. (Louisville, University, Louisville, Ky.). In: Imaginative engineering thru education and experience; Proceedings of the Southeast Region 3 Conference, Williamsburg, Va., April 4-6, 1977. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 307-310. 7 refs.

The University of Louisville Solar Energy Research Project (ULSERP) will provide 75% heating and partial cooling for a 171.8 sq m administration building. In the present paper, the ULSERP control system, instrumentation system, and the IMSAI 8080 microcomputer, used as a data acquisition and control center, are discussed. The computer permits maximum system variation, energy optimization, and evaluation of the cost effectiveness of the ULSERP components. The F-8 controller has eight inputs for instruments, 16 outputs for controls, and 1024 bytes of random access memory for storing the control program. V.P.

A78-17568 **Federal policy and the electric vehicle.** M. R. Virkler (Virginia, University, Charlottesville, Va.). In: Imaginative engineering thru education and experience; Proceedings of the Southeast Region 3 Conference, Williamsburg, Va., April 4-6, 1977. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 385-388. 9 refs.

This paper examines the role that the federal government can play in the growth of a developing technology, the electric vehicle. The need for this form of transportation, along with a brief description of the present state of the technology, is presented. Various alternatives for government intervention, including certain regulatory approaches and the recent 'Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976,' are discussed, along with arguments for and against them. (Author)

A78-17570 **Design considerations for an electric vehicle solid-state motor controller with regenerative braking capability.** D. E. Kissel (Jeffboat, Inc., Jeffersonville, Ind.) and J. D. Cole (Louisville, University, Louisville, Ky.). In: Imaginative engineering thru education and experience; Proceedings of the Southeast Region 3 Conference, Williamsburg, Va., April 4-6, 1977. New York, Institute of Electrical and Electronics Engineers, Inc., 1977, p. 394-397.

A78-17653 **Variance analysis of wind characteristics for energy conversion.** R. B. Corotis, A. B. Sigl, and M. P. Cohen (Northwestern University, Evanston, Ill.). *Journal of Applied Meteorology,* vol. 16, Nov. 1977, p. 1149-1157. 8 refs. NSF Grant No. AER-75-00357; Contract No. EY-76-S-06-2342.

A variance analysis of hourly wind data obtained by anemometry is used to characterize their variance and independence for direct energy conversion systems. While the analysis included the equivalent number of independent hours in a day, it did not provide the details of the correlation structure. For this purpose, an autocorrelation and cross-correlation analysis performed on the hourly records demonstrates significant correlation in the wind at a single site for 8-12 hr period and between sites for similar time lags and separations up to 100 km or more. It is also found that the diurnal cycle strongly depends on season and elevation. S.D.

A78-17670 **The future of oil (L'avenir du pétrole).** P. Desprairies (Institut Francais du Pétrole, Rueil-Malmaison, Hauts-de-Seine, France). *Entropie,* vol. 13, no. 78, Nov.-Dec. 1977, p. 12-15. In French.

It is shown that oil exists in sufficient quantities to cover needs until the end of the next century as regards applications for which it cannot easily be replaced, for example as a petrochemical basis. It is concluded that in order to ensure an average growth rate of approximately 3 to 5 percent, nuclear power should be developed, together with unconventional oil from very deep deposits offshore or on land, and synthetic oil from the hydrogenation of coal, the development of which should be accelerated without delay. (Author)

A78-17671 # **A solid waste package deal - Energy and materials from garbage.** N. Rueth. *Mechanical Engineering,* vol. 99, Dec. 1977, p. 24-29.

The paper describes a highly automated solid waste treatment system that can provide fuel for energy generation. Water is added to the waste which is then wet-shredded; afterwards, in several steps using water as a conveyor, the system separates ferrous metals, removes aluminum and nonferrous metals, and dries and optically sorts glass. A homogeneous fuel is produced, and 48% of the glass, 80% of the aluminum, 90% of the ferrous metals, and a small amount of nonferrous metals are recovered. A hydrapulper similar to a giant blender is used to shred waste. One disadvantage caused by the addition of water is that the fuel obtained from waste produces only a moderate-temperature steam; advantages are that wet-shredding eliminates both worker exposure to dust from shredding and spontaneous combustion of dry-shredded garbage. The cost effectiveness of the system is considered, and the financing of a plant using this treatment is reported. M.L.

A78-17672 # **Update - Automobile fuel economy.** D. S. Shupe (Cincinnati, University, Cincinnati, Ohio). *Mechanical Engineering,* vol. 99, Dec. 1977, p. 30-34. 13 refs.

Automobile fuel economy is analyzed with attention to power plant (including accessories), aerodynamic drag, tire resistance, inertial mass, driving pattern, and length of trip. Differences in fuel consumption data obtained by dynamometer tests and by road tests are described. Automobile modifications that would conserve fuel are considered; these modifications are divided into short-term, intermediate, and long-term categories. M.L.

A78-17673 **Solar power stations (Les centrales solaires).** M. Rodot, J.-C. Etievant (CNRS, Paris, France), J. Deflandre (Agence Nationale de Valorisation de la Recherche, Neuilly-sur-Seine, Hauts-de-Seine, France), and J.-L. Peube (Poitiers, Université, Odeillo, Pyrénées-Orientales, France). *La Recherche,* vol. 8, Dec. 1977, p. 1038-1048. 5 refs. In French.

The use of solar energy is considered with reference to existing and planned large-scale solar energy systems. The technology of optical systems is studied, and the Odeillo project is examined as an example of an optical system. The Sofretes power stations, which use a less common thermal approach, are also described. It is noted that present stations are less than 20 percent efficient. The development of new technologies to utilize solar energy is discussed. M.L.

A78-17789 **Optimal design of anisotropic /fiber-reinforced/ flywheels.** R. M. Christensen and E. M. Wu (California, University, Livermore, Calif.). *Journal of Composite Materials,* vol. 11, Oct. 1977, p. 395-404. 7 refs. Army-supported research; Contract No. W-7405-eng-048.

An analysis is given of the kinetic energy storage capacity of anisotropic flywheels. Using a uniform strain failure criteria, the optimal shapes of flywheels are determined as a function of the degree of anisotropy. Within this spectrum of shapes, practical design considerations are shown to favor the case where there is equal reinforcement in the radial and circumferential directions. Comparisons are made between the present solid-wheel-type design and the ring design. (Author)

A78-17948 # **The energy of near-surface internal waves in the Strait of Georgia.** G. Samuels and P. H. LeBlond (British Columbia, University, Vancouver, Canada). *Atmosphere,* vol. 15, no. 3, 1977, p. 151-159. 14 refs.

An estimate of the energy content of near-surface internal waves in the Strait of Georgia is obtained from a combination of aerial photographs and in-situ measurements. The role of these waves in the tidal energy budget and in the mixing processes in the Strait is discussed. (Author)

A78-17949 **Economic load distribution in the hybrid hydrothermal power system (Wirtschaftliche Lastverteilung im hydrothermischen Verbundsystem).** U. Langer. *Energiewirtschaftliche Tagesfragen,* vol. 27, Nov. 1977, p. 731, 732, 734. 10 refs. In German.

The Pontriagin maximum principle in a convenient form is used in the determination of the optimal operational conditions for a hybrid power system which consists of a thermal supplementary power station and five power stations based on a use of water power. Linear approaches or dynamic programming methods are usually employed for such operational optimization studies. The use of both conventional procedures has certain disadvantages related to excessive requirements with respect to computer storage and computer time. The described optimization procedure was implemented in FORTRAN. The computer times required for the two examples considered were 6 and 7.5 sec. The computer storage requirements for the new algorithm are significantly lower than those in the case of other optimization procedures. G.R.

A78-17950 **Energy-politics alternatives for the urban region of Munich until 1985 (Energiepolitische Alternativen für die Stadtregion München bis 1985).** F. Hanssmann and W. Fischer. *Energiewirtschaftliche Tagesfragen,* vol. 27, Nov. 1977, p. 738-743. 5 refs. In German.

The development of planning objectives related to the solution of energy problems involves usually a selection of compromises. There is generally no perfect strategy for obtaining simultaneously optimum values in relation to all objectives. The least expensive solution involves usually neither the cleanest nor the most reliable approach. Exacting quantitative models of the energy system are needed for the solution of the complex planning problems. A regional energy model for the urban region of Munich is employed for an analysis of alternatives in the area of energy system development, taking into account alternatives which can be implemented during the time period ending 1985. Attention is given to a basic strategy on a nonnuclear basis, nuclear power generation, power stations based on a use of coal, remote heating systems, and increase of the contribution of gas-using consumer technologies, electric storage heating, the further development of public transportation systems, and a fully electrified household. Alternative environmental constellations are considered along with direct model results, tradeoff analyses, and aspects of strategy selection. G.R.

A78-18022 **Advances in aircraft efficiency.** B. Walsh. *Aviation Engineering and Maintenance,* vol. 1, Oct. 1977, p. 48, 49.

The paper surveys NASA's Aircraft Energy Efficiency program. In particular, attention is given to its six major elements: (1) engine component improvement, aimed at a 5% reduction in annual fuel consumption, (2) the energy efficient engine program, (3) the development of advanced turboprop propulsion systems, (4) the creation of advanced aerodynamics and active control technology applicable to transport aircraft, (5) the development of alternative laminar flow designs, and (6) the study of potential composite primary structures for weight reduction and fuel economy. S.C.S.

A78-18023 **The design and performance of high temperature turbines in turbofan engines.** G. L. Wilde (Rolls-Royce Ltd., Derby, England). *(Gas Turbine Society of Japan, JSME, and ASME, Joint Gas Turbine Congress, Tokyo, Japan, May 22-27, 1977.) Aeronautical Journal,* vol. 81, Aug. 1977, p. 342-352.

The paper discusses a number of technical and design factors that influence the choice of turbine entry temperature in a future turbofan engine for efficient civil airliner operation. Attention is directed to the need to study turbo-machinery losses and how they may be reduced. It is concluded that turbine entry temperatures above 1600 K would probably not be advantageous. Experimental work involving turbine nozzle and blade cascade tunnel tests, model turbine rig tests, and full scale high-temperature experimental engine tests is reported. High turbine entry temperature effects are analyzed, and the RB 211 high-pressure turbine as well as high temperature turbine cooling development using the Adour engine high-pressure spool are described. The need for improvements in turbine design and materials is examined. M.L.

A78-18025 **Economic energy utilization by means of remote heating (Wirtschaftliche Energienutzung durch Fernwärme).** W. Burkhardt (München, Fachhochschule, Munich, West Germany). *HLH - Zeitschrift für Heizung, Lüftung, Klimatechnik, Haustechnik,* vol. 28, Oct. 1977, p. 353-358. 10 refs. In German.

A thermodynamic analysis of conversion of heat and electric energy generated at power plants is presented, and procedures for coupling power and heat output for purposes of remote heating are discussed. It is shown that remote heating is practical with a relatively low expenditure of primary power, although the efficiency depends strongly on the temperatures of the heated locations. Combinations of different heat delivery systems (steam, high-temperature hot water, low-temperature hot water) with different heat generation processes (steam generation, gas turbine) are examined. The organization of the heating system in the heated location and the use of electric current for heating are considered. M.L.

A78-18049 **Further Stirling engine development work. II (Weiterentwicklungen am Stirlingmotor. II).** F. Zacharias. *Motortechnische Zeitschrift,* vol. 38, Dec. 1977, p. 569-573. In German.

A description is presented of Stirling engine development work conducted in the Netherlands, the U.S., Sweden, Germany, and the UK. An engine type considered in the Netherlands was the first Stirling engine with a good efficiency, clean exhaust gases, low operational noise, and an absence of vibrational effects. Disadvantages are the great constructional complexity of the engine and certain internal sealing problems. An engine using a swash plate was developed for a use in passenger cars. The engine, which is intended for the U.S. market, provides a power of 170 PS and employs hydrogen as operational gas. An experimental model of the engine has been used in a passenger car since April 1976. The power is adjusted by changing the operational pressure level with the aid of a compressor device. An engine developed in Sweden has a power rating of 100 PS and uses as operational gas also hydrogen. Two engines developed in Germany employ helium as operational medium. A Stirling-engine thermomechanical generator (TMG) with a power of about 20 W, which was designed in the UK, is also described. The TMG is to provide maintenance-free long-term service in buoys. G.R.

A78-18050 **A study of the formation of unpumpable residues of crude oil on tankers for the purpose of preventing marine pollution.** S. M. Nunuparov. *Marine Technology Society Journal,* vol. 11, July-Aug. 1977, p. 9-17.

Based on mathematical treatment of experimental model data, methods are recommended for estimating the anticipated volumes of crude oil residues in tankers. Factors considered include the area of cargo tank metallic surfaces which come in contact with oil, the degree of roughness (i.e., the corrosion condition) of the tank surfaces, the properties of the oil, and the temperature during unloading. Graphs are presented of the specific adhesiveness of oils on the surfaces of cargo tanks, and the relationship between tanker size and tank surface areas is explored. Recommended procedures for optimizing tank washing are suggested, and the comparative energy expenditure for tank washing on a 50,000 deadweight steam-powered tanker is calculated. M.L.

A78-18089 **A computer model for large-scale offshore wind-power systems.** I. G. Dambolena (Bucknell University, Lewisburg, Pa.), R. F. Rikkers, and F. C. Kaminsky (Massachusetts, University, Amherst, Mass.). *Wind Engineering,* vol. 1, no. 3, 1977, p. 163-168. 6 refs.

A computer-based planning model has been developed to evaluate the cost and simulate the performance of offshore wind-power systems. In these systems, the electricity produced by wind generators either satisfies directly demand or produces hydrogen by water electrolysis. The hydrogen is stored and later used to produce electricity in fuel cells. Using as inputs basic characteristics of the system and historical or computer-generated time series for wind speed and electricity demand, the model simulates system performance over time. A history of the energy produced and the discounted annual cost of the system are used to evaluate alternatives. The output also contains information which is useful in pointing towards more favorable design alternatives. Use of the model to analyze a specific wind-power system for New England indicates that electric energy could perhaps be generated at a competitive cost. (Author)

A78-18090 **Betz type limitation of vortex wind machines.** J. L. Loth (West Virginia University, Morgantown, W. Va.). *Wind Engineering,* vol. 1, no. 3, 1977, p. 169-185. 13 refs. Contract No. E(40-1)-5135.

Various vortex wind machines, which use a vortex generator in the form of a low aspect ratio wing or vanes in a tower, are evaluated to determine theoretical power limitations. The maximum possible power output is represented by a Betz-type dimensionless power coefficient. S.C.S.

A78-18091 **Vortex augmentation of wind energy.** P. M. Sforza (New York, Polytechnic Institute, Farmingdale, N.Y.). *Wind Engineering,* vol. 1, no. 3, 1977, p. 186-197. 12 refs. NSF Grant No. AER-75-00850; Contract No. E(49-18)-2358.

Aerodynamic devices which can concentrate and augment natural winds are discussed. The keynotes element is the generation and control of discrete vortices of high power density by the appropriate interaction of suitably designed aerodynamic surfaces with natural winds of relatively low power density. Properly designed turbines are utilized to transform the energy in this compacted vortex field to useful shaft work. This idea is termed the Vortex Augmentor Concept (VAC). The basis for the concept is described and experimental studies of the vortex flow field are discussed. Turbine rotor requirements and advantages are outlined and a test facility for such rotors is illustrated. A prototype wind energy conversion system incorporating the VAC is described. The field test program for the prototype is discussed. (Author)

A78-18092 **Performance characteristics of concentrator-augmented Savonius wind rotors.** A. Sabzevari (Pahlavi University, Shiraz, Iran). *Wind Engineering,* vol. 1, no. 3, 1977, p. 198-206.

This paper describes the performance characteristics of seven S-rotor configurations tested in the wind tunnel to study the effect of wind concentrator, diffuser and ducting on the tip speed ratio and power output. The configurations tested included both continuous and split S sections. (Author)

A78-18093 **Design parameters affecting the performance of resistance-type, vertical-axis windrotors - An experimental investigation.** S. Sivasegaram (University of Sri Lanka, Peradeniya, Sri Lanka). *Wind Engineering,* vol. 1, no. 3, 1977, p. 207-217. 7 refs.

A78-18094 **Speed polar of a wind turbine powered cargo boat.** R. Flatt (Lausanne, Ecole Polytechnique Fédérale, Lausanne, Switzerland). *Wind Engineering,* vol. 1, no. 3, 1977, p. 218-230. 7 refs.

A calculation procedure is derived for the speed of a boat propelled by a wind turbine. The calculation, which does not consider Reynolds number effects, requires three dimensionless physical parameters and two interdependent variables. When applied to a 45,000 ton cargo boat, a nearly circular polar, having an average speed of about 4 m/s for an assumed true wind speed of 10 m/s, is obtained. S.C.S.

A78-18095 **The consequences and lessons of four years of high-priced energy (Conséquences et leçons de quatre années d'énergie chère).** F. Gihel. *Revue de l'Energie,* vol. 28, Nov. 1977, p. 513-518. In French.

Since the drastic restructuring of petroleum price levels in 1973, growth rates in the developed nations have approximated 1 percent, or about one-fourth their pre-1973 levels. This decline in industrial expansion may have serious effects on future growth, with especially severe results for third-world countries. Thus energy conservation programs, both national and international (e.g. within the contexts of the European Economic Community and the UN) need to be developed. Hampering coherent petroleum conservation programs and orderly pricing policy evolution are U.S. domestic fuel price supports, restrictive production policies in Venezuela, and uncertainties connected to the Alaskan oil field development. J.M.B.

A78-18096 **The world balance between energy needs and resources by the year 2000. II - Evolution and regional aspects of the problem (L'équilibre mondial entre besoins et ressources d'énergie à l'horizon 2000. II - Evolution et régionalisation du problème).** J.-R. Frisch (Electricité de France, Direction Générale, Paris, France). *Revue de l'Energie,* vol. 28, Nov. 1977, p. 533-550. 24 refs. In French.

Demographic trends, production of coal, petroleum, natural gas, hydroelectric and nuclear power for Western and Eastern Europe, the Soviet Union, North America, the third-world nations and mainland China are discussed for the period from the present to the year 2000. In general, it is found that the third-world nations and China will increasingly dominate energy production; since industrial development has in the past taken place in regions of intensive energy production, a consequent rapid rise in the development of the third-world is seen by the end of the century. A greater reliance on nuclear power in North America and Western Europe is also forecast. J.M.B.

A78-18097 * # **Finite-element solutions for geothermal systems.** J. C. Chen and J. E. Conel (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). *Journal of Energy,* vol. 1, Nov.-Dec. 1977, p. 364-369. 19 refs. Contract No. NAS7-100.

Vector potential and scalar potential are used to formulate the governing equations for a single-component and single-phase geothermal system. By assuming an initial temperature field, the fluid velocity can be determined which, in turn, is used to calculate the convective heat transfer. The energy equation is then solved by considering convected heat as a distributed source. Using the resulting temperature to compute new source terms, the final results are obtained by iterations of the procedure. Finite-element methods are proposed for modeling of realistic geothermal systems; the advantages of such methods are discussed. The developed methodology is then applied to a sample problem. Favorable agreement is obtained by comparisons with a previous study. (Author)

A78-18099 # **Selected wind tunnel test results for the Darrieus wind turbine.** B. F. Blackwell and R. E. Sheldahl (Sandia Laboratories, Albuquerque, N. Mex.). *Journal of Energy,* vol. 1, Nov.-Dec. 1977, p. 382-386. 13 refs. Research supported by the U.S. Department of Energy.

Five blade configurations of a 2-m-diam Darrieus wind turbine have been tested in a low-speed wind tunnel. Rotor solidity, Reynolds number, and free-stream velocities tested were in the following ranges: solidity, 13-30%; Reynolds number, 100,000-300,000; free-stream velocity, 7-11 m/s. The airfoil selection for all configurations was NACA 0012. The parameters measured were rotor torque, rotor rotational speed, and tunnel conditions. Data are presented in the form of power coefficient as a function of tip-speed ratio along with comparative results from an analytical model. (Author)

A78-18223 **Potential of wind as an energy source in Iran.** A. Sabzevari (Pahlavi University, Shiraz, Iran). *Iranian Journal of Science and Technology,* vol. 6, no. 2, 1977, p. 51-62. 25 refs.

Wind energy is a clean, abundant resource in Iran. It can be captured by large-group wind turbine generators to supplement the electricity provided by thermal power plants. It can also be captured by medium-scale local wind turbogenerators to supply the energy needs of so many thousands of scattered rural centers in the windy regions, in particular in the eastern provinces of the country. (Author)

A78-18325 # **Solar and wind power - Some meteorological aspects.** C. N. Duncan (Edinburgh, University, Edinburgh, Scotland). *Weather,* vol. 32, Dec. 1977, p. 451-456. 5 refs.

A study is made of the feasibility of using the sun for heating and the wind for electricity production. A discussion of converting wind power into electricity suggests that the major problem encountered is one of storage. It is also noted that less demanding uses of electrical energy (such as lighthouses, farm machinery, and automatic weather stations) constitute the most feasible applications of small-scale, wind-driven electricity generators. With regard to the production of heat from solar power it is shown that it is most efficient to operate solar heat collectors at temperatures close to air temperature, and that without the use of a concentrator, the highest possible temperature which may be achieved in the winter is only 40-50 C. Efficiency may be assumed to be 25% for electricity generated by wind power, and 50% for heating via water-filled solar heat collectors. S.C.S.

A78-18392 Computer simulation of the periodic electrostatic focusing converter. W. L. Barr, B. C. Howard, and R. W. Moir (California, University, Livermore, Calif.). *IEEE Transactions on Plasma Science,* vol. PS-5, Dec. 1977, p. 248-258. 21 refs.

The Dart computer code was used to compute the efficiency of energy recovery in the periodic electrostatic focusing direct energy converter. Several hundred ion trajectories were followed down the magnetic expander, through the diverter-separator, through the electrostatic electron repeller, down the channel where electrostatic focusing and self-consistent space-charge fields are calculated, to collection at some electrode. Losses due to space-charge effects, secondary electron effects, charge exchange and ionization, and several less important mechanisms were able to be calculated. Implications for reactor design are discussed. By using the computed efficiencies, cost estimates for a direct converter were obtained, and it turns out that the cost must still be reduced substantially for the converter to be economically competitive. P.T.H.

A78-18408 Techniques for the determination of ohmic drop in half-cells and full cells - A review. M. Hayes, A. T. Kuhn, and W. Patefield (Salford, University, Salford, Lancs., England). *Journal of Power Sources,* vol. 2, Dec. 1977, p. 121-136. 43 refs.

Different methods for the experimental determination of ohmic drop in batteries and half-cells are reviewed. The limitations in use of Luggin capillaries are defined. A novel method for elimination of ohmic error in high-resistance cells is described. This employs a programmable calculator or a minicomputer. By interpretation of the deviations from the log-rate law, values of internal resistance may be determined with some precision. A typical example is given and the results are compared with those obtained by classical oscillographic methods. (Author)

A78-18410 Current efficiency in the lithium-water battery. E. L. Littauer, W. R. Momyer, and K. C. Tsai (Lockheed Research Laboratories, Palo Alto, Calif.). *Journal of Power Sources,* vol. 2, Dec. 1977, p. 163-176. 5 refs.

Under well-controlled conditions, the exceptional energy of the Li-H2O reaction can be harnessed electrochemically with high Faradaic efficiency. The most important adjustable control parameters are electrolyte flow rate, electrolyte concentration, temperature and anode-cathode contact pressure. In single cell discharges, it is simple to control these factors. However, when dealing with multicell battery stacks in a bipolar configuration, good balance from cell to cell is more difficult to attain. This is then reflected by a reduction in efficiency of the Li dissolution reaction. This paper describes a technique to diagnose the efficiency of individual cells or cell stacks via comparison of polarization curves and information on the open circuit corrosion rate of Li in the electrolyte of interest. (Author)

A78-18412 An electrochemically regenerative hydrogen-chlorine energy storage system for electric utilities. E. Gileadi, S. Srinivasan, F. J. Salzano, C. Braun, A. Beaufrere (Brookhaven National Laboratory, Upton, N.Y.), L. J. Nuttall, A. B. Laconti (General Electric Co., Wilmington, Mass.), and S. Gottesfeld. *Journal of Power Sources,* vol. 2, Dec. 1977, p. 191-200. 11 refs. ERDA-supported research.

Electrolysis of HCl and storage of hydrogen and chlorine is proposed as a means for energy storage for the electric utility industry. An economic evaluation is presented which shows that the system has a clear advantage over the hydrogen-air storage system and is comparable in cost to gas turbines. The system is flexible, allowing both energy storage and hydrogen production for industrial purposes, and lends itself easily to scale-up. Assuming that the R & D goals of this new system are met, it will compete successfully with all other electric energy storage devices presently considered. (Author)

A78-18498 Improving sludge incineration and vacuum filtration with pulverized coal. S. W. Hathaway and R. A. Olexsey (U.S. Environmental Protection Agency, Municipal Environmental Research Laboratory, Cincinnati, Ohio). *Water Pollution Control Federation, Journal,* vol. 49, Dec. 1977, p. 2419-2430. 6 refs.

It was found that the addition of powdered coal to sludge leads to a significant increase in cake solids when the powdered coal is added before filtration. Calculated heat balances for the multiple hearth incinerator with 427 C (800 F) stack gas indicate a requirement of 25.9% cake solids content for the sludge tested to sustain autogenous combustion. Autogenous combustion could be achieved with a coal dosage of 0.11 kg coal/kg dry sludge solids. The significant increase in cake solids caused by coal addition and the slight increase in filter yield (on a sludge solids basis) demonstrate that the addition of coal to sludge before filtration would require less coal to achieve autogenous incineration than adding coal to the sludge cake after filtration. Dewatering is often a major cost of sludge incineration. Pulverized coal is considered to be a cheaper fuel for incineration than alternative (and, at times, less available) fuels, but the hazards associated with grinding coal are examined. M.L.

A78-18521 # The problem of photosynthetic hydrogen (Problema fotosinteticheskogo vodoroda). A. A. Krasnovskii (Akademiia Nauk SSSR, Institut Biokhimii, Moscow, USSR). *Akademiia Nauk SSSR, Izvestiia, Seriia Biologicheskaia,* Sept.-Oct. 1977, p. 650-662. 32 refs. In Russian.

The article reviews photosynthetic hydrogen evolution in Chlorella and in model systems. The role of the carbon cycle in Chlorella was studied, as was the ability of chloroplast suspensions to reduce viologen and evolve hydrogen. Reduced NAD illuminated at 365 nm was found to be capable of reducing viologen and ferrodoxin; in the presence of hydrogenase, hydrogen gas is evolved. This reaction is sensitized to visible light by porphyrins. Photoevolution of hydrogen gas occurs in solutions of solubilized chlorophyll, electron donor, and hydrogenase when illuminated by red light. The reaction efficiency is comparable to that of chloroplast suspensions, and methylviologen enhances hydrogen photoproduction. The ability of inorganic catalysts to reduce viologens and generate hydrogen when illuminated by ultraviolet was also investigated. M.L.

A78-18624 Exotic power and energy storage. M. O. Surface. *Power Engineering,* vol. 81, Dec. 1977, p. 36-44.

Consideration is given to a variety of near-term energy storage systems, including both conventional and underground hydro-pumped storage, compressed air storage for combustion turbines, thermal energy storage in central power plants, and the lead-acid battery. Potential intermediate-term systems, which may be developed during the 1985-2000 period, are identified, such as advanced batteries, flywheel storage, and hydrogen storage. The concept of direct electrical storage in superconducting magnets is suggested as a possible long-term storage system. It is noted that most alternative energy systems may be classified as either base-load power or variable systems. Attention is also given to base-load systems in conjunction with orbital power satellites, and to geothermal power plants, magnetohydrodynamics, and fuel cells. S.C.S.

A78-18644 Doped silver catalysts for H2/air fuel cells. K. Höhne (Siemens AG, Forschungslaboratorien, Erlangen, West Germany). *Siemens Forschungs- und Entwicklungsberichte,* vol. 6, no. 6, 1977, p. 350-354. 5 refs. Research supported by the Bundesministerium für Forschung und Technologie.

An investigation was conducted with the objective to improve a doped silver catalyst reported by Höhne (1974). The improvement is to make it possible to employ the catalyst for a use of air in H2/air fuel cells with an alkaline electrolyte. The considered catalyst is doped with small amounts of Bi, Ni, and Ti. The effect of the parameters of catalyst manufacturing conditions on the catalyst characteristics was studied. Attempts were made to improve the catalytic activity with mercury-containing additives. Electrodes were obtained with a composition of 76.6% catalyst material, 23% Teflon, and 0.4% asbestos. The electrodes were tested in fuel cells containing sedimented bonded Raney nickel electrodes as anodes. The carbon dioxide of the air used in the experiments was removed with the aid of soda lime. It was found that the Hg-additive improves the stability of the catalyst for long-term operations. G.R.

A78-18646 **Model considerations concerning the gas-electrolyte balance of supported gas-diffusion electrodes for fuel cells (Modellbetrachtungen zum Gas-Elektrolyt-Haushalt von gestützten Gasdiffusionselektroden für Brennstoffzellen).** H. Grüne (Siemens AG, Forschungslaboratorien, Erlangen, West Germany). *Siemens Forschungs- und Entwicklungsberichte,* vol. 6, no. 6, 1977, p. 364-370. In German. Research supported by the Bundesministerium für Forschung und Technologie.

A theoretical investigation is conducted regarding the effect of the electrode structure on the operational characteristics of fuel cells. The design of an ideal gas diffusion electrode for maximum performance involves a compromise between a large volume-related catalyst surface, short gas diffusion paths, and a small diaphragm resistance. In a hydrophilic electrode a lower limit exists for the radius of the gas pores under given operational conditions in connection with the capillary pressure of the electrolyte. The supported electrode considered by Vielstich (1965) and Sturm et al. (1966) has a usable pore structure which can be easily implemented. The differences between the ideal and the supported electrode are examined and a spheric model is discussed. The adaptation of the model concepts to the relations found in the case of an actual catalyst powder is considered, taking into account spherical and nonspherical catalyst particles. Attention is also given to the time required to reach equilibrium conditions. G.R.

A78-18669 **Current and future fuels for transport aircraft (Les carburants actuels et futurs des avions de transport).** J.-P. Troadec (Direction Générale de l'Aviation Civile, Paris, France). *France Transports - Aviation Civile,* Fall 1977, p. 46, 47. In French.

Some of the basic characteristics of liquid hydrogen and methane as aircraft fuels are compared with the characteristics of the current Jet A and synthetic Jet A fuels. Liquid hydrogen's advantages include an elevated ratio of calorific value to mass, its nonpolluting combustion, and the fact that it can be obtained nearly everywhere without large transportation costs. Its disadvantages include the storage problem, the safety question, and its cost. Liquid methane has smaller production cost and requires less energy for production than liquid hydrogen. P.T.H.

A78-18674 **Constraining the energy gobbler.** G. Kaplan. *IEEE Spectrum,* vol. 14, Dec. 1977, p. 26-32.

Techniques for recovering industrial waste heat are reviewed; precisely controlled combustion processors, the use of a single system to generate both electric power and process heat, surveillance of energy consumption in industrial plants, the improvement of motors and inductive heating equipment, and applications of the fuel-cell energy conversion process are considered. Precise, durable oxygen sensing devices to facilitate combustion control are described, and the costs of energy management schemes involving personal surveillance, minicomputers, or full-scale monitoring systems are compared. Series-parallel combinations of a large number of fuel cells are suggested as a nonpolluting on-site industrial power- and heat-generating option for the future. J.M.B.

A78-18681 # **Solar powered vapor-compressive refrigeration system using ejector as the thermal compressors.** L.-T. Chen (National Tsing Hua University, Hsinchu, Nationalist China). *National Science Council, Proceedings, Part 3 - Engineering and Applied Sciences,* May 1977, p. 115-132.

The paper describes the principle of a thermal compressor, which is basically an ejector which utilizes the momentum of a high-velocity jet of vapor to entrain and accelerate a slower moving medium, and thereby achieve self-compression of the medium. Expressions describing the performance of thermal compressors are given. A solar refrigeration system using a thermal compressor is proposed, and its cycle is analyzed. P.T.H.

A78-18702 # **Review of the development of small- and medium-capacity gas turbines at the Motoren- und Turbinen Union (Übersicht über die Entwicklung von Gasturbinen kleiner und mittlerer Leistung in der MTU).** W. Heilmann (Motoren- und Turbinen-Union München GmbH, Munich, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Kleingasturbinen, Stuttgart, West Germany, Oct. 11, 12, 1977, Paper 77-061.* 30 p. 9 refs. In German.

Small- and medium-capacity gas turbines under development for turboprop aircraft and helicopters, as well as for armored and commercial vehicle propulsion, are discussed. Design problems related to axial turbines, ceramic components, regenerative gas turbines, and the optimal expansion ratios for turbines with capacities from 250 to greater than 800 kW are considered; in addition, combustion chamber technology is mentioned. Prototype gas turbines with capacities of 500 to 600 kW or 800 to 1800 kW are described. J.M.B.

A78-18708 # **High-temperature ceramics for automobile gas turbines (Hochtemperaturkeramik für Automobilgasturbinen).** P. Walzer (Volkswagenwerk AG, Wolfsburg, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Kleingasturbinen, Stuttgart, West Germany, Oct. 11, 12, 1977, Paper 77-073.* 18 p. In German.

A number of advantages could be obtained by using in automobiles gas turbines with an inlet temperature of 1600 K. These advantages are mainly related to lower fuel consumption and decreased pollutant emission. The employment of the high operational temperatures makes it necessary to use for the construction of the turbines ceramic materials, such as silicon nitride or silicon carbide. Investigations concerning the development of turbine components made of such materials are conducted by a German automobile manufacturer and the ceramics industry. The current status of these investigations is reviewed. Flame tubes and guide-vane rings have successfully passed tests lasting 20 hours. Prototype turbine wheels have withstood the effects of peripheral speeds of 450 m/s. They showed also resistance to thermal shocks which were as high as 600 K/s. G.R.

A78-18711 # **Recent developments in heat exchangers for vehicle gas turbines (Neuere Entwicklungen an Wärmetauschern für Fahrzeuggasturbinen).** J. Heuer and K. Wiegard (Daimler-Benz AG, Stuttgart, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Kleingasturbinen, Stuttgart, West Germany, Oct. 11, 12, 1977, Paper 77-075.* 25 p. In German.

Theoretical and experimental results on rotating regenerative heat exchangers are reported. Recent improvements in the matrix are described, and temperature measurements useful for improving seal design are considered. The requirements of a ceramic plate-fin recuperative heat exchanger are examined with respect to volume, matrix wall strength, and thermal conductivity of construction material. M.L.

A78-18713 # **The gas turbine as an advantageous propulsion unit for high-performance rail traffic (Die Gasturbine als vorteilhafter Antrieb im Schienenhochleistungsverkehr).** H. Luz (Stuttgart, Universität, Stuttgart, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Kleingasturbinen, Stuttgart, West Germany, Oct. 11, 12, 1977, Paper.* 21 p. In German.

Operational experience obtained with three German self-propelled railroad cars and also an operation with similar cars in France and the U.S. have demonstrated that it is basically feasible to use gas turbines for the propulsion of vehicles on rails. In the case of the German vehicles, use was made of modified helicopter engines. There are some basic differences concerning the operational requirements for gas turbines used for railroad traction applications and for applications related to aviation or electric power generation. These differences are mainly related to a greater exposure of the railroad-traction turbines to vibrational stresses and temperature fluctuations. The requirements for trains traveling at speeds up to 300 km/h are examined, taking into account the installation of gas turbines into locomotives, aspects of gas turbine operation, and questions of operational economy. Attention is given to the use of hybrid vehicles which can be used on electrified and on nonelectrified sections of the railroad network, the utilization of engine waste heat for heating applications, and the calculation of the operational characteristics of a gas turbine for railroad-traction applications. G.R.

A78-18750 * # **Solar power satellite status report.** H. P. Davis (NASA, Johnson Space Center, Houston, Tex.). *Texas Solar Energy Society, Conference on Solar Energy in the Southwest '77, Dallas, Tex., Aug. 27, 28, 1977, Paper.* 17 p.

The development of a solar power satellite program is considered. It is suggested that the solar power satellite is an engineering rather than a science program - that is, that no scientific breakthroughs are required before initiating the project. Available technology is examined, and several key questions are discussed: how efficient is microwave transfer of energy; how feasible is construction in space; and will the advantages of continuous insolation compensate for the costs of building a solar power plant in synchronous orbit 23,000 miles above the earth. M.L.

A78-18775 # **Coal gasification and water resources development.** E. E. Whitlatch, Jr. (Ohio State University, Columbus, Ohio). *American Society of Civil Engineers, Water Resources Planning and Management Division, Journal,* vol. 103, Nov. 1977, p. 299-314. 25 refs. Research supported by the U.S. Department of the Interior.

Since water resources development will be needed in almost all of the potential coal producing regions to support coal gasification plants, models are presented to aid in the coordinated development of a coal conversion industry and regional water resources. The models can be used to help determine the true economic value of water when used by the energy industry, and the cost of interbasin transfers of water can be compared to the calculated water value to estimate the worth of such transfers. The models can also be used to study the inherent tradeoffs and effect upon water resources of the development alternatives of a diffuse set of small low-Btu coal gasification plants versus a few large centralized high-Btu plants. The models also indicate the sensitivity of coal gasification plant locations to changes in unit cost of materials or processes essential to plant functioning. Thus, it is intended that the models will help determine the economically most advantageous sites for coal gasification plants. M.L.

A78-18784 * **Thermal alteration experiments on organic matter in recent marine sediments as a model for petroleum genesis.** M. J. Baedecker, R. Ikan, R. Ishiwatari, and I. R. Kaplan (California, University, Los Angeles, Calif.). In: Chemistry of marine sediments. Ann Arbor, Mich., Ann Arbor Science Publishers, Inc., 1977, p. 55-72. 39 refs. Grant No. NGR-05-007-221.

The fate of naturally occurring lipids and pigments in a marine sediment exposed to elevated temperatures was studied. Samples of a young marine sediment from Tanner Basin, California, were heated to a series of temperatures (65-200 C) for varying periods of time (7-64 days). The sediment was analyzed prior to and after heating for pigments, isoprenoid compounds, alcohols, fatty acids, and hydrocarbons. Structural changes caused by heating unextractable organic material (kerogen) were also studied, and the significance of the results for understanding petroleum genesis is considered. Among other results, fatty acids and hydrocarbons increased in abundance although there appeared to be no obvious precursor-to-product relationship via simple decarboxylation reactions. Chlorins were partially converted into porphyrins. The phytyl side chain of pheophytin was initially preserved intact by reduction of the phytyl double bond, but later converted to a variety of isoprenoid compounds including alkanes. Thermal grafting of components onto kerogen occurred as well as structural changes caused by heat. M.L.

A78-18785 **All-glass collectors in solar energy utilization.** C. Deminet and W. D. Beverly (Boeing Co., Seattle, Wash.). *American Ceramic Society Bulletin,* vol. 56, Dec. 1977, p. 1058, 1059, 1067. 9 refs. NSF Grant No. AER-74-09139.

An all-glass flat plate solar collector concept has been developed. It consists of a glass panel structure containing vacuum cells and liquid passageways and is manufactured by a continuous glass-forming process. Solar energy is directly absorbed, depending on the collector's applications, in a variety of working fluids. (Author)

A78-18816 **Ground as a heat source (Erdreich als Wärmequelle).** J. Neiss and E. R. F. Winter (München, Technische Universität, Munich, West Germany). *Electrowärme International, Edition A - Elektrowärme im Technischen Ausbau,* vol. 35, Nov. 1977, p. A323-A327. 7 refs. In German.

The ground represents a suitable heat source for heat pump installations if acceptable quantities of ground material can provide the heat required for the heating of a dwelling house. It is assumed that there will not be an excessive decrease in the evaporator temperature, because such a decrease would lead to an intolerable decrease in heat pump efficiency. The operational parameters of the considered heat pump system, including the time-dependent temperatures of the ground and the circulating brine heat-transfer medium, can be calculated with the aid of an electronic computer. The conduction of such calculations requires a knowledge of the thermophysical properties of the ground. These properties are density, heat capacity, and heat conductance of the humid porous ground. The determination of the heat conductance of the ground is considered along with the calculation of the ground temperature relations and the computation of the brine temperature. The results of the simulation of heat pump operation with the aid of an electronic computer are discussed, taking into account operational conditions involving different types of soil, the utilization of ground layers at different depths, and temporal variations. G.R.

A78-18819 **Estimates of smoke and sulphur dioxide pollution from fuel combustion in the United Kingdom for 1975 and 1976.** M.-L. Weatherley (Warren Spring Laboratory, Stevenage, Herts., England). *Clean Air* (UK), vol. 7, Winter 1977, p. 4-8.

The main sources of SO2 pollution in the U.K. during the years 1975-76 are listed: domestic (home heating), railways, and industry. A breakdown of net SO2 emission weight is given in terms of fuel source used, and height of the emission above ground. An appendix is presented, listing different sources of fuel consumption and the type of fuel (coal, gas oil, fuel oil, solid smokeless fuels, diesel fuel, and petroleum) usually used by each source. The actual sulfur content of the fuels is discussed; and results of a survey showing concentrations of airborne pollutants (SO2, CO, NOx) at various sites in London are given. D.M.W.

A78-18826 **International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volumes 1 & 2 (Journées Internationales d'Etude sur l'Hydrogène et ses Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volumes 1 & 2).** Workshop sponsored by the Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. Vol. 1, 653 p.; vol. 2, 237 p. In French, English, and German. Price of two volumes, $60.

Coal gasification, partial oxidation, catalytic cracking, electrolysis and thermochemical cycle techniques for obtaining hydrogen fuels are reviewed, and the use of hydrogen for aircraft fuel, automobile propulsion systems and peak-load electrical generation is discussed. Topics of the papers include fixed bed, fluidized bed and entrained phase coal gasification procedures, materials problems in advanced electrolysis systems, solid polymer electrolyte water electrolysis cells, computer codes for analyzing the feasibility of thermochemical cycles that produce hydrogen, the use of photosynthetic processes for hydrogen generation, hydrogen fuel transport and storage systems (including those that use metal hydrides), a NASA study of the feasibility of adopting liquid hydrogen aircraft fuel, hydrogen as used in chemical processing, and the toxicological effects of hydrogen. J.M.B.

A78-18827 # **Inventory of world energy resources (Inventaire des ressources énergétiques mondiales).** M. Van Rysselberge. In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 23 p. 8 refs. In French.

Worldwide inventories of crude oil, shale oil, natural gas, coal, and nuclear fuels published in the early and mid 1970s are reviewed. These data indicate a rapidly worsening fuel situation for Western Europe and Japan. In addition, alternative energy resources, including liquid hydrocarbons, (produced by the Fischer-Tropsch process), solar energy, hydroelectric power, geothermal energy, fast breeder reactors, and nuclear fusion techniques, are considered. The use of hydrogen as a fuel is also mentioned. J.M.B.

A78-18828 # **Methods for the production of hydrogen from natural gas and petroleum fractions (Verfahren zur Herstellung von Wasserstoff aus Erdgas und Erdölfraktionen).** H. Juntgen (Bergbau-Forschung GmbH, Essen, West Germany). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 21 p. 10 refs. In German.

Partial oxidation of heavy petroleum distillates and catalytic cracking of methane and light hydrocarbons, two techniques of obtaining hydrogen for industrial processes, are contrasted in terms of economics and technological difficulties. Problems such as desulfurization, the high cost of the partial oxidation installations, as well as the formation of soot in both the catalytic cracking and the partial oxidation processes, are considered. The relative costs of methane and naptha cracking with conventional techniques and with high-temperature nuclear reactor techniques are also assessed. J.M.B.

A78-18829 # **Hydrogen production from coal gasification.** H. Teggers, H. Huettner, and L. Schrader (Rheinische Braunkohlenwerke AG, Cologne, West Germany). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 35 p. 15 refs.

Fixed bed, fluidized bed and entrained phase techniques for hydrogen production from coal gasification are considered. Process heat may be supplied by the addition of oxygen, solid, liquid or gaseous heat carriers or indirectly through heat-transferring walls. In particular, attention is given to the selection of the Lurgi pressure process, the Winkler process or the Koppers-Totzek process for treating various types of coal. In addition, helium-heated methane steam reforming processes are described; the use of high-temperature nuclear reactors for process heat, which may result in feed coal savings of about 50 percent, is also mentioned. J.M.B.

A78-18830 # **Electrolytic production of hydrogen.** A. B. Hart (Central Electricity Generating Board, Research Laboratories, Leatherhead, Surrey, England). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 18 p. 30 refs.

It is suggested that electrolytic production of hydrogen through use of off-peak nuclear generator capacity could provide a commercially attractive means of producing industrial fuel for the United Kingdom by the end of the century. Essential thermodynamic properties relevant to the electrolysis of water to produce hydrogen are reviewed, and studies of electrical efficiency losses incurred in electrolytic processes are taken into account. Particular attention is given to advanced techniques involving the use of alkaline electrolytes with asbestos separators; the possibility of employing a solid polymer ion exchange membrane or solid zirconia at 1273 K as the electrolyte is also discussed. J.M.B.

A78-18831 # **Possibilities for improving the electrolysis of water in alkaline solutions (Possibilités d'amélioration de l'électrolyse de l'eau en solution alcaline).** J. C. Sohm (Grenoble, Université, Grenoble, France) and R. Graziotti (Electricité de France, Paris, France). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 29 p. 17 refs. In French.

Current density, temperature and pressure are studied as critical parameters for the electrolysis of water in alkaline solutions to produce hydrogen fuel. In addition, the use of nickel-based alloy electrodes as catalytic activators is mentioned. The adoption of high-temperature and high-pressure electrolytic processes has resulted in problems connected with the durability of diaphragms and other components of the electrolytic systems; the durability of metals and plastics (such as polysulfone) in alkaline solutions is therefore analyzed. Emphasis is placed on currently available commercial apparatus for the electrolytic processes. J.M.B.

A78-18832 # **Solid electrolyte and elevated temperature water electrolysis.** S. Srinivasan and F. J. Salzano (Brookhaven National Laboratory, Upton, N.Y.). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 24 p. 18 refs. ERDA-sponsored research.

Solid polymer electrolyte water electrolysis cells, a highly efficient and low-cost solution to hydrogen fuel production, are described. Maximization of the surface area of the electrocatalysts (by impregnation of the catalyst particles on solid polymers) and minimization of electrode spacing permit operation of the cell at high current densities and high energy efficiencies. Plans for a 0.5 Mw demonstration cell that will have a current density of one amp per sq cm with a voltage input of 1.58 volts are reported. Solid oxide (e.g., yttria-stabilized zirconia) electrolyte water electrolysis cells capable of electrolyzing water at temperatures above 1000 C, though further off in terms of development, may eventually provide even more efficient means of hydrogen production. J.M.B.

A78-18833 # **Thermodynamics of thermochemical cycles in the decomposition of water (Thermodynamique des cycles thermichimiques de décomposition de l'eau).** B. Esteve and J. P. Ribcats (Gaz de France, Paris, France). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 24 p. 11 refs. In French.

The irreversibilities in thermochemical processes for the decomposition of water are analyzed; such irreversibilities include those of thermal origin (arising during heat transfer), of chemical origin (arising during reactions), and of mechanical origin (arising during the transfer or treatment of compounds). Calculations for the maximum output of thermochemical cycles are discussed, and the efficiency of thermochemical decomposition of water is compared with that of conventional electrolysis techniques. Automatic methods used in searching for viable water-splitting thermochemical cycles are also mentioned. J.M.B.

A78-18834 # **Thermochemical hydrogen production - Engineering efficiency and economics.** J. E. Funk (Kentucky, University, Lexington, Ky.) and K. F. Knoche. In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 25 p. 18 refs.

This paper presents a discussion of efficiency and costs for thermochemical hydrogen production processes. The effect of maximum process temperature on efficiency for four sulfur cycles is shown. The most recent results on the hybrid sulfuric acid process are included along with a comprehensive flow sheet for this process. The results of an exergy analysis, which clearly shows where the irreversibilities occur in the plant and how they influence the nuclear reactor power rating, is also presented. Finally, the effect of overall process thermal efficiency and chemical plant investment cost on hydrogen production cost is developed. (Author)

A78-18835 # **Design and evaluation of thermochemical cycles - The work performed at J.R.C. Ispra establishment.** G. De Beni (EURATOM and Comitato Nazionale per l'Energia Nucleare, Centro Comune di Ricerche, Ispra, Italy). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 19 p. 12 refs.

Attention is given to such proposed water-splitting thermochemical cycles as the hydrolysis of calcium bromide, iron-chlorine cycles, and hybrid cycles involving sulfuric acid decomposition. Computer codes written for the evaluation of the thermal efficiency and the heat coupling of chemical plants with heat sources are reviewed, with emphasis on their utility as thermochemical cycle design aids. Other considerations relevant to the design of cycles include the cost of separating materials, problems in the fluidification of solids, and thermodynamic limits related to the number of reactions in pure and hybrid cycles. A sulfur dioxide-iodine cycle which uses excess liquid sulfur dioxide as a means for separating hydriodic and sulfuric acid is held to be very promising. J.M.B.

A78-18837 # **The hydrogen pipeline network in the Rhine-Ruhr area.** Ch. Isting (Chemische Werke Hüls AG, Marl, West Germany). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 22 p. 5 refs.

A hydrogen distribution system which includes 875 km of pipeline between 25 chemical and petrochemical plants in the Rhine-Ruhr area is described. The hydrogen is produced by partial oxidation, electrolysis of water, catalytic cracking of methane, or coal gasification; it is used to manufacture such products as ammonia, fuel gas, and methanol. Venting techniques to prevent explosions, leakage testing, insulation for the pipelines, the automatic line rupture shutoff valves, hydrogen diffusion into the grain boundaries of the pipe materials, government regulation of the distribution network, and the central control facility of the pipeline network are considered. J.M.B.

A78-18838 # **Storage and distribution of large quantities of hydrogen (Stockage et transport de grandes quantités d'hydrogène).** G. Donat (Electricité de France, Paris, France) and J. Colonna (Gaz de France, Paris, France). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 19 p. In French.

Storage of hydrogen gas in abandoned mines and in porous or permeable caverns (including anticlines with underground aquifers) is discussed; in general, techniques applied to the storage and transport of natural gas may also be adapted to hydrogen. In addition, attention is given to the storage of liquid hydrogen, which may allow for maintenance in spherical reservoirs of the equivalent of 10 million normal cu m of gas with daily evaporation losses of less than 0.05 percent. A comparative analysis of the costs of transporting hydrogen and natural gas through pipelines is presented. J.M.B.

A78-18839 # **Materials problems in hydrogen energy systems.** B. C. Syrett, R. L. Jones, and N. H. G. Daniels (Stanford Research Institute, Menlo Park, Calif.). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 12 p.

Research in support of a large-scale hydrogen fuel production system projected for implementation in the U.S. by 2020 is described. Improvements in corrosion-resistant materials for anodes, the development of separator materials with high conductivity and good performance to about 200 C, and the development of inexpensive polymers for cell frames are discussed. In addition, the need for gas diffusion electrode structures with high effective electrode areas, as well as active, nonnoble electrocatalysts for both the anode and cathode, is mentioned. For solid polymer electrolyzers, inexpensive ion-conducting membranes with high ionic conductivity and temperature resistance are required. J.M.B.

A78-18840 # **The manufacture of synthetic natural gas by hydrogenation of fossil fuel residuals (Fabrication de gaz naturel synthétique par hydrogénation de combustibles fossiles residuels).** J. Ribesse. In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 19 p. 5 refs. In French.

The hydrogenation of fossil fuel residuals is discussed, with emphasis on the high-pressure, in situ gasification of coal. High-pressure gasification has the advantages of accelerating reaction times and rendering even very deep deposits accessible to exploitation. Composition of the gaseous product and required energy consumption are compared for gasification processes which employ air and water, oxygen and water, or hydrogen as the gasifying agent. Attention is also given to surface installations for desulfurizing and further refining. J.M.B.

A78-18841 # **Hydrogen fuel cells and hydrogen engines (Les piles et les moteurs à hydrogene).** Y. Breele (Institut Francais du Pétrole, Rueil-Malmaison, Hauts-de-Seine, France). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 19 p. In French.

The use of hydrogen-air fuel cells for vehicle traction is discussed. Three types of hydrogen-air fuel cells are currently under development: a high-temperature solid electrolyte cell; a low-temperature acid electrolyte cell; and a low-temperature basic electrolyte cell. Problems related to the weight of the batteries, the necessity of purifying the air used in some cells, and the fragility of the nickel-base anode catalyzers in the fuel cells may be outweighed by the absence of noise and polluting emissions which would characterize vehicles powered by hydrogen-air batteries. J.M.B.

A78-18842 # **Technical and economic aspects of hydrogen storage in metal hydrides (Technische und wirtschaftliche Aspekte der Wasserstoffspeicherung in Metallhydriden).** R. Schmitt (Battelle, Geneva, Switzerland). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 49 p. 33 refs. In German.

The recovery of hydrogen from such metal hydrides as LiH, MgH_2, TiH_2, CaH_2, and Fe-Ti-H compounds is studied, with the aim of evaluating the viability of the technique for the storage of hydrogen fuel. The pressure-temperature dependence of the reactions, enthalpies of formation, the kinetics of the hydrogen absorption and desorption, and the mechanical and chemical stability of the metal hydrides are taken into account in the evaluation. Economic aspects of the study include the cost of the metals, the possibility of reusing the metals, the expense involved in constructing storage facilities, and the energy costs associated with the absorption and desorption reactions. Development of portable metal hydride hydrogen storage reservoirs is also mentioned. J.M.B.

A78-18843 * # Hydrogen fueled subsonic aircraft - A prospective. R. D. Witcofski (NASA, Langley Research Center, Hampton, Va.). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 31 p. 12 refs.

The performance characteristics of hydrogen-fueled subsonic transport aircraft are compared with those of aircraft using conventional aviation kerosene. Results of the Cryogenically Fueled Aircraft Technology Program sponsored by NASA indicate that liquid hydrogen may be particularly efficient for subsonic transport craft when ranges of 4000 km or more are involved; however, development of advanced cryogenic tanks for liquid hydrogen fuel is required. The NASA-sponsored program also found no major technical obstacles for international airports converting the liquid hydrogen fueling systems. Resource utilization efficiency and fuel production costs for hydrogen produced by coal gasification or for liquid methane or synthetic aviation kerosene are also assessed. J.M.B.

A78-18844 # Hydrogen cryogenic storage - Liquid for automotive applications and cryoadsorbents for pipeline distribution systems. W. Peschka and C. Carpetis (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Cologne, West Germany). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 21 p.

The design of a compact cryogenic tank for storing the liquid hydrogen used in an automobile engine is described, and a cryogenic storage system which would employ adsorbent materials at liquid nitrogen temperatures and moderate pressures is proposed. The design of the cryogenic tank would include a metal hydride to achieve a loss-free storage period of eight to ten days; a prototype tank with a complete pressure and valve control system has been tested. Low-pressure cryogenic storage facilities making use of such adsorbents as activated charcoal or nickel-silicate compounds are also mentioned. If regenerative heat recovery is introduced into the system, the cryoadsorbents may offer a more efficient means of storage than conventional liquid hydrogen tanks. J.M.B.

A78-18845 # The storage of hydrogen in the form of metal hydrides - An application to thermal engines (Stockage de l'hydrogène sous forme d'hydrures métalliques - Application à des moteurs thermiques). C. Gales and P. Perroud (Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires de Grenoble, Grenoble, France). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 34 p. 20 refs. In French.

The possibility of using $LaNi_5H_6$, $FeTiH_2$, or MgH_2 as metal hydride storage systems for hydrogen-fueled automobile engines is discussed. A study of magnesium-copper and magnesium-nickel hydrides indicates that they provide more stable storage systems than pure magnesium hydrides. Several test engines employing hydrogen fuel have been developed: a single-cylinder motor originally designed for use with air-gasoline mixtures; a four-cylinder engine modified to run on an air-hydrogen mixture; and a gas turbine. J.M.B.

A78-18846 # Future peak-power plants based on hydrogen-oxygen rocket steam generators (Wasserstoff-Sauerstoff-Raketendampferzeuger für zukünftige Spitzenlastkraftwerke). J. Nitsch, R. Reinkenhof, and H. Sternfeld (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Cologne, West Germany). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 30 p. 13 refs. In German.

It is proposed that future peak-power demands may be met by an electrical generating system which uses excess power for the electrolysis of water during low demand periods, and relies on hydrogen-oxygen rocket steam generators for the peak-power loads. Rocket steam generators, which mix water vapor into the combusting gases to produce steam for turbines, are described; attention is given to the influence of water droplet size and flow path on steam generating capacity. Although hydrogen-oxygen peak power electrical generation may not be economically feasible at present, increased fossil fuel costs and advances in electrolysis techniques may make the argument for the concept stronger in the future. J.M.B.

A78-18847 # Technical concepts and economic prospects for thermal hydrogen power plants for peak load generation (Technische Konzepte und wirtschaftliche Aussichten von thermischen Wasserstoff-Kraftwerken für Spitzenstromerzeugung). W. Tanner (Dornier System GmbH, Friedrichshafen, West Germany). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 1. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 28 p. In German.

Attention is given to hydrogen-oxygen steam generators and closed gas turbine processes with internal hydrogen-oxygen combustion, two techniques applicable to peak-load electrical generation. Costs of the electrolysis, the hydrogen and oxygen storage facilities, and the steam generators or gas turbine adaptations needed for the nitrogen-oxygen power plants are analyzed. In addition, advantages of the hydrogen-oxygen power plants, including the absence of polluting emissions and the low cost of raw materials for fuel are mentioned. J.M.B.

A78-18848 # Outline for a hydrogen economy in 1985-2000 (Scénarios pour une économie de l'hydrogène en 1985-2000). P. Valette, L. Valette, M. Siebker, and J. Leclercq (S.C.I.E.N.C.E., Brussels, Belgium). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 2. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 20 p. In French.

Three methods for predicting the market share of hydrogen-produced energy in the 1985-2000 period are described. The classical method extrapolates trends, the Delphi method is based on a consensus of predictions by experts and the semi-quantitative and quantitative methods seek to isolate factors and assess their significance. The results of the three methods are compared and discussed. M.L.

A78-18849 # Chemistry of thermochemical cycles from United States hydrogen programme - Thermochemical hydrogen production: Chemistry and thermochemical efficiency. M. Bowman (California, University, Los Alamos, N. Mex.). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 2. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 23 p. 31 refs.

The paper summarizes institutional research programs on hydrogen production by thermochemical methods. Experimental data on the thermochemical cycles are provided, and the advantages and disadvantages of the cycles are discussed. Problems such as manipulations involving solids, the drying of large volumes of solutions, and heat transfers from a heat exchanger surface to a solid are considered. It is suggested that the absence of experimental testing of some proposed cycles invalidates estimates of their process efficiency. M.L.

A78-18850 # **Comparison of the costs of producing hydrogen by electrolysis and by nuclear-based thermochemistry (Comparaison des coûts de production de l'hydrogène par électrolyse et thermochimie sur base nucléaire).** C. Derive (Electricité de France, Paris, France) and B. Esteve (Gaz de France, Paris, France). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 2. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 32 p. 18 refs. In French.

Procedures for manufacturing hydrogen are reviewed with attention to costs and state of technological development. It is concluded that, at present, the most economical way to produce hydrogen is to establish large-scale facilities for processing hydrocarbons (natural gas). Eventually, the off-peak production of electric energy at nuclear plants might make electrolysis a competitive method. Factors which will determine if thermochemical means will ultimately become more economical than electrolysis are considered. Requirements for the development of large hydrogen-producing facilities are examined. M.L.

A78-18852 # **Uses of nuclear heat at high temperatures for energy conversion processes.** H. Barnert (Kernforschungsanlage Jülich GmbH, Institut für Reaktorentwicklung, Jülich, West Germany). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 2. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 23 p. 25 refs.

Four conversion processes for high temperature heat production are discussed. The combined production of electricity and process steam or district heat is considered economically competitive for relatively short distances of transportation and at high consumption densities. For 'nuclear long distance energy', nuclear energy is converted into an energy form which can be transported economically in comparison with hot water. Nuclear coal gasification will, possibly, lower coal consumption, reduce CO_2 emissions, eliminate SO_2 and NOx emissions, and increase overall efficiency. Nuclear hydrogen production by water splitting through the sulfuric acid hybrid cycle is considered. M.L.

A78-18853 # **Profitability of a hydrogen network in a chemical complex (Rentabilité d'un réseau d'hydrogène dans un complexe chimique).** J. R. Costes (Rhône Poulenc, Paris, France). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 2. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 12 p. In French.

The various kinds of industrial producers and industrial consumers of hydrogen gas are considered with attention to the purity of the gas consumer or producer. Three network systems connecting producers and consumers are proposed; the different networks would carry 'rich gas', very pure hydrogen, or combustion gas, and would connect consumers only to those industries which produce the desired grade of gas. These network systems might provide hydrogen at a cost competitive with that provided by commercial hydrogen sources. M.L.

A78-18854 # **Aspects relative to security and environment in the production and use of hydrogen in the new Esso refinery at Antwerp (Aspects relatifs à la sécurité et l'environnement dans la production et l'utilisation d'hydrogène au sein de la nouvelle raffinerie Esso à Anvers).** A. Theyskens (Esso Belgium, Antwerp, Belgium). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 2. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 30 p. In French.

A78-18855 # **Toxicological aspects of the use of hydrogen in the future as main energy source.** A. Heyndrickx and M. Martens (Gent, Rijksuniversiteit, Ghent, Belgium). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 2. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 6 p.

Toxicological hazards associated with the use of hydrogen as fuel are considered with attention to metal hydrides. The hydrides are converted by water into hydroxides which, as caustic agents, affect skin, eyes, and respiratory membranes. Boron hydrides, such as diborane, cause damage to the lungs, central nervous system, liver, and kidneys. Volatile hydrides form explosive mixtures with air and nonvolatile hydrides can form potentially explosive dust clouds. On the other hand, hydrogen combustion does not produce the pollutants associated with hydrocarbon combustion (although NOx can be formed during hydrogen combustion in certain circumstances). The effects of the release of huge amounts of water vapor if hydrogen combustion becomes widespread should be considered. M.L.

A78-18856 # **Safety in hydrogen transport and storage installations (La sécurité dans les installations de transport et de stockage d'hydrogène).** C. Nezer (Association Vinçotte, Brussels, Belgium). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 2. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 23 p. 15 refs. In French.

Properties of hydrogen gas and liquid are described, and safety procedures for handling hydrogen are discussed. Points considered include materials suitable for hydrogen containers, safety distances for hydrogen containers, safety valves, the flaming of discharged hydrogen, walls and run-off ditches, and the siting of large installations. Procedures for avoiding the formation and ignition of hydrogen-air mixtures are examined; these procedures can involve purging equipment, avoiding and detecting contamination, and avoiding electric sparks. The storage of hydrogen gas in subterranean caves is considered. M.L.

A78-18857 # **Safety aspects of a widespread hydrogen energy economy.** R. Schmucker (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für chemische Raketenantriebe, Lampoldshausen, West Germany). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 2. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 30 p. 39 refs.

Profitability constraints on safety considerations in a widespread hydrogen energy economy are discussed. Hydrogen uses and possible human contact are examined with attention to the ignition and combustion characteristics of hydrogen. Three approaches to safety are urged - education, improvement of safety procedures, and passive means. For example, people should learn about the flammability of hydrogen, the need for ventilation and catalytic burning of leaked hydrogen, and the necessity of avoiding hydrogen storage areas. Technological improvements would involve hydrogen and hydrogen flame detectors for household use, methods of removing large amounts of uncombusted hydrogen in densely populated areas, and methods of gas/particle addition and extraction. M.L.

A78-18858 # **Safety problems in the use of liquid hydrogen (Problèmes de sécurités liés à l'utilisation de l'hydrogène liquide).** A. Faure (L'Air Liquide, Paris, France). In: International Workshop on Hydrogen and its Perspectives, Liège, Belgium, November 15-18, 1976, Proceedings. Volume 2. Liège, Association des Ingenieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, 1977. 24 p. 14 refs. In French.

Cryogenic and combustion hazards associated with the use of liquid hydrogen are examined. Cryogenic hazards include contamination by condensed air, excessive pressures, damage to exposed materials, and human tissue destruction. Procedures are considered for avoiding the formation of flammable mixtures in liquid hydrogen containers or in the atmosphere, and for avoiding ignition sources. Safety features for storage sites and methods of fighting hydrogen fires are discussed. M.L.

A78-18908 **Numerical methods for studying compressed magnetic field generators.** J. R. Freeman and S. L. Thompson (Sandia Laboratories, Albuquerque, N. Mex.). *Journal of Computational Physics,* vol. 25, Dec. 1977, p. 332-352. 22 refs.

Explosively driven compressed magnetic field (CMF) power supplies have been used for a variety of applications. A two-dimensional MHD computational model, entitled COMAG, has been constructed to study the characteristics of helically wound CMF generators. The code combines an existing Eulerian materials response code with a two-dimensional (2D) magnetic field solver to compute the self-consistent interaction between the field and the conductors, including magnetic forces, Joule heating, and nonlinear, resistive diffusion. Sample results are presented. (Author)

A78-18949 # **Characteristics of water-emulsion fuels (Svoistva vodo-emul'sionnykh topliv).** I. N. Danilov and R. A. Danilova (Bashkirskii Nauchno-Issledovatel'skii Institut Neftianoi Promyshlennosti, Ufa, USSR). *Khimiia i Tekhnologiia Topliv i Masel,* no. 12, 1977, p. 30-33. 8 refs. In Russian.

A review is presented of various characteristics of water-emulsion fuels. It is shown that such fuels have a reduced rate of flame propagation on an open surface, and burn well in the chambers of internal combustion engines when the water concentration is not greater than 30%. Within these limits, an increase in water concentration is found to increase the octane level of gases and decrease the cetane number in diesel fuels. S.C.S.

A78-19222 # **The availability of jet fuel over the next two decades.** C. P. Dalton. *(International Air Transport Association, Annual General Meeting, 33rd, Madrid, Spain, Nov. 1977.) Aircraft Engineering,* vol. 49, Dec. 1977, p. 8-14.

Aircraft fuel availability in the Western nations as a function of crude oil supply, general economic growth, and aviation fuel demand is analyzed within the framework of present conditions, and projected over the next two decades. Consumption of kerosene, the primary aviation fuel, is compared with other aviation fuels in terms of price and percentage of total use. Technical limitations (easily surmountable) involved in the refinement of crude oil into kerosene are discussed together with the overlapping uses of various fuel oils. Consumption of aviation fuel is seen to increase in proportion to the growth of the Western economy - resulting in a cyclical pattern, whereby increased aviation fuel demand (perhaps outstripping supply in the 1980's) drives up crude oil price, thus putting a damper on overall economic growth. Deliberate interruptions of crude oil flow, as occurred in 1973, are considered possible but not likely and finally, substitutes for oil products in aviation fuel are not considered technologically possible for the time frame discussed. D.M.W.

A78-19225 **A cylindrical dioptrics, nonfocalising solar collector.** F. Demichelis, A. Russo, and G. Russo (Torino, Politecnico, Turin, Italy). *Nuovo Cimento, Lettere,* vol. 20, Dec. 3, 1977, p. 503-506.

A nonfocalizing dioptric is employed to improve the interception of solar energy by flat-plate solar collectors. A computer program provides estimations of the angle dependence of the reflection along the dioptric dome of the collector at intervals of one degree of solar elevation. The optical analysis aids in developing an optimal shape for the collector. The optimization of circulation and heat transfer for a dioptric flat-plate solar collector utilizing one-through circulation of a monophase liquid coolant is also considered. J.M.B.

A78-19244 **Basis of cheap energy (Billige Energie woraus).** M. Dehli. *Energie,* vol. 29, Nov. 1977, p. 344-350. 8 refs. In German.

Safety considerations make it advisable to select locations outside densely populated areas for the establishment of nuclear power stations. However, the additional cost related to the transportation of energy in the form of hot water or steam to the places in which the energy is used represents problems. Approaches are discussed for more economical forms of energy transportation, giving attention to the Adam-Eva system involving the use of a high-temperature reactor employing helium which is heated to a temperature of about 950 C. An evaluation of the economic conditions shows that the use of the considered system does not have any advantages for energy-supply applications in the public sector. An economical supply of great industrial installations with steam appears problematical. The evaluation compares on the basis of model calculations light-water reactor heating power stations and heating power stations using fossil fuels with the Adam-Eva system. In the case of greatly increasing prices for fossil energy carriers, nuclear heat from light-water reactors would still be more economical than the energy from the Adam-Eva system. G.R.

A78-19245 **The construction of long-distance thermal-energy supply systems in Mannheim within the framework of a demonstration project (Der Ausbau der Fernwärmeversorgung in Mannheim im Rahmen des Demonstrationsprojektes).** H. P. Winkens (Rhein-Neckar AG, Energie- und Wasserwerke, Mannheim, West Germany). *Energie,* vol. 29, Nov. 1977, p. 355-362. In German.

The results of a study for the development of long-distance thermal-energy supply systems in West Germany are considered, taking into account the feasibility of a use of regional systems. It is found that a cost-effective supply of the Rhine-Neckar region with heat from a nuclear power station is possible. Such a solution would significantly improve environmental conditions. However, an extension of existing facilities for providing heat energy from the existing large power station is also feasible. A utilization of heat from both energy sources is considered in the study. The thermal energy provided is to be employed for residential heating applications and for a use by industry. One half of the heat energy is to be supplied in the form of hot water, and the other half in the form of steam. Plans for a demonstration project for the city of Mannheim are discussed, taking into account economic considerations, details concerning the pipeline network, the construction schedule, a power station which uses urban refuse as fuel, and questions related to a utilization of the provided heat by residential heating systems. G.R.

A78-19246 **Unconventional types of power-heat coupling (Unkonventionelle Arten der Kraft-Wärme-Kopplung).** M. Rudolph (München, Technische Universität, Munich, West Germany). *Energie,* vol. 29, Nov. 1977, p. 368-373. In German.

In conventional power stations it is attempted to obtain an optimum efficiency of electric power generation in connection with an operation which leads to minimum temperatures for the condensate. For a use of power-station waste heat for space-heating applications it is, however, necessary to increase the condensate temperature. A description is presented of a number of approaches which can be used in cases in which a utilization of the power-station waste heat is desired. The employment of heat pumps for a subsequent enhancement of the temperature of the waste-heat carrier makes it possible to optimize power-station operation without regard for the heat requirements. Attention is also given to installations for a withdrawal of heat energy by means of a direct coupling procedure, a comparison of yearly energy requirements, and the effect of power-heat coupling on the electric generating capacity. G.R.

A78-19247 **The block heating power station - Characteristics and first experience (Das Blockheizkraftwerk - Kennzeichen und erste Erfahrungen).** W. Piller and U. Wolff (München, Technische Universität, Munich, West Germany). *Energie,* vol. 29, Nov. 1977, p. 376-379. In German.

A 'block heating power station' is defined as an installation which generates simultaneously power and heat. One or several internal combustion engines drive a generator for the production of electric power. The thermal energy contained in the cooling water and in the exhaust gas is utilized as completely as possible for heating applications. Installations providing electric power in the range from 100 to 5000 kW and thermal waste heat quantities from 150 to 7500 kW are considered. Attention is given to an adaptation of installation designs to power and heat requirements, questions of internal combustion engine operation, high fixed costs, the operation of a prototype installation, basic trends, the first results, and a reduction in efficiency. G.R.

A78-19268 **Limiting values of the energy generated by pulsed MHD converters.** O. S. Popel' and O. A. Sinkevich (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *(Teplofizika Vysokikh Temperatur,* vol. 15, Mar.-Apr. 1977, p. 385-389.) *High Temperature,* vol. 15, no. 2, Sept. 1977, p. 320-324. 8 refs. Translation.

The energy characteristics of pulsed MHD energy converters operating at active and inductive loads are analyzed over a wide range of magnetic Reynolds numbers. The limiting values of the power extractable from the flow are determined as a function of such converter parameters as the channel dimensions; plasma velocity and conductivity; and magnetic field induction. The optimal values of the active and inductive loads are identified. V.P.

A78-19269 **Two-dimensional electrical effects in a frame-type MHD channel.** V. A. Bitiurin, B. M. Burakhanov, V. A. Zhelnin, V. I. Kovbasiuk, T. N. Kuznetsova, and S. A. Medin (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *(Teplofizika Vysokikh Temperatur,* vol. 15, Mar.-Apr. 1977, p. 390-398.) *High Temperature,* vol. 15, no. 2, Sept. 1977, p. 324-332. 13 refs. Translation.

The present paper deals with the characteristics of sectional MHD-channels in which electrical conductivity and flow rate is nonuniformly distributed over the channel cross section. A numerical method is proposed for solving the electrodynamic problem in parametric form. This makes it possible to analyze the electrical characteristics of the channel on the basis of a solution of an elliptic equation. The influence of the plasma parameters on the characteristics of the channel is assessed, and the latter are compared with those of an equivalent Faraday channel. The comparison shows that the influence of two-dimensional electric effects in a diagonal MHD generator do not exceed those of a Faraday generator. V.P.

A78-19374 **A monolithic series-array solar-cell system.** R. M. Warner, Jr., E. M. Murray, and W. K. Smith (Minnesota, University, Minneapolis, Minn.). *Applied Physics Letters,* vol. 31, Dec. 15, 1977, p. 838, 839.

A process is described for fabricating a monolithic series-array solar battery by combining solar-cell technology with the technology developed for dielectric isolation of integrated circuits. Current-voltage characteristics are presented for a five-cell monolith illuminated by a tungsten source providing an incident power density of 33 mW/sq cm. The overall efficiency of the array in this case is shown to be approximately 8%. It is noted that no antireflection coating was employed in this array, except for an SiO2 layer that was incident to fabrication. F.G.M.

A78-19472 **Molecular-beam epitaxy in space.** J. R. Arthur (Physical Electronics Industries, Eden Prairie, Minn.). *(NASA Ames Research Center and American Vacuum Society, Symposium on the Use of the Space Shuttle for Science and Engineering, Moffett Field, Calif., May 9-11, 1977.) Journal of Vacuum Science and Technology,* vol. 14, Nov.-Dec. 1977, p. 1283, 1284. 14 refs.

Molecular-beam epitaxy (MBE), used to create high-quality semiconductor films, may in the future find applications to the production of large-scale solar cell arrays in space, or to the preparation of flat, well-ordered surfaces of III-V compounds for surface experiments. Although the vacuum levels attainable through use of the Shuttle would not significantly improve GaAs film growth techniques as currently developed on earth, a vacuum chamber equipped with an intermediate airlock on board the Shuttle could provide means for rapid substrate recycling. J.M.B.

A78-19486 # **Influence of the effect of storage on models of power cell dynamics (Influence de l'effet de stockage sur la modélisation et la dynamique des cellules de puissance).** A. J. Fossard (Ecole Nationale Supérieure de l'Aéronautique et de l'Espace; ONERA, Centre d'Etudes et de Recherches de Toulouse, Toulouse, France) and M. Clique (ONERA, Centre d'Etudes et de Recherches de Toulouse, Toulouse, France). *ESA Journal,* vol. 1, no. 3, 1977, p. 283-297. 22 refs. In French. European Space Research and Technology Centre Contract No. 2590/75-AK.

A computer model (the 'injected current method') valid for all types of power cells (buck, boost, buck-boost) in both heavy and light modes of conduction has been developed for analyzing switching dc-dc converters. The model is simple and accurate; but its essential drawback is that it does not account for the storage effect of the switching transistors. Equations are thus presented augmenting the computer model, taking this storage effect into account; and also analyzing the effect of input/output filters. The extended model is then valid for the analysis of a wide variety of switching converter functions. D.M.W.

A78-19525 # **Utilization of exhaust-gas heat from gas turbine power plants (Ispol'zovanie tepla vykhlopnykh gazov privodnykh gazoturbinnykh ustanovok).** B. I. Shelkovskii, I. L. Iurashchik, and I. I. Smoliakov. *Promyshlennaia Energetika,* Sept. 1977, p. 44-46. 5 refs. In Russian.

Consideration is given to the use of waste exhaust-gas heat from gas turbine power plants for diverse purposes of heat supply in cold remote areas: water heating, heat supply of compressor stations of main pipelines, and domestic heat supply for remote communities. An analysis is presented of waste-heat exchangers in gas turbine power plants. Waste heat utilization costs are studied as a function of the thermal load of the power plant and the number of hours of its yearly operation. Technical and cost indicators of waste heat utilization for different types of power plants in a heat-distribution radius of 2 km are presented. B.J.

A78-19543 * # **Next steps in space transportation and operations.** J. H. Disher (NASA, Office of Space Transportation Systems, Washington, D.C.). *Astronautics and Aeronautics,* vol. 16, Jan. 1978, p. 22-30. 8 refs.

Design of a 25-kW power or utilities module, capable of extending the effective duration of Spacelab missions, is discussed. The power module, planned for availability in 1984, could also support a Spacelab modified to be a free-flyer by providing attitude control and power. In addition, development of a 250-kW power module to support a Shuttle-tended space platform or a Shuttle-tended space construction base is projected. A free-flying teleoperator capable of deboosting Skylab, systems to construct large planar arrays in space, and a habitable module providing crew quarters for continuously manned operations are also described. J.M.B.

A78-19600 **Tokamak fusion power reactors.** W. M. Stacey, Jr. and M. A. Abdou (Argonne National Laboratory, Argonne, Ill.). *Nuclear Technology,* vol. 37, Jan. 1978, p. 29-39. 18 refs. ERDA-supported research.

The major parameters and corresponding economic characteristics of a representative class of commercial Tokamak fusion power reactors are examined as a function of four major design parameters: plasma beta-t, toroidal magnetic field strength, first-wall lifetime, and power output. It is shown that for beta-t greater than or equal to 0.06, the minimum cost of energy is obtained for toroidal field strengths of approximately 8 to 9 T. Tokamak power plants exhibit an economy of scaling with a lower cost of energy for larger power reactors. Representative design parameters, costs, schedule, and technology advances are presented for a sequence of three reactors that could lead to the demonstration of commercial feasibility of this class of Tokamak fusion power reactors near the turn of the century. (Author)

A78-19616 **Energy resource development - The monitoring components.** G. B. Morgan (U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nev.). *Environmental Science and Technology,* vol. 12, Jan. 1978, p. 34-43.

In connection with the continuing development of energy resources, it is very important to keep environmental pollutant concentrations at acceptable levels. In order to achieve this objective it is necessary to have information with respect to exposure-pollutant effect relations, pollutant sources, and the effectiveness of the considered controls. Monitoring systems and techniques for obtaining the needed information are considered, taking into account papers from eight different Federal agencies. Attention is given to aspects of water monitoring, the use of remote sensing data for a detection of SO2-produced vegetation damage, models for the prediction of the radiological impact of releases to the atmosphere from nuclear power, and the tracking of particulate pollutants by Doppler lidar. G.R.

A78-19625 **Geothermal well stimulation with a secondary fluid.** I. Sheinbaum (I. Sheinbaum Co., Pasadena, Calif.). *Geothermal Energy,* vol. 6, Jan. 1978, p. 33-38. 12 refs.

The stimulation of liquid dominated geothermal wells for maximizing the production of thermal energy seems to be the next frontier of geothermal research. By injecting a secondary fluid down the geothermal well bore it is possible to optimize the production of a geothermal well and at the same time pump the geothermal heat to the surface. The system can be advantageously utilized for self-flowing and non-self-flowing geothermal reservoirs where the geothermal heat can be utilized above ground for the production of power by any of the known power cycles. The use of this stimulation technique will eliminate the necessity for down hole pumping and the parasitic losses associated with it. (Author)

A78-19826 **Current costs of solar powered organic Rankine cycle engines.** R. E. Barber (Barber-Nichols Engineering Co., Arvada, Colo.). *Solar Energy,* vol. 20, no. 1, 1978, p. 1-6. 8 refs.

Attention is given to small solar power systems, noting various types of solar collectors and their respective efficiencies. Rankine cycle efficiency is described for various cycle temperatures, and the estimated solar conversion system efficiency is discussed as a function of collector temperature. The total system cost for a Rankine electrical power system is broken down into percentages allocated to individual components, and installation costs are projected. In addition, the estimated installed cost of a Rankine power system is defined for various types of collectors, including flat plate, evacuated tube, Fresnel lens, and tracking concentrators. S.C.S.

A78-19827 **Solar energy collector orientation and tracking mode.** R. C. Neville (California, University, Santa Barbara, Calif.). *Solar Energy,* vol. 20, no. 1, 1978, p. 7-11. 7 refs.

The maximum solar energy available to an earth-surface collector is examined as a function of latitude, the north-south tilt of the collector from the earth's surface, and whether the collector is an ideal tracker (follows the sun both north-south and east-west), an east-west tracker (follows the sun east-west but is fixed in the north-south direction) or a fixed type. It is shown that the ideal tracker gives maximum potentially available energy, the use of an east-west tracking device results in 5-10 per cent degradation in potential performance, of fixed collectors is degraded by close to 50 percent. Insolation data by season of the year is also provided. (Author)

A78-19828 **Design and performance of an air collector for industrial crop dehydration.** P. W. Niles, E. J. Carnegie, J. G. Pohl, and J. M. Cherne (California Polytechnic State University, San Luis Obispo; TRW, Inc., Systems and Energy Div., Redondo Beach, Calif.). *Solar Energy,* vol. 20, no. 1, 1978, p. 19-23. 7 refs. NSF Grant No. ERT-74-19063.

Test results are reported for the operation of unglazed and single-glazed solar collectors used to heat air to the 90 C (194 F) range. The collectors were constructed of standard black-painted metal decking and were tested in various lengths so that pressure drops and convective heat transfer rates could be varied independent of collector operation temperature. It is shown that the experimental collector performance results with single pass operation are in substantial agreement with standard collector analysis procedures. These results give a firm basis for collector and system optimization. (Author)

A78-19829 * **Irradiance for skew rays incident upon a trough-like solar collector of arbitrary shape.** G. L. Strobel and D. G. Burkhard (Georgia, University, Athens, Ga.). *Solar Energy,* vol. 20, no. 1, 1978, p. 25-27. NASA-supported research.

A78-19830 **The effect of off-south orientation on the performance of flat-plate solar collectors.** J. D. Felske (MIT, Cambridge, Mass.). *Solar Energy,* vol. 20, no. 1, 1978, p. 29-36. 9 refs. NSF Grant No. PTP-75-05156.

There are many instances in which an off-south installation of a flat-plate solar collector is more compatible with a building's orientation than a due-south installation. In these cases it is important to determine the magnitude of the performance sacrificed by conforming to the building architecture. The study investigates the collector performance and optimum tilt as functions of the off-south angle, collection temperature, number of glass covers and the relative amounts of direct and diffuse radiation. It was found that the yearly energy collection for a given collector tilt is insensitive to the off-south angle and that in some cases it actually improves with increasing azimuthal angle. It was also found that for a given azimuthal angle an optimum collector tilt exists which is between 3 and 10 less than the latitude. Calculations were based on New York City weather. (Author)

A78-19831 **Asymmetrical non-imaging cylindrical solar concentrators.** D. R. Mills and J. E. Giutronich (New South Wales, University, Kensington, Australia). *Solar Energy,* vol. 20, no. 1, 1978, p. 45-55. 8 refs.

Two types of asymmetrical concentrators, parabolic and non-parabolic, are compared to those with symmetrical designs. Asymmetrical configurations are found to provide many advantages, including: (1) a concentration versus time-of-day relationship which can compensate for projected solar-area fall-off, allowing more uniform energy output when this is desirable, (2) greater operational flexibility, (3) easier adaptation to vacuum-insulated receivers, and (4) possible increased concentration and energy collection per unit of mirror area for systems with receivers which can make use of the large daily changes in energy input. It is noted that although a higher tracking frequency may be required, a tilting adjustment every few days will provide adequate compensation. S.C.S.

A78-19832 **Effects of phase-change energy storage on the performance of air-based and liquid-based solar heating systems.** D. J. Morrison and S. I. Abdel-Khalik (Wisconsin, University, Madison, Wis.). *Solar Energy,* vol. 20, no. 1, 1978, p. 57-67. 12 refs. Contract No. E(11-1)-2588.

Models describing the transient behavior of phase-change energy storage (PCES) units are presented. Simulation techniques are used in conjunction with these models to determine the performance of solar heating systems utilizing PCES. Both air-based and liquid-based systems are investigated. The effects of storage capacity, storage unit heat transfer characteristics, collector area and location on the system performance are investigated for systems utilizing sodium sulfate decahydrate and paraffin wax as storage media. Optimum ranges of storage sizes are recommended on the basis of systems' thermal performance. Comparison is made between systems utilizing PCES and those using sensible heat storage, viz. rock beds in air-based systems and water tanks in liquid-based systems. The variation of the solar supplied fraction of load with storage size and collector area is given for systems utilizing both types of storage. The effects of location and collector energy loss coefficient on the relative performance of PCES and sensible heat storage are also investigated. (Author)

A78-19833 **The circular cylindrical reflector - Application to a shallow solar pond electricity generating system.** C. F. Kooi. *Solar Energy,* vol. 20, no. 1, 1978, p. 69-73. 12 refs.

A78-19834 **Advances in solar water heating for domestic use in Australia.** J. T. Czarnecki and W. R. W. Read (Commonwealth Scientific and Industrial Research Organization, Div. of Mechanical Engineering, Highett, Victoria, Australia). *Solar Energy,* vol. 20, no. 1, 1978, p. 75-80.

A method enabling retrofitting of solar collectors to existing domestic, low pressure electric water heaters has been developed and tested. The performance of the proposed system was found to be comparable with the performance of conventional solar water heaters when the size of the solar collectors is suitably matched to the average daily consumption of hot water. Other developments described are a solar energy operated pump and an airlift pump, both suitable for circulation of water in domestic solar water heaters, and an electronic controller for the circulating pumps. (Author)

A78-19835 **Geometric factors for plane specular reflectors.** N. E. Wijeysundera (University of Sri Lanka, Peradeniya, Sri Lanka). *Solar Energy,* vol. 20, no. 1, 1978, p. 81-85. 7 refs.

The solar radiation collection of flat plate collectors, hot-box ovens, and thin film solar cells may be increased by plane specular reflectors. A general formula is derived for calculating the geometric factor between the plane specular reflector and the corresponding collector surface. It is based on matrix transformations, and is therefore applicable to digital computer programs. Specific geometric factors for east-west and north-south configurations are also discussed. S.C.S.

A78-19836 **On the right to sunshine.** M. M. Eisenstadt (Soltrax, Inc., Albuquerque, N. Mex.) and A. E. Utton (New Mexico, University, Albuquerque, N. Mex.). *Solar Energy,* vol. 20, no. 1, 1978, p. 87, 88. 17 refs.

Problems associated with operating a residentially located solar energy system are discussed. Historical cases dealing with legal rights to the free flow of light and air are reviewed. Methods for creating solar rights are suggested, including easements and zoning. S.C.S.

A78-19837 **Inexpensive solar collectors for agricultural requirements.** J. H. Schlag, D. C. Ray, A. P. Sheppard, and J. M. Wood (Georgia Institute of Technology, Atlanta, Ga.). *Solar Energy,* vol. 20, no. 1, 1978, p. 89-91. Research sponsored by Georgia Institute of Genetics; U.S. Department of Agriculture Contract No. 12-14-7001-566.

Two types of inexpensive solar collectors are discussed: the black film, hot air collector system, and the rock absorption and storage collector system. A review is presented of collector instrumentation, noting (1) the automated data collection system used for assessing collector design research, (2) the remote data collection system for field collector evaluation, and (3) the solar instrumentation component design. S.C.S.

A78-19838 **Transmission of sunlight through a uniform water-drop atmosphere.** D. C. de Packh (Entropy Research, Hollywood, Md.). *Solar Energy,* vol. 20, no. 1, 1978, p. 93-95.

A computer calculation is derived for the transmission of normal-incidence parallel radiation through a uniform water-drop atmosphere. The calculation employs a Chandrasekhar transport equation which is in effect the time-dependent Boltzmann equation. Although the analysis assumes that the collector is directed at the sun, which is at the zenith, it is also applicable to other cases. S.C.S.

A78-19839 **A correction procedure for separating direct and diffuse insolation on a horizontal surface.** R. Bruno (Philips GmbH, Forschungslaboratorium, Aachen, West Germany). *Solar Energy,* vol. 20, no. 1, 1978, p. 97-100. 6 refs. Research supported by the Bundesministerium für Forschung und Technologie.

A78-19840 **Estimation of the monthly average of the diffuse component of total insolation on a horizontal surface.** M. Iqbal (British Columbia, University, Vancouver, Canada). *Solar Energy,* vol. 20, no. 1, 1978, p. 101-105. 16 refs. Research supported by the National Research Council of Canada.

A78-19893 **Efficiency of Drude mirror-type selective transparent filters for solar thermal conversion.** S. Yoshida (Ministry of International Trade and Industry, Electrotechnical Laboratory, Tokyo, Japan). *Applied Optics,* vol. 17, Jan. 1, 1978, p. 145-150. 14 refs.

The efficiency of the solar collector consisting of a selective absorber and a selective transparent filter is derived for comparing and evaluating the collectors. The efficiency of Drude mirror type selective transparent filters is calculated in cases of a blackbody absorber and the Al_2O_3-Mo-Al_2O_3-Mo highly selective absorber. As Drude mirrors, Sn-doped In_2O_3 films were formed on Pyrex glass plates by RF sputtering, and the dependence of the efficiencies on the operating conditions of the collector, including solar concentration and temperature of the absorber, is discussed. (Author)

A78-20075 **Generation of air pollutants from kerosene combustion in commercial and domestic glasshouses.** T. W. Ashenden, T. A. Mansfield, and R. M. Harrison (Lancaster, University, Lancaster, England). *Environmental Pollution,* vol. 14, Oct. 1977, p. 93-100. 24 refs. Research supported by the Agricultural Research Council and Natural Environmental Research Council.

The amounts of ethylene, sulphur dioxide and nitrogen oxides produced by kerosene burners commonly used in glasshouses have been monitored. The pollution levels produced during normal CO_2 enrichment and during heating of domestic glasshouses are below those expected to cause major effects on most crops. They are, however, above the threshold concentrations for producing physiological injury and the growth of some more sensitive species might be affected. In a commercial glasshouse which was being heated experimentally by diversion of the gases from a flue normally venting to the outside, the pollution levels were much higher and could account for rapid damage observed in the crop. Both ethylene and nitrogen oxides (NO and NO_2) were present in phytotoxic amounts. It is suggested that more attention should be given to air pollutants produced by flueless kerosene burners before attempts are made to use them on a wider scale in commercial horticulture. (Author)

A78-20117 **Coatings of ultrafine chromium particles - Efficient selective absorbers of solar energy.** C. G. Granqvist (Chalmers Tekniska Hogskola, Goteborg, Sweden). *Physica Scripta,* vol. 16, Sept.-Oct. 1977, p. 163, 164. 9 refs.

Results are presented for calculations of the optical and IR absorption in coatings consisting of ultrafine (diameters less than about 10 nm) chromium particles. These calculations indicate that such coatings are strongly absorbing below a certain wavelength and practically transparent above it. It is suggested that if these coatings are deposited onto metal backings of low emissivity, they would have the desired properties of an efficient photothermal solar-energy converter, viz., high absorptance over the solar spectrum combined with low emissivity for thermal reradiation. Some properties of these coatings and of electrodeposited 'black chromium' are compared. F.G.M.

A78-20148 **The industrialization of space - A myth or tomorrow's reality. I (L'industrialisation de l'espace - Mythe ou réalité de demain. I).** A. Dupas (Paris XI, Université, Orsay, Essonne, France). *L'Aéronautique et l'Astronautique,* no. 67, 1977, p. 57-64. 16 refs. In French.

A review of the O'Neill concept for space colonization is presented, noting the proposed utilization of extraterrestrial resources and the mass driver propulsion technique. Further projects for the industrialization of space, as they follow from the O'Neill concept, are suggested, including an industrial space complex and a space solar power station. S.C.S.

A78-20199 **Cold wall Faraday type generating channel.** Y. Kusaka, T. Masuda, S. Ikeda, and T. Honda (Ministry of International Trade and Industry, Electrotechnical Laboratory, Tanashi, Tokyo, Japan). *Energy Conversion,* vol. 17, no. 1, 1977, p. 7-18. 14 refs.

The ability of an improved peg wall type channel consisting of peg pieces coated by Al_2O_3 thin layers to serve as a cold wall Faraday type generating channel was tested. Channels for various MHD generators were designed with the help of data obtained in preliminary experiments. A 230-hr long-operation test, as well as shorter generation tests performed at high Hall field strengths, are described. Through these tests, the side walls endured satisfactorily, but traces of breakdowns on the interelectrode insulators were observed on both anode and cathode sides for the very high Hall field strength. The construction and durability of an improved peg wall type channel are discussed. (Author)

A78-20200 **On some new criteria of efficiency of thermoelectric materials.** A. P. Ivaniuk, A. S. Okhotin (Akademiia Nauk SSSR, Institut Kosmicheskikh Issledovanii, Moscow, USSR), and A. S. Pushkarskii (Akademiia Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). *Energy Conversion,* vol. 17, no. 1, 1977, p. 19-21.

Two expressions are presented for the maximum specific power of a thermogenerator, and the use of a new parameter in these expressions for estimating material characteristics is tested. One expression is for a constant heat flux supplied mechanism, and the other expression refers to the use of a constant temperature difference between the hot junction and the cooling agent under no-load conditions. The new parameter represents the limiting variations of temperature difference on the semiconductor from no-load to short-circuiting. Thermoelements of various heights were made from several materials, and their maximum specific power was measured for various values of heat flux and temperature difference. The results are analyzed, and it is concluded that use of the parameter will aid the development of thermoelectric generators. M.L.

A78-20244 **Comparison of the fossil fuel energy requirements for solar, natural gas, and electrical water heating systems.** J. Zucchetto (Stockholms Universitet, Stockholm, Sweden) and S. Brown (Florida, University, Gainesville, Fla.). *Resource Recovery and Conservation,* vol. 2, Nov. 1977, p. 283-300. 19 refs. Research supported by the Federal Energy Administration; Contract No. E(40-10)-4398.

A comparison between solar and fossil fuel heating is presented with primary attention given to cost factors. In most areas of the United States, solar heating is found to be several times more cost efficient than comparable electric water heating, and about half as efficient as natural gas water heating per Joule of energy produced. An input/output flow model is devised, with all costs, including those of raw materials for solar heater construction, installation, energy consumption rates, and heat loss from inefficiencies in the heater system taken into account. Over the projected lifetime of solar heaters (10-25 years), the savings are said to be substantial in comparison with fossil fuel heaters; and solar heaters do not damage the environment. D.M.W.

A78-20248 **Comparison of two government reports as to their approaches to recycling.** D. A. Tillman (Materials Associates, Inc., Washington, D.C.). *Resource Recovery and Conservation,* vol. 2, Nov. 1977, p. 361-364.

Two government agencies, the National Commission on Materials Policy (NCMP) and the National Commission on Supplies and Shortages (NCSS) were established to suggest ways to conserve energy and raw materials. Differences in the approaches of these agencies to the problem of recycling are pointed out. While both agencies favored a cooperative conservation effort from government and private sectors, the NCMP emphasized economic incentives to private industry, e.g., tax breaks to encourage recycling materials; and the NCSS recommended economic penalties, e.g., an end to depletion allowances to encourage conservation. Still another difference was that the NCMP favored both materials recovery, and energy recovery from waste materials; but the NCSS favored only materials recovery, considering energy recovery not economically efficient. Both agencies were agreed, however, that the consumer cost of a good or service should reflect the environmental cost, i.e., the cost that recycling or pollution control adds to the cost of production. D.M.W.

A78-20360 **Status report on controlled thermonuclear fusion.** *Nuclear Fusion,* vol. 18, Jan. 1978, p. 137-149.

The current status of controlled-fusion research and prospects for controlled thermonuclear fusion are reviewed. Magnetic confinement in Tokamaks, stellarators, diffuse pinches, and various open systems is discussed along with inertial confinement with the aid of lasers, electron beams, and ion beams, as well as magnetic compression by means of imploding liners. Conceptual-design studies for D-T Tokamak reactors are summarized, and problems are examined which involve reactor blankets, tritium processing, vacuum-wall irradiation, magnetic divertors, neutron-induced radioactivity of reactor structural materials, the design and construction of superconducting magnetic-field coils, reactor maintenance, cold-fuel injection, plasma heating, and energy storage. Several conceptual designs proposed for laser-fusion reactors are noted, and fusion fuel reserves are considered. The environmental impact of fusion reactors is evaluated with respect to materials acquisition, reactor siting, routine reactor operation, reactor shutdown, accidents, and nuclear-weapons implications. The time scale, effort, and cost of developing fusion power as an economical electricity-producing source are tentatively estimated. F.G.M.

A78-20423 **The evening out of hot junction temperatures in solar thermoelectric generators by a disk method (Vyravnivanie temperatur goriachikh spaev v solnechnykh termoelectrogeneratorakh metodom diska).** E. Annamukhamedov (Turkmenskii Gosudarstvennyi Universitet, Ashkhabad, Turkmen SSR). *Akademiia Nauk Turkmenskoi SSR, Izvestiia, Seriia Fiziko-Tekhnicheskikh, Khimicheskikh i Geologicheskikh Nauk,* no. 5, 1977, p. 26-31. In Russian.

The paper analyzes a disk method of maintaining an identical temperature in all the thermoelements of solar thermoelectric generators. (Nonuniformity of temperatures results in a loss of efficiency.) The method of determining the optimum thickness of the high-thermoconductance disk relies on a solution for the disk temperature field. By separation of variables the temperature field is analyzed for a uniform compact disk, and a procedure for calculating the temperature field is explained. M.L.

A78-20424 # **Choice of the optimal parabolocylindrical concentrator with a tubiform receiver (Vybor optimal'nogo parabolotsilindricheskogo kontsentratora s priemnikom v vide truby).** Kh. Durdyev, A. Davletov, M. Khodzhiev, and B. Rozyev (Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR). *Akademiia Nauk Turkmenskoi SSR, Izvestiia, Seriia Fiziko-Tekhnicheskikh, Khimicheskikh i Geologicheskikh Nauk,* no. 5, 1977, p. 32-40. In Russian.

A procedure for estimating the optimal dimensions of parabolocylindrical concentrators and the optimal spatial arrangement of the concentrators and tubiform receiver is presented. (Optimal in this context signifies maximal mean geometric concentration.) Three spatial configurations are analyzed, and parametric equations are derived for estimating the desired dimensions. M.L.

A78-20425 **Conference on National Energy Policy, Washington, D.C., May 17, 1977, Proceedings.** Conference sponsored by the American Association for the Advancement of Science, Carnegie Institution of Washington, and Mitre Corp. Washington, D.C., American Association for the Advancement of Science, 1977. 149 p. $6.00.

Technological and economic problems involved in implementing the U.S. National Energy Plan announced by President Carter in April, 1977 are discussed. Topics considered include shale oil development, coal gasification, off-shore oil development, the decontrol of natural gas prices prevailing in interstate commerce, tax credits for improved fuel conservation measures adopted by business, import restrictions on petroleum, a cost-benefit analysis of nuclear power plants, off-gas scrubber systems and emissions control for electrical generating plants, cogeneration of electricity and process steam, and coal conversion regulatory policy. J.M.B.

A78-20476 * **Effects of rotor location, coning, and tilt on critical loads in large wind turbines.** D. A. Spera and D. C. Janetzke (NASA, Lewis Research Center, Wind Turbine Analysis Section, Cleveland, Ohio). *Wind Technology Journal,* vol.1, Summer 1977, p. 5-10. 7 refs.

Three large (1500 kW) horizontal rotor configurations were analyzed to determine the effects on dynamic loads of upwind and downwind rotor locations, coned and radial blade positions, and tilted and horizontal rotor axis positions. Loads were calculated for a range of wind velocities at three locations in the structure: the blade shank, the hub shaft, and the yaw drive. Blade axis coning and rotor axis tilt were found to have little effect on loads. However, locating the rotor upwind of the tower significantly reduced loads at all locations analyzed. (Author)

A78-20477 **Cylindrical arrays of vertical-axis wind turbines.** R. A. Willem (New Mexico State University, Las Cruces, N. Mex.). *Wind Technology Journal,* vol.1, Summer 1977, p. 11-16. 5 refs.

This paper presents the concept of wind energy conversion using tall cylindrical arrays of vertical-axis turbines. This concept provides an alternative to the large single turbine approach for economical wind power conversion. Various aspects of the concepts are considered and a comparison is made with respect to ground-mounted turbine systems. (Author)

A78-20478 **The use of built form to enhance the output of wind collectors.** D. R. Coonley. *Wind Technology Journal,* vol.1, Summer 1977, p. 24-30. 11 refs.

Consideration is given to using a built form to increase the output of wind collectors. The application of wind energy conservation systems (WECS) to buildings is discussed, and the advantages and disadvantages encountered are noted. Attention is given to various wind system design considerations, including social and economic aspects, adaptation to existing structures, and community design for the use of wind energy. Potential methods integrating several energy sources into a single comportable system are reviewed. S.C.S.

A78-20496 **Energy performance of solar walls - A computer analysis.** F. Arumi and M. Hourmanesh (Texas, University, Austin, Tex.). *Energy and Buildings,* vol. 1, Oct. 1977, p. 167-174. 10 refs.

The computer model for the Dynamic Energy Response of Buildings (DEROB) is applied to passive solar systems. The method consists of: (1) reading geometric data describing the building under consideration, and generating geometric dependent arrays, (2) reading the thermophysical properties of the building materials, and generating material properties, and (3) reading user information (such as geographical location, weather data, and occupancy schedule) in order to calculate hourly load values, temperature distributions, and other data. As an example, the system is used to evaluate the potential performance of a Trombe wall in Texas. S.C.S.

A78-20516 **Liquid hydrogen as energy source - Economic considerations through a comparison with imported liquefied natural gas (Die Energieversorgung mit flüssigem Wasserstoff - Wirtschaftlichkeitsbetrachtungen durch Vergleich mit LNG-Import).** G. Kandler. *Gas Wärme International,* vol. 26, Aug. 1977, p. 373-377. 7 refs. In German.

The processes of liquefaction, transport, and distribution of natural gas, regarded as achieved technologies, are used as a basis for comparing the corresponding processes for liquid hydrogen. The main factor in the economic picture is the fact that the minimum energy per unit mass required for hydrogen liquefaction is about 13 times higher than that for natural gas liquefaction. Solar energy may be used in the process of obtaining hydrogen from water. The sun's energy will be without cost, but many investments must be made in order to develop a workable system. Estimates are made for the development of a complete liquid hydrogen import chain. Bearing in mind the increasing cost of fossil fuels, one concludes that liquid hydrogen can become competitive at the beginning of the 21st century. P.T.H.

A78-20524 **Fuels and energy from renewable resources; Proceedings of the Symposium, Chicago, Ill., August 29-September 2, 1977.** Symposium sponsored by the American Chemical Society. Edited by D. A. Tillman (Materials Associates, Inc., Washington, D.C.), K. V. Sarkanen (Washington, University, Seattle, Wash.), and L. L. Anderson (Utah, University, Salt Lake City, Utah). New York, Academic Press, Inc., 1977. 352 p. $17.50.

Quantitative estimates of energy requirements for the longer term are considered, taking into account the rationale for estimating energy requirements, the approaches used for obtaining energy targets, and the relation of conservation to employment. Attention is given to the present contribution of renewable resources, the anticipated competition for available wood fuels in the U.S., a thermal analysis of forest fuels, the conversion of stagnated timber stands to productive sites and use of noncommercial material for fuel, industrial wood energy conversion, and the pyrolysis-gasification-combustion process. Prospects for cogeneration of steam and power in the forest products industry are discussed along with the feasibility of utilizing crop and forestry residues to produce energy, the use of wood oil from pyrolysis of pine bark-sawdust mixture, the logistics of energy resources and residues, bagasse as a renewable energy source, the use of ginning waste as an energy source, the design of a large-scale manure/methane facility, and energy recovery from municipal wastes. G.R.

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STAR ENTRIES

N78-10035*# Douglas Aircraft Co., Inc., Long Beach, Calif.
COST/BENEFIT TRADEOFFS FOR REDUCING THE ENERGY CONSUMPTION OF THE COMMERCIAL AIR TRANSPORTATION SYSTEM Summary Report, 5 Nov. 1974 - 30 Jun. 1976
E. F. Kraus and J. C. VanAbkoude Jun. 1976 77 p
(Contract NAS2-8618)
(NASA-CR-137925; MDC-J7340) Avail: NTIS HC A05/MF A01 CSCL 05C

The fuel saving potential and cost effectiveness of numerous operational and technical options proposed for reducing the fuel consumption of the U.S. commercial airline fleet was examined and compared. The impact of the most promising fuel conserving options on fuel consumption, passenger demand, operating costs and airline profits when implemented in the U.S. domestic and international airline fleets was determined. A forecast estimate was made of the potential fuel savings achievable in the U.S. scheduled air transportation system. Specifically, the means for reducing the jet fuel consumption of the U.S. scheduled airlines in domestic and international passenger operations were investigated. A design analysis was made of two turboprop aircraft as possible fuel conserving derivatives of the DC-9-30. Author

N78-10185*# McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.
SPACE STATION SYSTEMS ANALYSIS STUDY. PART 3: DOCUMENTATION. VOLUME 7: SCB ALTERNATE EPS EVALUATION, TASK 10
Sep. 1977 344 p refs
(Contract NAS9-14958)
(NASA-CR-151535; MDC-G6954-Pt-3-Vol-7) Avail: NTIS HC A15/MF A01 CSCL 22A

Power levels up to 100 kWe average were baselined for the electrical power system of the space construction base, a long-duration manned facility capable of supporting manufacturing and large scale construction projects in space. Alternatives to the solar array battery systems discussed include: (1) solar concentrator/brayton; (2) solar concentrator/thermionic; (3) isotope/brayton; (4) nuclear/brayton; (5) nuclear thermoelectric; and (6) nuclear thermionic. Author

N78-10306*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE LIQUID HYDROGEN OPTION FOR THE SUBSONIC TRANSPORT: A STATUS REPORT
Peter F. Korycinski Sep. 1977 28 p refs Presented at 12th Intersoc. Energy Conversion Eng. Conf., Washington, D. C., 28 Aug. - 2 Sep. 1977
(NASA-TM-74089) Avail: NTIS HC A03/MF A01 CSCL 21D

Continued subsonic air transport design studies include the option for a liquid hydrogen fuel system as an aircraft fuel conservation measure. Elements of this option discussed include: (1) economical production of hydrogen; (2) efficient liquefaction of hydrogen; (3) materials for long service life LH2 fuel tanks; (4) insulation materials; (5) LH2 fuel service and installations at major air terminals; (6) assessment of LH2 hazards; and (7) the engineering definition of an LH2 fuel system for a large subsonic passenger air transport. Author

N78-10308# Southwest Research Inst., San Antonio, Tex. Army Fuels and Lubricants Research Lab.
A REVIEW OF DIESEL FUEL DETERIORATION AND RELATED PROBLEMS
Leo L. Stavinoha and Maurice E. LePera May 1977 33 p refs
(Contract DAAG53-76-C-0003)
(AD-A043566; AFLRL-88) Avail: NTIS HC A03/MF A01 CSCL 21/4

This report represents in essence an 'overview' presented by the authors at a seminar sponsored by the U.S. Army Research Office (ARO) in April 1977 to promote basic research in the area of 'Diesel Fuel Stability'. This report provides a review of the general topic of fuel deterioration with primary emphasis on diesel or distillate fuels used in compression ignition engines which power the majority of Army tactical and combat vehicles. Selected field problems regarding fuel stability and related problems are presented and the status of on-going research and development programs are outlined. This information has been prepared to place in perspective the background and field problems which have prompted current research activities to detect, predict, and prevent fuel stability associated equipment failures. A selected bibliography used as the basis for the review portion of this report and as a source for additional fuel stability information has been provided. Author (GRA)

N78-10444 Polish Academy of Sciences, Warsaw.
GENERALIZATION OF THE DESCRIPTION OF ENERGY CONVERSION IN CO2 IMPULSE LASERS [UOGOLNIENIE OPISU KONWERSJI ENERGII W IMPULSOWYCH LASERACH CO2]
Wojciech W. Byszenski 5 Apr. 1977 88 p refs In POLISH
Avail: Issuing Activity

The conversion of electrical energy to laser radiation energy was studied with emphasis on controlled glow discharge in a high pressure mixture of molecular gases, CO2, N2, and H2O. The processes of excitation of modes of oscillations, relaxation of their energy, and forced emission of radiation were analyzed and a simple theoretical model describing energy conversion was developed. The model was generalized so that it applies to the majority of laser types and CO2 impulse amplifiers. Methods of approximate calculation of the coefficients occuring in the equations are given. These coefficients describe the velocity of energy transport to oscillation modes as a result of collisions of the electron-molecule type Author

N78-10467* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
OIL COOLING SYSTEM FOR A GAS TURBINE ENGINE Patent
George A. Coffinberry (GE, Cincinnati) and Howard B. Kast, inventors (to NASA) (GE, Cincinnati) Issued 16 Aug. 1977 10 p Filed 17 Jul. 1975 Sponsored by NASA
(NASA-Case-LEW-12321-1; US-Patent-4,041,697; US-Patent-Appl-SN-596641; US-Patent-Class-60-39.28R; US-Patent-Class-60-39.66; US-Patent-Class-415-180; US-Patent-Class-123-41.33; US-Patent-Class-123-122E; US-Patent-Class-137-104) Avail: US Patent Office CSCL 21E

A gas turbine engine fuel delivery and control system is provided with means to recirculate all fuel in excess of fuel control requirements back to aircraft fuel tank, thereby increasing the fuel pump heat sink and decreasing the pump temperature rise without the addition of valving other than that normally employed. A fuel/oil heat exchanger and associated circuitry is provided to maintain the hot engine oil in heat exchange relationship with the cool engine fuel. Where anti-icing of the fuel filter is required, means are provided to maintain the fuel temperature entering the filter at or above a minimum level to prevent freezing thereof. Fluid circuitry is provided to route hot engine oil through a plurality of heat exchangers disposed within the system to provide for selective cooling of the oil.
Official Gazette of the U.S. Patent Office

N78-10483# AiResearch Mfg. Co., Torrance, Calif.
ENGINEERING TESTS FOR ENERGY STORAGE CARS AT THE TRANSPORTATION TEST CENTER. VOLUME 1: PROGRAM DESCRIPTION AND TEST SUMMARY Final Report, May 1974 - Jan. 1975

William T. Curran May 1977 138 p
(Contract DOT-TSC-838)
(PB-269400/8; DOT-TSC-UMTA-77-6-1;
UMTA-MA-06-0025-77-2) Avail: NTIS HC A07/MF A01 CSCL 13F

Tests were conducted to demonstrate the principles and feasibility of an energy storage type propulsion system, and its adaptability to an existing car design. The program comprised four phases of tests: (1) verification of safe arrival; (2) debugging procedures; (3) performance verification tests; and (4) expanded test program. Test data collected during the performance verification and expanded test program phases are presented. GRA

N78-10484# AiResearch Mfg. Co., Torrance, Calif.
ENGINEERING TESTS FOR ENERGY STORAGE CARS AT THE TRANSPORTATION TEST CENTER. VOLUME 2: PERFORMANCE POWER CONSUMPTION AND RADIO FREQUENCY INTERFERENCE TESTS Final Report, May 1974 - Jan. 1975
William T. Curran May 1977 112 p
(Contract DOT-TSC-838-2)
(PB-269401/6; DOT-TSC-UMTA-77-6-2) Avail: NTIS HC A06/MF A01; HC also available in set of 4 reports as PB-269399-SET HC E10 CSCL 13F

The principles and feasibility of an energy-storage-type propulsion system and its adaptability to an existing car design were demonstrated in four phases of tests on two New York City Transit Authority R-32 cars where propulsion system was replaced by an energy storage system. The four test phases were: verification of safe arrival, debugging procedures, performance verification tests, and expanded test program. Test data collected during the performance verification and expanded test program phases are presented. GRA

N78-10485# AiResearch Mfg. Co., Torrance, Calif.
ENGINEERING TESTS FOR ENERGY STORAGE CARS AT THE TRANSPORTATION TEST CENTER. VOLUME 3: NOISE TESTS Final Report, May 1974 - Jan. 1975
William T. Curran May 1977 91 p
(Contract DOT-TSC-838)
(PB-269402/4; DOT-TSC-UMTA-77-6-3;
UMTA-MA-06-0025-77-4) Avail: NTIS HC A05/MF A01 CSCL 13F

The test program comprised four phases of tests on two New York City Transit Authority R-32 cars where propulsion system had been replaced by an energy storage system. The four test phases were: verification of safe arrival, debugging procedures, performance verification tests, and expanded test program. GRA

N78-10486# AiResearch Mfg. Co., Torrance, Calif.
ENGINEERING TESTS FOR ENERGY STORAGE CARS AT THE TRANSPORTATION TESTS CENTER. VOLUME 4: RIDE ROUGHNESS TESTS Final Report, May 1974 - Jan. 1975
William T. Curran May 1977 168 p refs
(Contract DOT-TSC-838)
(PB-269403/2; DOT-TSC-UMTA-77-6-4;
UMTA-MA-06-0025-77-5) Avail: NTIS HC A08/MF A01 CSCL 13F

Tests were conducted to demonstrate the principles and feasibility of an energy storage type propulsion system, its adaptability to an energy storage type propulsion system, and its adaptability to an existing car design. The program comprised four phases of tests on two New York City Transit Authority R-32 cars where the conventional propulsion system was replaced by an energy storage system. The four test phases were: (1) verification of safe arrival; (2) debugging procedures; (3) performance verification tests; and (4) expanded test program. GRA

N78-10545# Netherland, Sewell and Associates, Inc., Dallas, Tex.
PRELIMINARY STUDY OF THE PRESENT AND POSSIBLE FUTURE OIL AND GAS DEVELOPMENT OF AREAS IMMEDIATELY SURROUNDING THE INTERIOR SALT DOMES UPPER GULF COAST SALT DOME BASINS OF EAST TEXAS, NORTH LOUISIANA, AND MISSISSIPPI
17 Dec. 1975 48 p refs
(Contract W-7405-eng-26)
(ORNL/Sub-75/87988) Avail: NTIS HC A03/MF A01

Present and possible future oil and gas development was investigated for the purpose of locating those salt domes where such oil and gas development would not interfere with the possible storage of radioactive waste material in the core of the salt dome. Preliminary findings indicate that several of the salt domes in each of the three basins under study are hydrocarbon barren and that the present and/or possible future oil and gas development on or in the areas immediately surrounding the salt domes should not interfere with the possible storage of radioactive waste material in the core of these salt domes. ERA

N78-10546# Geological Survey, Bay Saint Louis, Miss. Water Resources Div.
COMPUTER TECHNIQUES TO AID IN THE INTERPRETATION OF SUBSURFACE FLUID-PRESSURE GRADIENTS
J. B. Wesselman and John Heath Jun. 1977 41 p refs
Sponsored by Dept. of Interior.
(PB-268603/8; USGS/WRD/WRI-77/035) Avail: NTIS HC A03/MF A01 CSCL 08I

Fluid-pressure gradients were investigated in two geopressured-geothermal areas in Texas and Louisiana. Data were obtained from drilling records, resistivity curves of geophysical logs, and pressure tests made in bore holes. These data were converted to gradients and graphed by computer techniques. Resistivity interpretation gave reasonable results at some point in about 70 percent of the wells. Evaluation of all available data shown in the individual and adjacent wells was found to be necessary for proper gradient interpretation. GRA

N78-10550# General Accounting Office, Washington, D. C. Energy and Minerals Div.
OUTER CONTINENTAL SHELF SALE 40: INADEQUATE DATA USED TO SELECT AND EVALUATE LANDS TO LEASE: DEPARTMENT OF THE INTERIOR Report to the Congress
28 Jun. 1977 65 p
(PB-269865/2; EMD-77-51) Avail: NTIS HC A04/MF A01 CSCL 10A

Selection and evaluation of outer continental shelf lands for leasing to develop domestic oil and natural gas resources is described. Ways to improve this Federal program are outlined. GRA

N78-10551 Minnesota Univ., Minneapolis.
DEMAND FOR GASOLINE Ph.D. Thesis
Carol Dahl Norling 1977 159 p refs
Avail: Univ. Microfilms Order No. 77-19018

Market model estimates for gasoline were improved with particular emphasis on the gasoline price elasticity of demand. The model used included a demand for gasoline, a supply of gasoline, and a stock of autos equation. The complete model as closely as data permitted was estimated on United States, Canadian, and European economic community data using 2SLS. Econometric problems arose in this simultaneous system approach requiring improved econometric techniques. The question of which right hand side variables are exogenous was determined by using a Sims exogeneity test. Time series estimates were supplemented by cross section estimates for only the demand equation for United States state data, and Canadian provincial data. In the United States the time series point estimate for price elasticity of aggregate gasoline demand is - 1.545 and the cross section point estimate is 1.048. Dissert. Abstr.

N78-10552 Michigan Univ., Ann Arbor.
SYNTHETIC FUEL AND ELECTRIC CARS: A COST EFFECTIVENESS COMPARISON OF ALTERNATIVES FOR SUBSTITUTING COAL FOR OIL Ph.D. Thesis
David Parlett Hughart 1977 359 p
Avail: Univ. Microfilms Order No. 77-18032

The economic feasibility of battery-powered electric cars was compared with that of synthetic crude oil as a means of substituting coal for oil in the U.S. over the next several decades. Electric propulsion promises to be the best choice for uses in which a maximum daily driving range of 75 to 150 miles is acceptable. Development of economically viable electric cars with substantially longer ranges appears dependent on the use of a technology such as electrified highways or rapid battery exchanges that would extend range beyond that allowed by the energy storage capacity of a car's battery. A public policy analysis perspective was adopted: public expenditure criteria were used to indicate the appropriate goals of government intervention (R and D, incentive programs). The differences between private and social costs were estimated for the two options. Dissert. Abstr.

N78-10553 Michigan Univ., Ann Arbor.
WORLD SOURCES OF ENERGY AND NEW ENERGY RESOURCE DEVELOPMENT IN IRAN Ph.D. Thesis
Hooshang Ashraf 1977 177 p
Avail: Univ. Microfilms Order No. 77-18453

The depletion of existing non-renewable energy sources, particularly in Iran, represents a major constraint on the economic growth of developing nations, and sustained growth in industrialized countries. Current world-wide energy resources and reserves were identified and analyzed in regard to advantages and disadvantages of use. Of the fourteen alternative energy sources evaluated, solar, geothermal, and nuclear power were shown to have the best potential for development based on the cost of producing one kilowatt hour of electricity. The probable capital outlay necessary to construct and operate power plants using these technologies in Iran was determined. The costs were integrated with current levels of energy development and technology in that country to provide guidelines and a timetable for integrating geothermal, solar, and nuclear power within the energy sector there. Dissert. Abstr.

N78-10554* National Aeronautics and Space Administration. Pasadena Office, Calif.
PORTABLE LINEAR-FOCUSED SOLAR THERMAL ENERGY COLLECTING SYSTEM Patent
Charles G. Miller (JPL) and Jens G. Pohl, inventors (to NASA) (JPL) Issued 4 Oct. 1977 12 p Filed 28 Apr. 1976 Supersedes N76-26690 (14 - 17, p 2218) Sponsored by NASA
(NASA-Case-NPO-13734-1; US-Patent-4,051,834; US-Patent-Appl-SN-680939; US-Patent-Class-126-271; US-Patent-Class-237-1A; US-Patent-Class-350-293; US-Patent-Class-350-299) Avail: US Patent Office CSCL 10A

A solar heat collection system is provided by utilizing a line-focusing device that is effectively a cylindrically curved concentrator within a protected environment formed by a transparent inflatable casing. A target, such as a fluid or gas carrying conduit is positioned within or near the casing containing the concentrator, at the line focus of the concentrator. The casing can be inflated at the site of use by a low pressure air supply to form a unitary light weight structure. The collector, including casing, concentrator and target, is readily transportable and can be used either at ground level or on rooftops. The inflatable concentrator can be replaced with a rigid metal or other concentrator while maintaining the novel advantages of the whole solar heat collection system.
Official Gazette of the U.S. Patent Office

N78-10555 Massachusetts Univ., Amherst.
SOLAR AND WIND HOME HEATING AND DOMESTIC HOT WATER SYSTEMS: ENERGY AND ECONOMICS STUDY Ph.D. Thesis
Ghazi Darkazalli 1977 273 p
Avail: Univ. Microfilms Order No. 77-13790

A development of a digital computer based methodology to calculate system performance and costs is presented. In addition to wind powered systems, solar, and combined wind and solar systems are considered in detail. The analysis is based on two separate computer programs: (1) an energy program that determines system performance as a function of subcomponent parameters and auxiliary energy requirements, and, (2) an economics program that calculates present and future (mass produced) costs of the wind and/or solar components and system. Complete details of all parts of the model, which is intended to be a general design tool for such systems, are presented. The results include a detailed series of runs based on hourly weather and solar data for a typical New England site, using an average and residence model. Also, additional runs are presented for other sites and residences. Dissert. Abstr.

N78-10556 Brown Univ., Providence, R. I.
A STUDY OF COPPER-SULFIDE/CADMIUM-SULFIDE PHOTOVOLTAIC CELLS BASED ON SULFURIZATION AND OTHER PROCESSES Ph.D. Thesis
Huey-Liang Hwang 1976 203 p
Avail: Univ. Microfilms Order No. 77-14132

A technique for fabrication of photovoltaic cells by the sulfurization process was developed. An efficiency of approximately 2% in direct sunlight was achieved. A comparison of properties of Cu(x)S/CdS solar cells, in which different methods were used to prepare the Cu(x)S layer, was done. The post-fabrication treatments, commonly used to improve the properties of Cu(x)S/CdS solar cells, were also studied. Cathodoluminescence was further developed as an analytical tool to study material properties. Dissert. Abstr.

N78-10558 Polish Academy of Sciences, Warsaw.
ENERGY MANAGEMENT AS A SCIENTIFIC DISCIPLINE [GOSPODARKA ENERGETYCZNA JAKO DYSCYPLINA NAUKOWA]
Wlodzimierz Bojarski and Janusz Cofala 4 Feb. 1977 163 p refs In POLISH
Avail: Issuing Activity

The domain of energy management research is defined. The divisions of this research are classified, the intermeshing of the discipline with other technical, natural, and social sciences is specified. The substantive and organizational structure of the national fuel and energy system is characterized. The factors integrating the system are enumerated and a general numerical characterization is provided. The central problem at present is optimizing the process of changing the structure of the national energy system in the long range taking into account all interrelationships and uncertainties. The general state of development of national and foreign scientific centers and international scientific organizations occupied with problems of energy management is described. The large amount of disintegrated organization and the structure of subsystems of national energy systems receive special attention. The need for creating a central research institution for integrating and stimulating economic system research in the domain of energy management is emphasized. Author

N78-10559*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
SOLAR POWER SATELLITE CONCEPT EVALUATION. VOLUME 1: SUMMARY Progress Report, Jul. 1976 - Jun. 1977
Jun. 1977 130 p
(NASA-TM-74820; JSC-12973-Vol-1) Avail: NTIS HC A07/MF A01 CSCL 10A

A program was developed to determine the technical feasiblity of a satellite solar power station. The space construction, maintenance, and transport systems are discussed. Environmental factors, in addition to manufacturing, natural resources, and energy were considered. Cost estimates and alternative systems are outlined. G.D.H.

N78-10560# Maxwell Labs., Inc., Woburn, Mass.
STUDY OF HIGH POWER, HIGH PERFORMANCE PORTABLE MHD GENERATOR POWER SUPPLY SYSTEMS Final Report, Jun. 1975 - Mar. 1976
Otto K. Sonju and Joseph Teno Aug. 1976 250 p refs
(Contract F33615-75-C-2069)
(AD-A040381; AFAPL-TR-76-87) Avail: NTIS HC A11/MF A01 CSCL 10/2

This report presents the results of a study program undertaken to investigate and evaluate high power, lightweight, MHD generator systems. Detailed design studies of various MHD generator systems for use as a prime source in the range of power from 10 to 50 MW operating for some 63 to 120 seconds total run time were performed. Both single and multipulse operations were considered. A relatively wide range of operating parameters were considered and eight specific point designs were investigated. A three-year development program for a lightweight ground based prototype MHD generator system was defined. The design of a high performance, compact MHD generator system involves the consideration and trade-off of a number of the MHD generator operating parameters including the power density, the efficiency, the magnet flux density, the length to diameter ratio of the channel, the channel configuration, the boundary layers, the conductivity, and the various flow parameters. Once compactness and optimization have been achieved in this regard, the matter of lightweight components becomes an important consideration. In the present study, trade-off studies in terms of the operating parameters were conducted, and the designs of lightweight components were studied and evaluated. Lightweight rocket-type combustors, both using solid and liquid fuels, exist and were evaluated in terms of performance in an MHD generator system. The design of compact, lightweight, superconducting magnets and generator channels were evaluated. A small lightweight MHD channel is currently being fabricated. GRA

N78-10561# Bechtel Corp., San Francisco, Calif.
COAL GASIFICATION STUDY HANDBOOK Final Report
Apr. 1977 102 p
(Contract N68305-76-C-0009)
(AD-A042385) Avail: NTIS HC A06/MF A01 CSCL 21/4

The purpose of this handbook is to provide: first, a procedure for evaluating the costs of a coal gasification plant in terms of the capital investment and operating costs. These are to be sensitive to several parameters defining coal, fuel gas, and sulfur emissions; second, a procedure for the derating of Navy base boilers, to reflect the change in performance resulting from introduction of fuel gas in place of coal or oil. The gas plant analysis is based in part on a detailed analysis of the gas treatment section of the plant. The remaining part of the plant performance is based on conventional stoichiometry and near approach to equilibrium in the gas production section. The boiler derating method is based on observations of the relative contribution to heat transfer made by radiation and convection, and on conventional relations describing these transfer processes. Author (GRA)

N78-10563# Purdue Univ., Lafayette, Ind.
MATERIAL SELECTION CONSIDERATIONS FOR FLUORIDE THERMAL ENERGY STORAGE CONTAINMENT IN A SODIUM HEAT PIPE ENVIRONMENT Final Report, 1 Jun. - Aug. 1976
Dean L. Jacobson May 1977 34 p refs Prepared in Cooperation with Arizona State Univ., Tempe
(Contract F33615-74-C-2014)
(AD-A042389; AFAPL-TR-77-9) Avail: NTIS HC A03/MF A01 CSCL 10/3

This contract involved a literature survey to determine the state-of-the-art of materials in a high temperature Na and vacuum environment as applied to thermal energy storage. It was found that little information exists for materials or heat pipes in the high temperature (1400 K) Na or vacuum environments. Program recommendations are to perform life tests on candidate materials and Na heat pipes with post test corrosion analyses. Na wicking parameter must be determined experimentally for accurate heat pipe design. Author (GRA)

N78-10566# Energy Research Corp., Danbury, Conn.
FUEL CELL STACKS Final Technical Report
S. G. Abens, B. S. Baker, and I. Michalko Jun. 1977 73 p
(Contract DAAK02-74-C-0367)
(AD-A042315; ERC-7396-4) Avail: NTIS HC A04/MF A01 CSCL 10/2

Manufacturing methods and techniques for phosphoric acid fuel cell stack production were developed. Electrodes, matrices, and bipolar gas distribution plates for cells with an active area of 0.4 sq. ft. were produced and tested. Assembly and testing of 2-, 10-, and 35-cell stacks was performed. Stacks were operated at 320F for up to 4,000 hours, and tolerance to CO was demonstrated. Author (GRA)

N78-10567# Army Construction Engineering Research Lab., Champaign, Ill.
TECHNOLOGY EVALUATION OF ARMY-SCALE WASTE-TO-ENERGY SYSTEMS
S. A. Hathaway and R. J. Dealy Jul. 1977 87 p refs
(DA Proj. 4A7-62719-AT-41)
(AD-A042578; CERL-IR-E-110) Avail: NTIS HC A05/MF A01 CSCL 13/1

This investigation evaluated current and emerging technologies for the converting waste to energy in applications scaled for use on Army fixed facilities and installations. Technologies reviewed include: mass burning of wastes in package (modular) and field-erected systems; use of refuse-derived fuel (RDF) in new combustion capital and as a supplementary fuel in existing Army-scale central steam generators; pyrolytic conversion of waste to a gaseous and liquid fuel; and anaerobic digestion of wastes to a fuel gas. The report includes application of a rating system for candidate technologies which considers dependability, practicability, conservation, environmental compatibility, economics, and length of operational history. Use of package waste-to-energy systems and use of RDF as a supplementary boiler fuel are treated in detail. Fully satisfactory methods of surveying installation solid waste to determine energy-recovery system design points are lacking, and currently used methods can result in misapplication of capital. Combustion of unprocessed and minimally processed (Once-shredded) solid waste in field-erected integrated waterwall combustors equipped with mechanical stokers is currently the superior energy recovery technology. Anaerobic digestion and pyrolytic conversion were found to be unproven but developing. GRA

N78-10568# Mallory Battery Co., Tarrytown, N. Y.
PRIMARY LITHIUM ORGANIC ELECTROLYTE BATTERY BA - 5598 ( )/U Final Report, 1 Dec. 1972 - Apr. 1976
S. Kravetz and N. Raman Jun. 1977 63 p
(Contract DAAB07-72-C-0288; DA Proj. 1L7-63702-DG-10)
(AD-A042799; ECOM-72-0288-F) Avail: NTIS HC A04/MF A01 CSCL 10/3

This report summarizes the program which was aimed at developing a Primary Lithium Organic Electrolyte Battery capable of operating over a temperature range of -40 F. to 125 F. A 15.0 volt battery was designed with hermetically sealed cells to withstand high temperature storage conditions and to operate simulated field equipment pulse loads. The cells are designed for energy densities up to 150 WH/LB at room temperatures at approximately 0.4A drains. The contract was modified to incorporate a new hermetically sealed cell to replace the original compression sealed cell. In addition to preventing leakage of SO2 during storage at 160 F., the cell design self venting mechanism enhanced the safety characteristics associated with Lithium Organic Primary Batteries. The battery nomenclature and configuration was modified in order to meet the Technical Requirements of the BA 5598 ( )/U Battery, which was reduced in size and weight to as much as 50% as compared to the original BA - 584 ( )/U Battery. Author (GRA)

N78-10569# Stein (Richard G.) and Associates, New York.
RESEARCH DESIGN CONSTRUCTION AND EVALUATION OF A LOW ENERGY UTILIZATION SCHOOL, PHASE 2
R. G. Stein, C. Stein, and P. F. Deibert 31 Mar. 1977 196 p
(Grant NSF AER-73-0357-A02)
(PB-269407/3; NSF/RA-770032) Avail: NTIS HC A09/MF A01 CSCL 13A

The development of a lighting program is discussed. This includes the evaluations of high-efficiency commercially available light fixtures; design, construction, and testing of fluorescent adaptors for buildings presently lighted with incandescent fixtures; modifications to ventilation systems; and the design of a filmstrip to involve the teachers and students in the school buildings in an energy conservation program. GRA

N78-10572# Spectrolab, Inc., Sylmar, Calif.
HIGH EFFICIENCY SOLAR PANEL (HESP) Final Report, 1 Jun. 1975 - 15 Jun. 1977
John Scott-Monck, Charles Gay, Paul Stella, and Frank Uno Wright-Patterson AFB, Ohio AFAPL 1 Jul. 1977 145 p refs

(Contract F33615-75-C-2)
(AD-A043382; AFAPL-TR-77-36) Avail: NTIS HC A07/MF A01 CSCL 10/2

A Family of high efficiency, weldable silicon solar cells, incorporating every feature of advanced technology developed in the past four years, was produced and subjected to space qualification testing. This matrix contained both field and non-field cells ranging in thickness from 0.10 mm to 0.30 mm, and in base resistivity from nominal two to one hundred ohm-cm. Initial power outputs as high as 20 mW/sq.cm (14.8% AMO efficiency) were produced by certain cell types within this group. All these cells had certain common features; a selectively etched front surface which reduced reflection losses, tantalum-palladium-silver front contacts, chromium-palladium-silver back contacts, junction depths approx 0.10 micrometers, and a tantalum pentoxide antireflection coating. For the field cells, acceptor doping was accomplished using a screen printed aluminum paste source. The baseline cell, which was 0.23 mm thick, nominal two ohm-cm, non-field type was produced in three sizes, 2 x 2 cm, 2 x 4 cm and 2 x 6 cm, the others in 2 x 2 cm form. The 2 x 2 cm baseline cell underwent a complete space qualification test cycle including all the typical environmental requirements such as temperature-humidity and thermal cycling. The baseline cell and eleven other types were tested to electron fluence levels of 1 x 10 to the 16th power equivalent 1 MeV electrons/sq.cm, fission spectrum neutron fluence levels of 1 x 10 to the 13th power equivalent 1 MeV neutrons/sq.cm, and were characterized with respect to their radiometric properties. GRA

N78-10573# National Bureau of Standards, Washington, D. C. Inst. for Materials Research.
MATERIALS FOR FUEL CELLS Annual Report, Jan. - Dec. 1976
L. H. Bennett, M. I. Cohen, A. L. Dragoo, A. D. Franklin, and A. J. McAllister May 1977 64 p refs
(PB-269518/7; NBSIR-77-1270) Avail: NTIS HC A04/MF A01 CSCL 10B

Transition metal carbides, borides and nitrides were examined with respect to stability and to catalytic oxidation of H2 as non-precious substitutes for Pt as fuel electrocatalysts. An automated system for electrochemical analysis was designed and built, using digital control and readout techniques to perform analog measurements. Studies of CeO2:Y2O3 ceramic electrolytes were designed to measure the influence of annealing and prolonged current passage on electrical properties of these materials. Work on a high temperature facility for these experiments and preparation of CeO2:Y2O3 ceramic specimens is described. GRA

N78-10574# Price Waterhouse and Co., Washington, D. C. Office of Government Services.
DIGEST OF FEDERAL REGISTERS
Mar. 1977 301 p
(Contract FEA-CR-06-70002-00)
(PB-270153/0; FEA/H-77/280) Avail: NTIS HC A14/MF A01 CSCL 05C

A compilation of the changes to Refiner and Reseller Pricing Regulations as they appeared in the Federal Register is presented. Included are the preambles and rulings in addition to the actual regulation language. GRA

N78-10575# Little (Arthur D.), Inc., Cambridge, Mass.
SOLAR AIR-CONDITIONING STUDY Final Report
Richard Merriam Apr. 1977 144 p refs
(Contract N68305-76-C-0029; zf57571001)
(AD-A043951; ADL-C-79679; CEL-CR-77.018) Avail: NTIS HC A07/MF A01 CSCL 13/1

The state-of-the-art of solar cooling is evaluated to determine the near term performance potentials and life-cycle costs of the most promising approaches. The heat actuated absorption cycle, Rankine cycle, and desiccant dehumidification cycle are examined. The principles of operation are described, performance coefficients are reviewed, operating constraints are examined, and the commercial status of each approach is evaluated. An analysis of the major solar cooling demonstrations (as of 1976) is carried out. Savings-to-investment ratios are calculated for solar cooling systems in buildings in seven locations within the United States. Author (GRA)

N78-10576# Energy Research and Development Administration, Washington, D. C. Div. of Solar Energy.
SOLAR ENERGY IN AMERICA'S FUTURE: A PRELIMINARY ASSESSMENT
Mar. 1977 126 p refs
(DSE/115-1) Avail: NTIS HC A07/MF A01

A study of potential roles that solar energy technologies could have for meeting U.S. energy needs over the next 45 years is documented. Computer simulations of different energy supply projections were developed by varying the input parameters of energy demand and energy costs. Some of these projections were chosen to be developed into broader scenarios-that is, richer scripts of the future. First, the implementation measures required to realize these scenarios were delineated. Then, the economic, socio-economic, socio-political, and environmental issues associated with different energy futures were identified, and these issues were compared among the three scenarios. Finally, six major societal issues were synthesized from an analysis of the scenarios. These issues and the three scenarios were evaluated from the perspectives of individuals in different perceptual frames of reference. ERA

N78-10577# Energy Research and Development Administration, Washington, D. C. Div. of Solar Energy.
SOLAR PROGRAM ASSESSMENT: ENVIRONMENTAL FACTORS
Mar. 1977 71 p refs
(ERDA-77-47/5) Avail: NTIS HC A04/MF A01

The major environmental, safety, and social/institutional issues associated with the further development of solar total energy systems (STES) are presented and prioritized. The basic concepts of STES are reviewed, as are their resource requirements. The potential effects of these systems on the full range of environmental concerns are discussed in terms of their relative significance and possible solutions. Only those impacts unique to the solar portion of the technology are discussed in depth. An environmental work plan is presented, listing R and D proposals and a NEPA work plan that might help clarify and/or alleviate specific environmental problems. ERA

N78-10578# Alaska Univ., Fairbanks.
WIND POWER POTENTIAL OF ALASKA. PART 2: WIND DURATION CURVE FITS AND OUTPUT POWER ESTIMATES FOR TYPICAL WINDMILLS
Tunis Wentink, Jr. Aug. 1976 92 p
(Contracts E-76-S-06-2229)
(RLO-2229-T12-76/1-Pt-2; UAG-R-240-Pt-2) Avail: NTIS HC A05/MF A01

An empirical analytical function (F1) and the Weibull function (F3) were compared for use in casting measured long-term wind speed frequency data in the form of the wind speed duration curves. Data from 18 Alaskan locations were used in the 248 cases treated. The fitted duration curves were coupled with the instantaneous power vs. wind speed characteristics for three wind energy conversion systems (WECS) to predict the probable monthly and annual mean energy productivity and power levels of the WECS. The validity of use of the long-term average wind speed as a key parameter in wind work is demonstrated. ERA

N78-10579# Dynatherm Corp., Cockeysville, Md.
HEAT PIPE CENTRAL SOLAR RECEIVER Semiannual Progress Report, 1 Mar. - 31 Aug. 1976
Walter B. Bienart and D. A. Wolf Nov. 1976 120 p refs
(Contract EY-76-C-02-2839)
(COO-2839-1) Avail: NTIS HC A06/MF A01

The concept is based on the use of heat pipes to transfer the concentrated solar flux to the gaseous working medium of a Brayton cycle conversion system. An open air cycle with recuperator and a turbine inlet temperature of 800 C (approximately 1500 F) was selected as the optimum choice. It yields a conversion efficiency of approximately 32 percent and an overall solar-to-electric efficiency of 20 percent. Three potential receiver configurations have been identified, two of them being of the cavity type and one being an external receiver. The required thermal diffuser heat pipes use liquid metal as the working fluid. The optimum size is approximately 5 cm in diameter and 2 to 3 cm in length. The design axial heat flux is 10 MW/m square meter which corresponds to a heat transfer rate of 20 kW per heat pipe. The theoretical foundations of these heat pipes have been developed and subscale prototypes have been tested successfully. The radial and axial heat fluxes of the prototypes met and exceeded the requirements for the full-scale heat pipes. ERA

N78-10580# Illinois Univ., Urbana. Center for Advanced Computation.
STRUCTURAL DESCRIPTIONS OF ALTERNATIVE ENERGY FUTURES
C. W. Bullard 1977 6 p refs Sponsored by ERDA
(COO-2865-7) Avail: NTIS HC A02/MF A01

Characterizing key structural features of a nation's economic system was emphasized in regard to long range energy policy analysis. It was shown that energy analysis techniques are well suited to such applications, particularly over time horizons beyond the reach of econometric methodologies. Tradeoffs between aggregation and uncertainty were discussed as a function of time horizon. For alternative energy futures, special attention was given to the assessment of impacts on lifestyles, technology, and employment. Author

N78-10581# Teledyne Energy Systems, Timonium, Md.
SELENIDE ISOTOPE GENERATORS
T. E. Hammel and W. E. Osmeyer 1977 7 p
(Contract EX-76-C-16-3077)
(CONF-770302-1) Avail: NTIS HC A02/MF A01

Predicted performance characteristics were established, through design studies, for radiosotope thermoelectric generators using selenide thermoelectric materials. These materials exhibited an efficiency growth potential as a function of improvements in both material composition and increased operating temperature. These performance characteristics were established for time intervals: 1981, 1983, and 1985. The 1981 generator was designed for the Jupiter orbiter probe mission and exhibits an efficiency of 10.5 percent. The 1983 system promises efficiency of 11 percent, and the 1985 system, 13.5 percent. Author

N78-10582# Israel Atomic Energy Commission, Tel Aviv.
GUIDELINES FOR FORECASTING ENERGY DEMAND
T. Sonnino Nov. 1976 22 p refs
(IA-1327) Avail: NTIS (US Sales Only) HC A02/MF A01; ERDA Depository Libraries

Four methodologies for forecasting energy demand are reviewed after considering the role of energy in the economy and the analysis of energy use in different economic sectors. The special case of Israel is considered throughout, and some forecasts for energy demands in the year 2000 are presented. An energy supply mix that may be considered feasible is proposed. ERA

N78-10583# Westinghouse Electric Corp., Pittsburgh, Pa.
STUDY OF THE MANUFACTURING COSTS OF LEAD-ACID BATTERIES FOR PEAKING POWER Final Report, period ending Oct. 1976
Dec. 1976 65 p
(Contract EX-76-C-01-2114)
(CONS/2114-2) Avail: NTIS HC A04/MF A01

A postulated 1000 MWh per year lead-acid battery business was studied which is dedicated to supplying a single design of 40 MWh peaking power batteries to electric utilities. State-of-the-art industrial technology is assumed, but the manufacturing facility and business organization is tailored to the one product. Analysis of the product costs and business expenses associated with such an operation indicates that substantially lower selling prices can be realized as compared with normal industrial battery pricing. ERA

N78-10584# Electrochemical Technology Corp., Seattle, Wash.
IMPROVEMENTS IN ENERGY EFFICIENCY OF INDUSTRIAL ELECTROCHEMICAL PROCESSES Final Report
T. R. Beck Jan. 1977 229 p refs
(Contract W-31-109-eng-38)
(ANL/OEPM-77-2) Avail: NTIS HC A11/MF A01

Industrial electrochemical processes for the purpose of identifying methods of improving energy efficiencies were studied. A historical perspective is given on energy usage by the aluminum and chlor-alkali industries. Past actions affecting energy efficiency are described as a background for discussing possible future improvements. Energy flow diagrams are provided for processes, showing the components and efficiency of energy usage. Possible methods of improving energy efficiency are then described. Emphasis is placed on aluminum reduction and manufacture of chlorine and sodium hydroxide since these are the most important of the electrochemical industries in terms of energy use and possible energy savings. ERA

N78-10585# Argonne National Lab., Ill.
DESIGN AND COST STUDY OF NICKEL-ZINC BATTERIES FOR ELECTRIC VEHICLE Final Report
M. Klein and D. Dube 1 Oct. 1976 132 p
(Contract W-31-109-eng-38)
(ANL-K-76-3541-1) Avail: NTIS HC A07/MF A01

A battery module configuration consisting of four 325-Ah cells was selected. A 24-kWh battery would be made up of 12 such modules. The key design parameter is operation current density. An energy density of 2.1 Wh/cu in. and 35 Wh/lb was obtained. A flow diagram was drawn for the manufacturing process. Pilot plant requirements are discussed. ERA

N78-10586# Oak Ridge National Lab., Tenn.
BOILING HEAT TRANSFER IN A BENCH-SCALE MOLTEN-SALT THERMAL ENERGY STORAGE DEVICE
R. M. Canon and J. D. Hewitt May 1977 36 p
(Contract W-7405-eng-26)
(ORNL/TM-5689) Avail: NTIS HC A03/MF A01

Overall boiling heat transfer coefficients were determined experimentally for a proposed thermal energy storage salt ($NaNO_3$) in a vertical-tube boiler for the following range of variables: (1) water flow (lb/hr/sq ft) = 840-2800; (2) steam temperature (deg F) = 295-475; (3) steam pressure (psi) = 50-500; and (4) heat flux (Btu/hr/sq ft) = 2100-6700. Tube and vessel heat fluxes and energy recovery fractions were also determined. ERA

N78-10587# California Univ., Livermore. Lawrence Livermore Lab.
FIBER-COMPOSITE SYSTEMS FOR ENERGY-STORAGE FLYWHEELS
L. S. Penn and E. S. Jessop 31 Dec. 1976 13 p refs Presented at the 22nd Natl. SAMPE Symp./Exhibition, San Diego, Calif. 26-28 Apr. 1977
(Contract W-7405-eng-48)
(UCRL-78610; Conf-770407-2) Avail: NTIS HC A02/MF A01

Fiber-composite systems for use in energy-storage flywheels (Kevlar 49/epoxy, Kevlar 29/epoxy, S2-glass/epoxy, and E-glass/epoxy) were studied. The performances of the four materials were compared and a relationship between results of conventional materials tests and spin tests was obtained. For each material, tensile tests of epoxy-coated strands, hydroburst tests of NOL rings, and hydroburst and spin tests of thin-rim composite rotors about 406 mm in diameter were performed. The results of the rotor and NOL ring hydroburst tests were the same as the results of the spin tests. For the thin-rim rotor design, hydroburst tests of the rotor or of the NOL ring can be used to predict spin performance. In terms of energy density, Kevlar 49/epoxy ranked highest, but in terms of energy density per unit cost, E-glass/epoxy was best. ERA

N78-10588# Oak Ridge National Lab., Tenn.
ASSESSMENT OF HIGH TEMPERATURE NUCLEAR ENERGY STORAGE SYSTEMS FOR THE PRODUCTION OF INTERMEDIATE AND PEAK-LOAD ELECTRIC POWER
E. C. Fox, L. C. Fuller, and M. D. Silverman 18 Apr. 1977 56 p refs
(Contract W-7405-eng-26)
(ORNL/TM-5821) Avail: NTIS HC A04/MF A01

An evaluation of thermal storage systems is made for several reactor concepts and economic comparisons are presented with conventional storage and peak power producing systems. It is concluded that dedicated nuclear storage has a small but possible useful role in providing intermediate and peak-load electric power. ERA

N78-10589# Brookhaven National Lab., Upton, N. Y.
PROSPECTS OF USING SUPERCONDUCTING dc LINES
V. E. Ignatov and A. V. Misulin 1976 10 p refs Transl. into ENGLISH from Krizhizhanovskij Ehnergeticheskij Inst., Moscow (USSR)
(BNL-TR-637) Avail: NTIS HC A02/MF A01

The storage of electric power in modern energy systems is described. A solution is proposed for combining the transmission and storage of electric power in superconducting dc power transmission lines in which cryotron-type transformers are connected to the superconducting transmission line and operated in parallel with the main semiconductor transformers. ERA

N78-10590# General Accounting Office, Washington, D. C. Energy and Minerals Div.
DOMESTIC ENERGY RESOURCE AND RESERVE ESTIMATES: USES, LIMITATIONS, AND NEEDED DATA
17 Mar. 1977 59 p
(PB-268966/9; EMD-77-6) Avail: NTIS HC A04/MF A01 CSCL 08I

The government's data on domestic resources and reserves of crude oil, natural gas, uranium, and coal were studied. It was found that estimates of resources and reserves of these fuels can be greatly improved. GRA

N78-10591# MetroStudy Corp., Washington, D. C.
COMMERCIAL SPACE: POLICY ANALYSIS OF PROFITABILITY OF RETROFIT FOR ENERGY CONSERVATION Final Report
John Williams, Dennis Eisen, Albert Beverly, and Richard Murray Jun. 1976 152 p refs
(Contract FEA-CO-04-50279)
(PB-269189/7; FEA/D-77/187) Avail: NTIS HC A08/MF A01 CSCL 13A

The formulation of policy alternatives to promote the retrofit of commercial buildings for energy conservation was investigated. The study design called for: (1) the collection of detailed financial data and building characteristics; (2) the identification of rational retrofit measures individually developed for selected buildings with an estimate of cost and energy saving; (3) a detailed analysis of the financial projection for each building over its expected life, for each retrofit option and for three selected policy alternatives; (4) the description of commercial space in 12 cities as derived from existing studies; and (5) the preparation of detailed inventories of the commercial space in 2 cities. GRA

N78-10592# Faucett (Jack) Associates, Inc., Chevy Chase, Md.
STATE-OF-THE-ART OF FUNCTIONAL USE DATA MEASURING ENERGY CONSUMPTION IN THE COMMERCIAL SECTOR Final Report
Hilary A. Kaufman and William Anderson Apr. 1977 82 p refs
(Contract FEA-P-03-77-4390-0)
(PB-269906/4; JACKFAU-77-173-1; FEA/B-77/224) Avail: NTIS HC A05/MF A01 CSCL 10A

Estimates of the amount of energy consumed in 1974 for each of the six functional uses in eight commercial industries are presented. The methodology used to estimate the overall energy consumption and to document the availability of information concerning functional use patterns of energy consumption is evaluated. GRA

N78-10593# Gruy Federal, Inc., Arlington, Va.
PRICING EFFECTS ON FRONTIER OIL PRODUCTION Final Report
20 Jun. 1977 273 p
(Contract FEA-CR-05-60813-00)
(PB-269807/4; FEA/H-77/223) Avail: NTIS HC A12/MF A01 CSCL 05C

A study was designed to analyze and evaluate the price effect on the rate and cost of converting the resource potential of frontier regions to produced oil. The frontier regions studied were: (1) Alaska - Onshore (Regions 18 and 19); (2) Lower 48 - Onshore (Deep Horizon); (3) Alaska - Offshore (Regions 20 and 21); (4) Pacific Offshore (Region 22); (5) Gulf of Mexico (Region 24). A computer model was developed to assess probable exploitation scenarios of oil reserves in these regions. GRA

N78-10594# Price Waterhouse and Co., Washington, D. C. Office of Government Services.
REFERENCE GUIDE TO CHANGES IN RESELLER PRICING REGULATIONS AND RULINGS
Mar. 1977 54 p
(Contract FEA-CR-06-70002-00)
(PB-270152/2; FEA/H-77/279) Avail: NTIS HC A04/MF A01 CSCL 05C

A reference guide was written to assist the FEA auditor in understanding the history of the FEA resellers pricing regulations. It is written in nonlegal language for easy reading. The reference guide presents a discussion of main topics within the regulations (crude oil costs, nonproduct costs, etc.) followed by time flow charts. The discussions and charts offer an overview of the rules and changes. GRA

N78-10595# Price Waterhouse and Co., Washington, D. C. Office of Government Services.
REFERENCE GUIDE TO CHANGES IN REFINER AND RESELLER PRICING REGULATIONS AND RULINGS
Mar. 1977 149 p
(Contract FEA-CR-06-77-4463-0)
(PB-270151/4; FEA/H-77/278) Avail: NTIS HC A07/MF A01 CSCL 05C

The reference guide was written to assist the FEA auditor in understanding the history of the FEA refiners and resellers pricing regulations. It is written in nonlegal language for easy reading. The Reference Guide presents a discussion of main topics within the regulations (crude oil costs, non-product costs, etc.) followed by time flow charts. The discussions and charts offer an overview of the rules and changes. GRA

N78-10596# Foster Associates, Inc., Washington, D.C. Energy Div.
IMPACT OF NATURAL GAS SHORTAGE ON MAJOR INDUSTRIAL FUEL-BURNING INSTALLATIONS. VOLUME 1: TEXT
J. A. Brickhill Mar. 1977 138 p refs 3 Vol.
(Contract EPA-68-02-1452)
(PB-269365/3; EPA-450/3-77-017a-Vol-1) Avail: NTIS HC A07/MF A01; also available in set of 3 reports PC E07, PB-269364-SET. CSCL 10A

The impact of natural gas shortages on major fuel burning installations was analyzed. The availability of natural gas through 1980 for major fuel burning installations, the alternate fuel burning capability of these plants, the need for alternate fuels such as fuel oil and coal to offset the gas shortages and the estimated increase in sulfur dioxide and particulate emissions from the burning of these alternate fuels were estimated. The narrative for the analysis of natural gas shortages on the gas fired plants is presented; with pertinent findings and conclusions. GRA

N78-10597# Foster Associates, Inc., Washington, D.C. Energy Div.
IMPACT OF NATURAL GAS SHORTAGE ON MAJOR INDUSTRIAL FUEL-BURNING INSTALLATIONS. VOLUME 2: SCHEDULES (DATA AND TABLES)
J. A. Brickhill Mar. 1977 95 p refs 3 Vol.
(Contract EPA-68-02-1452)
(PB-269366/1; EPA-450/3-77-017-b-Vol-2) Avail: NTIS HC A05/MF A01; also available in set of 3 reports, PC E07, PB-269364-SET CSCL 10A
The impact of natural gas shortages on major fuel burning installations was analyzed. Gas curtailments plans, natural gas supplies, FEA survey data for MFBI and applicable state air pollution control regulations were reviewed. The availability of natural gas through 1980 for major fuel burning installations, the alternate fuel burning capability of these plants, the need for alternate fuels such as fuel oil and coal to offset the gas shortages and the estimated increase in sulfur dioxide and particulate emissions from the burning of these alternate fuels were estimated. Schedules of data summaries for the natural gas fired plants are presented. GRA

N78-10598# Foster Associates, Inc., Washington, D.C. Energy Div.
IMPACT OF NATURAL GAS SHORTAGE ON MAJOR INDUSTRIAL FUEL BURNING INSTALLATIONS. VOLUME 3: APPENDIX: SUMMARY AND ANALYSIS OF FUEL-BURNING CHARACTERISTICS OF MFBIS
J. A. Brickhill Mar. 1977 91 p refs 3 Vol.
(Contract EPA-68-02-1452)
(PB-269367/9; EPA-450/3-77-017-c-Vol-3) Avail: NTIS CSCL 10A
The impact of natural gas shortages on major fuel burning installations was analyzed. Gas curtailments plans, natural gas supplies, FEA survey data for MFBI and applicable state air pollution control regulations were reviewed. A limited analysis of all the MFBI data is presented. GRA

N78-10599# Federal Energy Administration, Washington, D. C. Office of Data and Analysis.
PROJECT INDEPENDENCE EVALUATION SYSTEM (PIES) DOCUMENTATION. VOLUME 14: A USERS GUIDE
Elizabeth Chase MacRae Jun. 1977 72 p
(PB-268850/5; FEA/W-77/115) Avail: NTIS HC A04/MF A01 CSCL 10A
The system consists of a number of complex interrelated computer models and associated data bases which can be used to project the state of the energy market in the years 1980, 1985, and 1990. By varying assumptions and data, the user can define alternative scenarios for the analysis of alternative energy issues. The purpose is to provide a potential PIES user with a description of how PIES operates with particular emphasis on the possible variations in assumptions and data that can be made in specifying alternative scenarios. GRA

N78-10600# Federal Energy Administration, Washington, D. C. Office of Regulatory Programs.
PETROLEUM SUPPLY ALTERNATIVES FOR THE NORTHERN TIER STATES THROUGH 1980
Mario Cardullo Jun. 1977 166 p
(PB-269809/0; FEA/H-77/183) Avail: NTIS HC A08/MF A01 CSCL 10A
The magnitude of the potential petroleum crude and product shortfall that will occur in the Northern Tier area as Canadian crude supplies are phased out is analyzed. The alternative(s) that will most effectively alleviate the crude and product shortfall in the near-term and facilitate implementation of the most satisfactory long-range solutions are evaluated. GRA

N78-10601# George Washington Univ., Washington, D. C. School of Engineering and Applied Science.
PERFORMANCE POTENTIAL OF THE ENERGY SEPARATOR WITHOUT MECHANICAL ENERGY RECOVERY
Joseph V. Foa Apr. 1977 25 p refs
(Grant NSF ENG-75-01409)
(PB-269721/7; TR-ES-772) Avail: NTIS HC A02/MF A01 CSCL 13A
The performance potential of the 'basic' energy separator heating or cooling system is evaluated. The best potential is found in uses involving the utilization of solar energy storage, in the simultaneous heating and cooling of separate spaces, and in vehicular air conditioning. The system is uniquely suited for application to the cooling of structures in supersonic aircraft. GRA

N78-10602# Los Alamos Scientific Lab., N. Mex.
USE OF BRACKISH GROUND WATER RESOURCES FOR REGIONAL ENERGY CENTER DEVELOPMENT, TULAROSA BASIN, NEW MEXICO: PRELIMINARY EVALUATION
Mar. 1977 503 p refs Sponsored by FEA
(PB-269898/3; FEA/G-77/101) Avail: NTIS HC A22/MF A01 CSCL 10A
The suitability of the Tularosa basin in south-central New Mexico as the site for a regional energy center is discussed, with the objective of broadening the technical and governmental dialogue about utilization of brackish aquifers, which occur in many parts of the West. Underlying the Tularosa Basin is roughly 40 million acrefeet of fresh and slightly saline water that is theoretically recoverable and could be used for cooling and other energy-related or industrial purposes. GRA

N78-10603# International Atomic Energy Agency, Vienna (Austria).
ENERGY IN DEVELOPING COUNTRIES: PROSPECTS AND PROBLEMS
V. Baum 1977 17 p refs Presented at Nucl. Power and its Fuel Cycles, Salzburg, Austria, 2 May 1977
(IAEA-CN-36/581; CONF-770505-235) Avail: NTIS (US Sales Only) HC A02/MF A01; ERDA Depository Libraries
Requirements for primary energy and electric power in the developing countries are analyzed in the light of projections of population and economic growth. The availability of indigenous energy resources and focuses on input requirements (capital, technology, trained personnel) for accelerated energy development; and possible supplies for such inputs from domestic sources, transnational corporations, multilateral institutions, and through co-operation among the developing countries themselves and between the developing and the developed countries are reviewed. ERA

N78-10605# Central Electricity Generating Board, London (England).
UK EXPERIENCE OF PLANNING THE NUCLEAR CONTRIBUTION TO THE UK POWER PROGRAMME
S. Catchpole and F. P. Jenkin 1977 9 p refs Presented at Intern. Conf. on Nucl. Power and its Fuel Cycles, Salzburg, Austria, 2 May 1977
(IAEA-CN-36/53; CONF-770505-243) Avail: NTIS (US Sales Only) HC A02/MF A01
The U.K. experience in planning nuclear program is outlined. The factors which have determined the size of such programs are examined together with those factors which have influenced their implementation. The role which the utility has played in the deployment of nuclear power in the U.K. is also discussed. At present, nuclear energy can only be utilized on a large scale via the electricity route, and the forecasting of electricity demand is therefore a key element in determining the size of the nuclear program. Other important issues which affect the nuclear contribution are: national fuel policies, discontinuities in price and availability of imported fossil fuels, plant capital costs, fuel price relativities, plant siting, rate of introduction of new nuclear systems, manufacturer's capability, public attitudes towards nuclear power and financing. The issues are dealt with in detail including their relative importance in the U.K. ERA

N78-10608# Coast Guard Research and Development Center, Groton, Conn.

FIELD INFRARED METHOD TO DISCRIMINATE NATURAL SEEPS FROM NON-SEEPS, SANTA BARBARA, CALIFORNIA AREA Final Report
DeLyle Eastwood and Douglas F. Grant Dec. 1976 25 p
(AD-A042861; CGR/DC-15/76; USCG-D-32-77) Avail: NTIS HC A02/MF A01 CSCL 20/6

A field infrared method has been developed to distinguish oil due to natural seepage in the Santa Barbara (California) Channel region from closely similar oils derived from spills at offshore drilling platforms or from shipping accidents. Differences between seep and non-seep oils have been found to persist in weathering studies carried out in outdoor tanks for one week. This method involving simple infrared instrumentation and a minimum of sample preparation. It permits rapid on-site analysis without special training. The major differences between seep and non-seep oils appear in the comparison between the 13.8 micrometers and 13.5 micrometers peaks (for both weathered and unweathered oils) and in the carbonyl region at 5.85 micrometers (for unweathered oils only). GRA

N78-10613# Battelle Pacific Northwest Labs., Richland, Wash.
APPROACH TO VALUING VISUAL POLLUTION FROM WESTERN ELECTRICITY PRODUCTION
L. E. Erickson Feb. 1977 76 p refs
(Contract EY-76-C-06-1830)
(BNWL-2103) Avail: NTIS HC A05/MF A01

Approaches used to value externalities are briefly described. The approach used relies heavily on an earlier application of bidding games to estimate people's willingness to pay for abatement of emissions from the Four Corners fossil-fuel power plant in northwestern New Mexico. The results of these surveys were used here to estimate the value of visual pollution from electric power plants for residents of an visitors to the Four Corners Air Quality Control Region, as a function of power plant emissions in that region. Preliminary results of this procedure for all of the air quality control regions in the Western Systems Coordinating Council area are presented. Visual pollution damages from electric power plants to residents of an recreational visitors to these western regions are estimated to total more than $100 million anually by 1985. ERA

N78-10614# Brookhaven National Lab., Upton, N. Y.
INTEGRATED ENVIRONMENTAL ANALYSIS AND THE DEVELOPMENT OF NEW ENERGY TECHNOLOGIES
P. F. Palmedo 25 Feb. 1977 21 p refs
(Contract EY-76-C-02-0016)
(BNL-22676) Avail: NTIS HC A02/MF A01

The environmental research program in ERDA is discussed. Health, environmental, and social concerns are considered integrally in the development of individual technologies. These concerns are appropriately reviewed in the formulation of overall ERDA R and D policy. The development of basic information and data which also serve the needs of the government environmental regulatory role is analyzed. Environmental effects are manifested at the local scale. Energy R and D policy must respond to national needs and national policies. The introduction of environmental considerations into the formulation and implementation of energy R and D policy requires bridging the gap between local effects and concerns and national decisions. A crucial step in this process is analzying problems on a regional (multi-state) basis. ERA

N78-10615# California Univ., Berkeley. Lawrence Berkeley Lab.
REVIEW OF AIR QUALITY MODELING TECHNIQUES. VOLUME 8: HEALTH AND SAFETY IMPACTS OF NUCLEAR, GEOTHERMAL, AND FOSSIL-FUEL ELECTRIC GENERATION IN CALIFORNIA Final Report
Leonard C. Rosen Jan. 1977 47 p refs Sponsored in part by Calif. Energy Resources Conser. and Develop. Comm.
(Contract W-7405-eng-48)
(LBL-5998) Avail: NTIS HC A03/MF A01

Air transport and diffusion models which are applicable to the assessment of the environmental effects of nuclear, geothermal, and fossil-fuel electric generation are reviewed. The general classification of models and model inputs are discussed. A detailed examination of the statistical, Gaussianplume, Gaussian puff, one-box and species-conservation-of-mass models is given. Representative models are discussed with attention given to the assumptions, input data requirement, advantages, disadvantages and applicability of each. ERA

N78-10622# Dayton Univ., Ohio. Research Inst.
AUTOMOBILE EXHAUST EMISSION SURVEILLANCE ANALYSIS OF THE FY 1974 PROGRAM
Alan P. Aerens and Michael Hill Sep. 1976 133 p refs
(Contract EPA-68-03-2384)
(PB-268782/0; EPA-460/3-76-019) Avail: NTIS HC A07/MF A01 CSCL 13B

Results of the FY 74 Emission Factor Program are summarized and compared with results of the FY 71, FY 72, and FY 73, Emissions Factor Programs. The Emission Factor Program provides a realistic assessment of the effectiveness of federal regulations by testing production vehicles in the hands of the monitoring public. The FY 74 program tested a sample of 1965 to 1975 model year vehicles in seven cities. GRA

N78-10631# Cameron Engineers, Inc., Denver, Colo.
EVALUATION OF BACKGROUND DATA RELATING TO NEW SOURCE PERFORMANCE STANDARDS FOR LURGI GASIFICATION Final Report, Sep. 1976 - Feb. 1977
J. E. Sinor Jun. 1977 226 p refs
(Contract EPA-68-02-2152)
(PB-269557/5; EPA-600/7-77-057) Avail: NTIS HC A11/MF A01 CSCL 13B

Two different schemes for sulfur removal were examined. The coal gasification plant was divided into 15 sections; each section is discussed in a separate chapter. Areas were identified in which projected emissions data were deemed inadequate for evaluation of environmental impact. Desirable information presently lacking in other areas is summarized. GRA

N78-10633# General Accounting Office, Washington, D. C. Community and Economic Development Div.
ENVIRONMENTAL PROTECTION ISSUES FACING THE NATION
8 Jul. 1977 66 p
(PB-269748/0; CED-77-92) Avail: NTIS HC A04/MF A01 CSCL 13B

Questions have been raised on whether the environmental goals are too close to achieve or whether the right balance has been struck between environmental objectives, energy, economic, and social goals. The major environmental issues facing the Congress and the Nation are described. GRA

N78-10636# Pacific Environmental Services, Inc., Santa Monica, Calif.
ECONOMIC ANALYSIS OF VAPOR RECOVERY SYSTEMS ON SMALL BULK PLANTS Final Report
R. J. Bryan, W. Jacobson, A. Kokin, R. Sakaida, and M. M. Yamada Sep. 1976 105 p refs
(Contract EPA-68-01-3156)
(PB-269884/3; EPA-340/1-77-013) Avail: NTIS HC A06/MF A01 CSCL 13B

Economic data and analysis to aid in assessing the feasibility and reasonable applicability of vapor recovery systems (particularly bottom-loading) on bulk plants are presented. GRA

N78-10672# Battelle Pacific Northwest Labs., Richland, Wash.
POSTULATED WEATHER MODIFICATION EFFECTS OF LARGE ENERGY RELEASES
J. V. Ramsdell, B. C. Scott, M. M. Orgill, D. S. Renne, J. E. Hubbard, and K. A. McGinnis Feb. 1977 112 p refs
(Contract EY-76-C-06-1830)
(BNWL-2162) Avail: NTIS HC A06/MF A01

Postulated impacts of large energy releases were examined in the light of existing technical information. The magnitudes of direct atmospheric modifications were estimated, and the ecological and economic implications of the modifications were explored. Energy releases from energy centers (10 to 40 power plants at a single site) and individual power plant clusters (1 to 4 power plants) were considered. In the atmosphere the energy will exist initially as increased temperature (sensible heat), moisture (latent heat), and air motion (kinetic energy). Addition of energy could result in increased cloudiness and fog, and changed precipitation patterns. A framework for economic analysis of the impacts of the postulated atmospheric modifications was established on the basis of costs and benefits. Willingness-to-pay was selected as the appropriate measure for valuing each impact. The primary and secondary atmospheric modifications may affect recreation, transportation, and aesthetics as well as agriculture and forestry. Economic values can be placed on some of the effects. ERA

N78-10814# Oak Ridge National Lab., Tenn.
SENSITIVITY THEORY FOR GENERAL NONLINEAR ALGEBRAIC EQUATIONS WITH CONSTRAINTS
E. M. Oblow Apr. 1977 17 p refs
(Contract W-7405-eng-26)
(ORNL/TM-5815) Avail: NTIS HC A02/MF A01

The general non-linear theory for algebraic equations is summarized and applied to a class of problems whose solutions are characterized by constrained extrema. Such equations form the basis of much work on energy systems modeling and the econometrics of power production and distribution. It is valuable to have a sensitivity theory available for these problem areas since it is difficult to repeatedly solve complex non-linear equations to find out the effects of alternative input assumptions or the uncertainties associated with predictions of system behavior. The sensitivity theory for a linear system of algebraic equations with constraints which can be solved using linear programming techniques is discussed. The role of the constraints in simplifying the problem so that sensitivity methodology can be applied is highlighted. The general non-linear method is summarized and applied to a non-linear programming problem in particular. Conclusions are drawn in about the applicability of the method for practical problems. ERA

N78-10957 Houston Univ., Tex.
A PILOT SYSTEM FOR THE TEXAS ENERGY DATA BANK AND INFORMATION RETRIEVAL SYSTEM Ph.D. Thesis
Daniel Velaire Goulet 1976 511 p
Avail: Univ. Microfilms Order No. 77-13633

An energy data base for the State of Texas was developed. The Texas Energy Data Bank and Information Retrieval System (TEDBIRS) is a pilot system which consists of a data management system capable of handling time series data, a user language, and a prototype data base. The data management system consists of 16 subroutines which initialize and update all time series data to the system. The user language consists of a retrieve command, 22 analysis commands, 2 documentation commands all written in FORTRAN 4. The command structure uses simple language and syntax. The language is capable of simple extension, making it very responsive to the user's needs. The prototype data base consists of 69 energy data vectors for the State of Texas over a 22 year period. Dissert. Abstr.

N78-10965# Denver Research Inst., Colo. Knowledge Utilization Program.
INFORMATION AND DATA FLOWS IN SOCIETAL PROBLEM AREAS: FOCUS-ENERGY Final Report
James E. Freeman, J. P. Kottenstette, and P. M. Gatseos May 1977 68 p refs
(Grant NSF SIS-74-19324)
(PB-269497/4; KNUTAP-5211-01-FR) Avail: NTIS HC A04/MF A01 CSCL 05B

The problem of how scientific and technical information and data (STID) flow from research into decision making was addressed in efforts to solve important societal problems. Two case studies of STID flows in the area of energy provide an empirical base for the study. Orientation and definitions are presented as well as how three emerging social values energy sufficiency, environmental protection, and citizen participation are increasingly shaping energy decision in the United States. A typology of energy STID flows is reviewed along with a set of eight key questions that administrators can use to determine the adequacy of information transfer arrangements supporting energy problem solving. Author

N78-10973*# Rockwell International Corp., Downey, Calif. Space Div.
INDUSTRIES IN SPACE TO BENEFIT MANKIND: A VIEW OVER THE NEXT 30 YEARS
[1977] 37 p Original contains color illustrations
(Contract NAS8-32198)
(NASA-CR-155203; SD-77-AP-0094) Avail: NTIS HC A03/MF A01 CSCL 05B

New products, services, and energy sources are available to man through the exploitation of the useful attributes of space and space shuttle operations. Benefits include: (1) industrial fuel conservation through the use of electronic teleconferencing, high temperature turbines, and the space processing of materials; (2) improved health care through the use of biotelemetry, teleoperators, and weightless hospitals; (3) more efficient communication systems such as portable telephones, individual warning devices, and direct satellite broadcasting for educational purposes; (4) more abundant crop growth and controlled climate modification by the use of space-based reflectors to direct the light of the sun and moon to specific areas on earth; (5) solar energy utilization; and (6) reduction in radiation hazards through the use of space-based nuclear fusion reactors. A.R.H.

N78-11063*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AIRCRAFT ENGINE EMISSIONS
Oct. 1977 452 p Conf. held in Cleveland, 18-19 May 1977
(NASA-CP-2021; E-9262) Avail: NTIS HC A20/MF A01 CSCL 21E

A conference on a aircraft engine emissions was held to present the results of recent and current work. Such diverse areas as components, controls, energy efficient engine designs, and noise and pollution reduction are discussed. For individual titles, see N78-11064 through N78-11080.

N78-11074*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ALTERNATIVE FUELS
Jack S. Grobman, Helmut F. Butze, Robert Friedman, Albert C. Antoine, and Thaine W. Reynolds *In its* Aircraft Eng. Emissions Oct. 1977 p 277-308 refs (For availability see N78-11063 02-07)
Avail: NTIS HC A20/MF A01 CSCL 21E

Potential problems related to the use of alternative aviation turbine fuels are discussed and both ongoing and required research into these fuels is described. This discussion is limited to aviation turbine fuels composed of liquid hydrocarbons. The advantages and disadvantages of the various solutions to the problems are summarized. The first solution is to continue to develop the necessary technology at the refinery to produce specification jet fuels regardless of the crude source. The second solution is to minimize energy consumption at the refinery and keep fuel costs down by relaxing specifications. Author

N78-11154*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. DSN Engineering Section.
A THERMODYNAMIC ANALYSIS OF A SOLAR-POWERED JET REFRIGERATION SYSTEM c44
F. L. Lansing and V. W. Chai *In its* The Deep Space Network 15 Oct. 1977 p 209-217 refs (For availability see N78-11132 02-12)
Avail: NTIS HC A11/MF A01 CSCL 10A

A method of using solar energy to drive a jet refrigeration system is described and analyzed. A new technique is presented in the form of a performance nomogram combining the energy and momentum equations to determine the performance characteristics. A numerical example, using water as the working fluid, is given to illustrate the nomogram procedure. The resulting coefficient of performance was found comparable with other refrigeration systems such as the solar-absorption system or the solar-Rankine turbocompressor system. Author

N78-11156*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. TDA Planning Office.
DYNAMIC MODELING AND SENSITIVITY ANALYSIS OF SOLAR THERMAL ENERGY CONVERSION SYSTEMS c44

C. L. Hamilton *In its* The Deep Space Network 15 Oct. 1977 p 226-232 refs (For availability see N78-11132 02-12)
Avail: NTIS HC A11/MF A01 CSCL 10A

Dynamic modeling is used to begin identifying what must be known about input radiation and system dynamic characteristics to estimate performance reliably. Daily operation of two conceptual solar energy systems was simulated under varying operating strategies with time-dependent radiation intensity ranging from smooth input of several magnitudes to input of constant total energy whose intensity oscillated with periods from 1/4 hour to 6 hours. Integrated daily system output and efficiency were functions of both level and dynamic characteristics of isolation. Sensitivity of output to changes in total input was greater than one. These findings support the feeling that interplay of radiation dynamics and collector response times affects the quality of energy delivered, and therefore system performance. Author

N78-11207 Pennsylvania State Univ., University Park.
QUALITATIVE AND QUANTITATIVE STUDIES OF VOLATILES FROM COAL PYROLYSIS USING MASS SPECTROMETRY AND GAS CHROMATOGRAPHY Ph.D. Thesis
Gerald Oscar Tremblay 1977 86 p
Avail: Univ. Microfilms Order No 77-17732

Type analysis was used to analyze the mass spectra. Mass spectrometric analysis of the products resulting from the pyrolysis in vacuo showed water, nitrogen, carbon monoxide, carbon dioxide, and straight chain hydrocarbons both saturated and monounsaturated up to about a seven carbon chain length. Also two major aromatic series appeared, benzene and naphthalene, methylated to differing extents. It was found that with increasing temperature mono-unsaturates were predominant over saturates and polyunsaturates. Only one of the two coals contained pyrite and that one yielded sulfur dioxide on pyrolysis. Hydrogen sulfide was evident from the pyrolyses of both coals that contained organic sulfur in equal percentages. The gas chromatograph was used to obtain quantitative product distributions from the coal pyrolyses in helium. Ethene, ethane, propene, and propane were analyzed. Dissert. Abstr.

N78-11213*# National Aeronautics and Space Administration, Washington, D. C.
SOLUBILIZATION OF COAL IN ORGANIC MEDIA
Ph. Lahaye and D. Decroocq Jun. 1977 44 p refs Transl. into ENGLISH from Solubilisation Du Charbon en Milieu Organique, Revue De l'Institut Francais de Petrole 31 (France), no. 1, Jan. - Feb. 1976 p 99-130 Original language document was announced as A76-46522 and N77-27498 Transl. by Scitran, Santa Barbara, Calif.
(NASA Order JE-654698)
(NASA-TM-75118) Avail: NTIS HC A03/MF A01 CSCL 07D

Study of the extraction of coal by organic solvents at moderate temperature has allowed us to understand the experimental conditions which will lead to a maximum yield of extract. Based on the results obtained on the effect of the nature of the solvent, it appears to be desirable in reaching this result to make use of binary mixtures or possibly of even more complex ones composed of amines or, more generally, of basic nitrogen-containing compounds. The use of the solvents discussed above was also considered for treatment of kerogen or the organic material contained in sedimentary rocks. Only 10 to 40% of the organic material was extracted from the samples. However, the chemical structure of kerogens is much more varied than that of coals, so it can be expected that kerogens which have undergone a strong evolution through the action of geologic conditions will maintain their very low solubilities, whatever the solvent used. Author

N78-11253# Southwest Research Inst., San Antonio, Tex. Army Fuels and Lubricants Research Lab.
CORRECTIVE ACTION PROGRAM FOR BROMOCHLOROMETHANE-CONTAINING FIRE-SAFE DIESEL FUEL Final Report
W. D. Weatherford, Jr. and B. R. Wright Sep. 1976 80 p refs
(Contract DAAG53-76-C-0003)
(AD-A043323; AFLRL-81) Avail: NTIS HC A05/MF A01 CSCL 21/4

Following a laboratory-engine endurance test of bromochloromethane (BCM) 'fire-safe fuel' (FSF) in a 12-cylinder, air-cooled, four-cycle AVDS 1790-2C diesel engine conducted by Teledyne Continental Motors, a multifaceted experimental program was originated by MERADCOM/AFLRL (Mobility Equipment Research and Development Command/Army Fuels and Lubricants Research Laboratory) to establish whether or not 'fixes' could be developed to overcome the problems that caused the engine endurance test to be terminated after 150 rather than the intended 400 operating hours. Recapitulation of test events, detailed post-test examinations of engine parts and used lubricant samples, and follow-through experimental studies by MERADCOM/AFLRL confirmed or indicated plausible mechanisms for the observed difficulties. First, the fuel pump plunger rod sticking problem was confirmed to have been caused by corrosion at the fuel-oil interface; second, the fuel injector valve sticking was caused by a lacquer-like deposit; third, the fuel injector nozzle holes had become substantially enlarged and elongated by predominately corrosive mechanisms; fourth, excessive distress experienced by the oil-control piston ring appeared to have resulted from combined effects of stress corrosion cracking caused by HCl and scuffing caused by inadequate lubrication and fifth, oil filter plugging was found to have resulted from the formation of halon by-product and wear-metal-containing sludge in the lubricant. GRA

N78-11254# Federal Energy Administration, Washington, D. C. Strategic Petroleum Reserve Office.
STRATEGIC PETROLEUM RESERVE: SUPPLEMENT TO FINAL ENVIRONMENTAL IMPACT STATEMENT FOR BAYOU CHOCTAW SALT DOME
May 1977 180 p refs
(PB-270435/1; FEA/S-77/129-Suppl; FES-76-5-Suppl) Avail: NTIS HC A09/MF A01 CSCL 21D

A supplemental to a site specific final Environment Impact Statement prepared for the proposed storage of crude oil at the Bayou Choctaw salt dome located in Iberville Parish, Louisiana. The project is part of the Strategic Petroleum Reserve program, created for the purpose of providing the United States with sufficient petroleum reserves to minimize the effects of any oil supply interruption. The supplement considers the incremental effects on the environment which would result from constructing terminal facilities at St. James together with the pipeline which would connect St. James to the Bayou Choctaw storage site. GRA

N78-11255# Federal Energy Administration, Washington, D. C. Strategic Petroleum Reserve, Central Rock Mine
STRATEGIC PETROLEUM RESERVE: CENTRAL ROCK MINE Final Report
Jul. 1977 515 p refs
(PB-270447/6; FEA/S-77/214) Avail: NTIS HC A22/MF A01 CSCL 21D

An Environmental Impact Statement identifying particularly sensitive environmental parameters investigated in detail for the Central Rock, Kentucky early storage reserve site is presented. The most sensitive parameters to be affected by oil storage development at the site appear to be water quality, air quality, and socioeconomic factors. (GRA)

N78-11256# Federal Energy Administration, Washington, D. C. Strategic Petroleum Reserve Office.
STRATEGIC PETROLEUM RESERVE: BYRON MOUND SALT DOME, DRAFT SUPPLEMENT Final Report
Jul. 1977 383 p refs Supplement to Report to PB-262839
(PB-270108/4; FEA/S-77/211-Suppl) Avail: NTIS HC A17/MF A01 CSCL 21D

A draft supplement to the environmental impact statement for an underground crude oil storage facility at the Bryan Mound salt dome located in Brazoria County, Texas is presented. The storage facility at the Bryan Mound salt dome is part of the Strategic Petroleum Reserve program, created for the purpose of providing the United States with sufficient petroleum reserves to minimize the effects of any oil supply interruption. Author

N78-11260*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LIQUID HYDROGEN FLASH VAPORIZER Patent Application
Albert M. Momenthy, inventor (to NASA) (Boeing Commercial Airplane Co., Seattle) Filed 21 Oct. 1977 9 p Sponsored by NASA
(NASA-Case-LAR-12159-1; US-Patent-Appl-SN-844347) Avail: NTIS HC A02/MF A01 CSCL 13I

A method and device are disclosed for initially reducing the temperature of a stream of LH2 in a fuel distribution line. The device allows some LH2 to escape into and vaporize in a shroud surrounding a length of the line just upstream of the nozzle. The effect of this controlled evaporation is to cool the LH2 in the line to satisfactorily low temperatures before it exits the line. This prevents the immediate vaporization of the fuel as it leaves the line. NASA

N78-11405# Chrysler Corp., Detroit, Mich.
BASELINE GAS TURBINE DEVELOPMENT PROGRAM Quarterly Progress Report
F. W. Schmidt and C. E. Wagner 31 Oct. 1976 112 p
(Contract EY-76-C-02-2749)
(COO-2749-16; QPR-16) Avail: NTIS HC A06/MF A01

A program is reported which demonstrates an experimental ungraded gas turbine powered automobile that meets the 1978 Federal Emissions Standards, has significantly improved fuel economy, and is competitive in performance, reliability, and potential manufacturing cost with the conventional piston engine powered, compact-size American automobile. Principal effort was in the area of diagnostic testing and corrective development. Three upgraded engines were assembled and two were run in the test cell. Special diagnostic instrumentation was installed on engine number three to evaluate the compressor, turbine, and hot engine leakage. Engine airflow, starting characteristics, oil flow/heat rejection/blowby, emissions, leakage, and component performance tests were conducted. ERA

N78-11500*# National Aeronautics and Space Administration. Pasadena Office, Calif.
IMPROVED SOLAR PHOTOLYSIS OF WATER Patent Application
Porter R. Ryason, inventor (to NASA) (JPL) Filed 30 Sep. 1977 18 p
(Contract NAS7-100)
(NASA-Case-NPO-14126-1; US-Patent-Appl-SN-838336) Avail: NTIS HC A02/MF A01 CSCL 10A

A cyclic process for the solar photolysis of water was developed. The process includes a first stage in which water is reduced in the presence of a Eu(+2) photo-oxidizable reagent producing hydrogen and spent oxidized Eu(+3) reagent. The spent reagent is reduced by means of a transition metal liquid complex reductant, RuL(+3) in a photoexcited state, such as a ruthenium pyridyl complex. Due to competing reactions between the photolysis and regeneration products, the photo-oxidation reaction must be separated from the regeneration in space and time by supporting the reagent and/or the reductant on solid supports and utilizing pH, wavelength and flow control to maximize hydrogen and oxygen production. NASA

N78-11501# Office of Naval Research, London (England).
EUROPEAN DEVELOPMENTS IN THE Na/S HIGH TEMPERATURE BATTERY FOR AUTOMOBILE PROPULSION AND ENERGY STORAGE
Abraham Sosin 13 Jun. 1977 18 p
(AD-A042541; ONRL-R-5-77) Avail: NTIS HC A02/MF A01 CSCL 10/3

The sodium-sulfur battery is a leading candidate for future use in the propulsion of automobiles, vans, buses, and trains and for energy storage and load-leveling by electrical utilities. This report presents a brief description of the fundamentals of the operation of the battery, with indication of some considerations which control its development into an important technological system. The status of the battery development in England, France and Germany is then reviewed. Author (GRA)

N78-11502# Air Force Academy, Colo. Frank J. Seiler Research Lab.
HIGH ENERGY DENSITY PELLETIZED ALUMINUM CHLORIDE THERMAL BATTERIES. PART 2: CATHODE SCREENING Technical Report, Jan. 1976 - Apr. 1977
John C. Nardi, John K. Erbacher, and Charles L. Hussey Apr. 1977 31 p refs
(AD-A043659; FJSRL-TR-77-0004-Pt-2) Avail: NTIS HC A03/MF A01 CSCL 10/3

Pelletized single cell experiments have been conducted to develop a family of potential cathode for a new, low temperature thermal battery system. The cells utilize a 60.2 a/o lithium-aluminum alloy anode and a molten salt electrolyte of NaCl-saturated AlCl3. They operate at temperatures between 175 and 250 C. A total of 40 sulfides, oxides, and halides were evaluated and compared to the molybdenum (V) chloride and copper (II) chloride cathodes previously studied. Of this group, three halides, WCl6, FeCl3, and TeCl4, exhibited long discharge lifetimes, high available energy density, and high voltages under load. Various brands of graphite, acetylene black, and various types of metallic current collectors also were evaluated for performance enhancement. Author (GRA)

N78-11504# Thermo Electron Corp., Waltham, Mass.
ERDA/NASA ADVANCED THERMIONIC TECHNOLOGY PROGRAM Progress Report
Feb. 1977 32 p refs
(Contract EY-76-C-02-3056)
(COO-3056-20; PR-20) Avail: NTIS HC A03/MF A01

Progress is reported in the areas of surface studies (surface theory and activation chamber experiments), plasma studies (converter theory and enhanced mode conversion experiments), converter development (low temperature conversion experiments and high efficiency conversion experiments), and component hardware (hot shell development). ERA

N78-11505# Warren Spring Lab., Stevenage (England).
ENERGY CONSIDERATIONS IN ELECTROHYDROMETALLURGY
Renato G. Bautista and Douglas S. Flett 1976 21 p refs
Presented at 69th Meeting of the AIChE, Chicago, 28 Nov. 1976
(Contract W-7405-eng-82)
(IS-M-83; Conf-761109-12; LR-221(FE);
ISBN-0-356240-70-2) Avail: NTIS HC A02/MF A01

Factors affecting energy consumption in electrohydrometallurgical processes are reviewed. It is shown that increasing the throughput of electrolytic cells requires increasing electrical energy consumption per unit weight of product but a reduction in heating requirements results. For high current density electrowinning considerable modification to the hydrodynamic conditions in the cell is necessary and suggested methods are discussed. ERA

N78-11506# Energy Research and Development Administration, Washington, D. C. Div. of Solar Energy.
SOLAR PROGRAM ASSESSMENT: ENVIRONMENTAL FACTORS. FUEL FROM BIOMASS
Mar. 1977 144 p refs
(ERDA-77-47/7) Avail: NTIS HC A07/MF A01

The major environmental issues associated with the further development of biomass production and biomass conversion systems are presented and evaluated with respect to priority. The basic concepts of the technology are reviewed, as are resource requirements. The potential effects of this technology on the full range of environmental concerns (i.e., air and water quality, biosystems, safety, social/institutional structures, etc.) are then discussed in terms of both their relative significance and possible solutions. Only those impacts unique to the solar portion of the technology are discussed in depth. An environmental work plan is presented, listing research and development proposals and a NEPA work plan, which might help clarify and/or alleviate specific environmental problems. ERA

N78-11507# Lockheed Missiles and Space Co., Sunnyvale, Calif.
OCEAN THERMAL ENERGY CONVERSION (OTEC) TEST FACILITIES STUDY PROGRAM, VOLUME 1

17 Jan. 1977 496 p refs
(Contract EY-76-C-03-1156)
(SAN/1156-77/1-Vol-1; LMSC-D506781-Vol-1) Avail: NTIS HC A21/MF A01

Alternative non-site specific OTEC test facilities/platform requirements for an integrated OTEC test program including both land and floating test facilities were studied. A progression of tests were established in which OTEC power cycle component designs proceeded through advanced research and technology, component, and systems test phases. This progression leads to the first OTEC pilot plant and provides support for following developments which potentially reduce the cost of OTEC energy. It also includes provisions for feedback of results from all test phases to enhance modifications to existing designs or development of new concepts. Emphasis is placed on defining the test facility which is capable of supporting the spectrum of tests envisioned. All test support facilities and equipment were identified and included in terms of space, utilities, cost, schedule, and constraints or risks. ERA

N78-11508# Oak Ridge National Lab., Tenn.
TRANSPORTATION ENERGY CONSERVATION DATA BOOK, SUPPLEMENT-3
A. S. Loebl May 1977 158 p refs
(Contract W-7405-eng-26)
(ORNL-5248) Avail: NTIS HC A08/MF A01

This series of documents is intended to provide a desk-top reference for use by the Transportation Energy Conservation Division of the Energy Research and Development Administration. The supplements contain statistics that expand and refine data presented in edition one. A variety of tables, charts, maps, and graphs is used in this volume to present statistical data on energy use and energy-related activity in the transportation sector. A major aspect of the data in this supplement focuses on energy supply to the transportation sector. Data on characteristics of transportation modes, fuel consumption characteristics, and conservation alternatives are also included and serve to augment and update information presented in edition one. The glossary represents a significant expansion. A list of references is provided, an index, and an annotated bibliography (showing recent acquisition) are included. ERA

N78-11509# Sandia Labs., Albuquerque, N. Mex.
DIAGNOSTIC ASSESSMENT FOR ADVANCED POWER SYSTEMS Interim Report
H. W. Coleman, D. R. Hardesty, and R. J. Cattolica Mar. 1977 116 p refs Prepared for advanced Power Systems Branch, ERDA/Fossil Energy
(Contract EY-76-C-04-0789)
(SAND-77-8216) Avail: NTIS HC A06/MF A01

Diagnostic techniques needed to characterize the flow at the combustor exit and turbine inlet in advanced, open-cycle gas turbine systems that will be used for stationary power generation are reviewed. Problem areas that are inherent in such systems are identified. For purposes of initially defining diagnostics requirements, two different advanced stationary power gas turbine systems are considered. System one is a low turbine inlet temperature system with high ash carry-over into the turbine, and system two is a high turbine inlet temperature system fired with a clean liquid or gaseous coal-derived fuel or incorporating an efficient interstage gas-cleanup system. Estimates of the properties of the turbine inlet flows to be expected in these systems are presented and serve as a basis from which the discussion of diagnostic techniques proceeds. Diagnostic techniques for the determination of particulate size distribution, particulate mass loading density, gas velocity, gas temperature, and species concentrations are discussed. ERA

N78-11510# National Physical Lab., Teddington (England).
INDUSTRIAL ENERGY THRIFT SCHEME Progress Report, 1 Jan. - 30 Sep. 1976
Apr. 1977 33 p
(NPL-Chem-68-Pr-1) Avail: NTIS HC A03/MF A01

The progress made during the first nine months of the industrial energy thrift scheme is summarized. The scheme was initiated in 1976 by the Department of Industry to promote the more efficient use of energy by U. K. industry. The scheme is also designed to gather information both on energy-saving opportunities and on the need for further R and D directed towards the improvement of energy utilization. The planning and organization of the scheme was carried out by the Department's Energy Unit in the Chemical Standards Division of the NPL. The Energy Unit is also responsible for the overall management of the scheme and for ensuring that the results are applied to the benefit of industry. Author (ESA)

N78-11511# International Institute for Applied Systems Analysis, Laxenburg (Austria).
AN ALGORITHM FOR CONSTRAINED OPTIMIZATION WITH SEMISMOOTH FUNCTIONS
R. Mifflin Feb. 1977 36 p refs
(Grant AFOSR-74-2695)
(IIASA-RR-77-3) Avail: NTIS HC A03/MF A01

Large-scale optimization models appear in many areas of application at IIASA. For example, such models are useful for estimating the economic value of introducing solar and wind generated electrical energy into an existing power grid and for determining equilibrium prices for agricultural commodities in international trade as a function of national policies. Certain methods of decomposition for solving such optimization problems require the solution of a relatively small problem, the objective function of which is not everywhere differentiable. An implementable algorithm that can be used to solve such nonsmooth optimization problems is presented. Author (ESA)

N78-11512# Technische Univ., Berlin (West Germany). Sonderforschungsbereich Magnetohydrodynamik.
COMPARISON OF SEVERAL COMPUTATION METHODS FOR INDUCTIVE MHDCHANNEL AND FREE JET CONVERTERS WITH NONMAGNETIC LIQUID METALS AS WORKING FLUIDS [VERGLEICH VERSCHIEDENER RECHENVERFAHREN FUER INDUKTIVE MHD-KANAL- UND FREISTRAHLWANDLER MIT NICHTMAGNETISCHEN FLUESSIGEN METALLEN ALS ARBEITSMITTEL]
D. Djamali-Schahni Apr. 1976 23 p refs In GERMAN
(Contract BMFT-PLE-ET-4003-A)
(SFB-MHD-27) Avail: NTIS HC A02/MF A01

Several methods for calculating inductive MHD converters are summarized and compared. Various converter configurations were investigated: flat and aximmetric channel and free jet converters, quadrupole and dipole. The flat configurations are compared with the data of an MHD generator. The computer programs described take into account only the electrodynamics of the channel and project converter. The introduction of hydrodynamic aspects is proposed. ESA

N78-11515# Maine Univ., Orono. Dept. of Electrical Engineering.
TERNARY COMPOUND THIN FILM SOLAR CELLS-2 Quarterly Report, 1 Jan. - 31 Mar. 1977
L. L. Kazmerski Apr. 1977 42 p refs Sponsored in part by ERDA
(Grant NSF AER-75-19576-A01)
(PB-270029/2; NSF/RA-770144; QR-2) Avail: NTIS HC A03/MF A01 CSCL 10B

The fabrication and performance of several vacuum deposited thin-film photovoltaic devices using 1-111-V12 chalcopyrite semiconductors are presented. The heterojunctions CdS/CuInS2 and CdS/CuInSe2 are described with measured solar-conversion efficiencies of 3.25% and 6.6% respectively. Little Photovoltaic response is observed in the CdS/CuInTe2 heterostructure. The photovoltaic effect in the first n,p CuInS2(3.6%) and n,p CuInSe2 (3.0%) thin-film homojunctions is demonstrated. Light and dark J-V characteristics, spectral responses and device parameters are reported for all these devices. Finally, the structure and stability of these ternary-based devices are examined. GRA

N78-11526# Ultrasystems, Inc., Irvine, Calif.
REDUCTION OF NITROGEN OXIDE EMISSIONS FROM FIELD OPERATING PACKAGE BOILERS, PHASE 3 Final Report, Jun. 1971 - Oct. 1976

M. P. Heap, C. McComis, T. J. Tyson, R. E. McMillan (Foster Wheeler Energy Corp.), R. E. Sommerland (Foster Wheeler Energy Corp.), and F. D. Zoldak (Foster Wheeler Energy Corp.) Jan. 1977 119 p
(Contract EPA-68-02-0222)
(PB-269277/0; EPA-600/2-77-025) Avail: NTIS HC A06/MF A01 CSCL 07A

Experimental investigations were carried out in a laboratory firetube boiler simulator, and an application program was conducted on two boilers operating in the field. The ultimate goal of the program was to determine if package boilers can operate in the field after modification to control NOx emissions without encountering practical problems. A 12 million Btu/hr firetube boiler and a 25 million Btu/hr heat output watertube boiler were modified to extract cooled combustion products from the stack and add them to the combustion air in the windbox. The effectiveness of FGR as a method of controlling NOx emissions was found to be dependent upon boiler type. It was effective in the firetube boiler: approximately 30% reduction in emissions was obtained with 40% recirculation. GRA

N78-11535# Selskapet for Industriell og Teknisk Forskning, Trondheim (Norway).
OFFSHORE OIL POLLUTION
Terje Vassbotn 8 Apr. 1976 26 p refs In NORWEGIAN; ENGLISH summary
(Contract NTNF-B-1810.5205)
(STF21-A76054; ISBN-82-595-0813-3) Avail: NTIS HC A03/MF A01

A literature review on the subject of the impact of petroleum and petroleum products on the marine environment was the basis for estimation of the present (1975) and future (1980) oil pollution in the North Sea. The estimation is based mainly on crude oil consumption and future requirements in Norway, Denmark, Great Britain, West Germany, Belgium, and the Netherlands. The total mineral oil spillage in the North Sea was estimated at 1.1 million tons in 1975 and 0.62 million tons in 1980; however, offshore operations are only responsible for about 0.2% and 5% of the total spillage in 1975 and 1980, respectively. Author (ESA)

N78-11541# Environmental Protection Agency, Research Triangle Park, N.C. Office of Air Quality Planning and Standards.
COMPILATION OF AIR POLLUTANT EMISSION FACTORS, SUPPLEMENT NO. 7
Apr. 1977 121 p
(PB-270281/9; AP-42-Suppl-7) Avail: NTIS HC A06/MF A01 CSCL 13B

Revised and updated emissions data are presented for anthracite coal combustion fuel oil combustion, bagasse combustion in sugar mills, residential fireplaces, open burning, dry cleaning, storage of petroleum liquids, transportation and marketing of petroleum liquids, adipic acid, carbon black, charcoal, phthalic anhydride, feed and grain mills and elevators, fish processing, portland cement manufacturing, lime manufacturing, and acid sulfite pulping. GRA

N78-11559# Purdue Univ., Lafayette, Ind. School of Aeronautics and Astronautics.
DYNAMIC OIL SHALE FRACTURE EXPERIMENTS Final Report, 1 Apr. 1975 - 31 Mar. 1977
Michael P. Felix 15 Mar. 1977 35 p Presented at Los Alamos Oil Shale Fracture Conf., Los Alamos Scientific Lab., N. Mex., Aug. 1976
(Grant NSF ENG-75-10313)
(PB-269258/0; A/A-77/2) Avail: NTIS HC A03/MF A01 CSCL 08I

The dynamic tensile stress amplitudes necessary to cause complete spall in unconfined oil shale samples were experimentally determined in the laboratory for pulse durations typically encountered in the field (60-100 microseconds). Tensile stresses were generated by free surface reflection of compressive pulses, and the stress-time history at the free surface was obtained by numerically differentiating the displacement-time history monitored by a fiber optic proximity sensor. A computer code was written to display the stress profile, obtained experimentally, over the length of the specimen as time increased. By using many specimens, the fracture thresholds for these pulse durations were determined. GRA

N78-11863# Stanford Research Inst., Menlo Park, Calif.
PRELIMINARY ASSESSMENT FOR DESIGNING EXPERIMENTS USING FEDERAL INNOVATION PROCESSES
Charles Williams, Egils Milbergs, and Robert Quick Apr. 1977 303 p
(Contract NSF C-828)
(PB-270089/6; CSSP-4676-14; NSF/RA-770121) Avail: NTIS HC A14/MF A01 CSCL 05A

The groundwork for a practical approach for systemically monitoring and evaluating naturally occurring federal innovation processes was established. A natural experimental approach that potentially can provide a cost effective strategy for evaluating the impact of alternative federal technology incentives was studied. The frameworks presented provide a set of tools to help evaluators to begin to describe the federal innovation process for individual cases and the components that affect each case. GRA

N78-11864# International Institute for Applied Systems Analysis, Laxenburg (Austria).
MULTI-ORGANIZATIONAL STRATEGIES: AN ANALYTIC FRAMEWORK AND CASE ILLUSTRATIONS
Cyril Davies, Ada Demb, Raul Espejo, and Roman Ostrowski Feb. 1977 33 p refs
(IIASA-RM-77-4) Avail: NTIS HC A03/MF A01

An analytical framework to support organizational strategies for the planning and management of multi-sectoral programs is presented. Two different case studies are reported. The first is concerned with the 'Impacts of Oil Development Offshore of the Northeast Coast of Scotland'. While some findings specific to Scotland are presented, stress is laid on conveying the methodology developed to study the orgranizational dimension of large development programs. This methodology is used in the second case study, the 'Bratsk-Ilimsk Territorial Production Complex', to analyze a particular policy issue presently under consideration by Soviet policy makers, namely, the need for new management mechanisms to support the present evolution of territorial production complexes. Author (ESA)

N78-11889*# Scientific Translation Service, Santa Barbara, Calif.
RESEARCH ON BATTERY-OPERATED ELECTRIC ROAD VEHICLES
V. S. Varpetian Oct. 1977 21 p refs Transl. into ENGLISH from Izv. Akad. Nauk Arm. SSR, Sor. Tekhn. Nauk (USSR), v. 29, no. 2, 1976 p 43-50 Originial language document was announced as A77-21701
(Contract NASw-2791)
(NASA-TM-75142) Avail: NTIS HC A02/MF A01 CSCL 13F

Mathematical analysis of battery-operated electric vehicles is presented. Attention is focused on assessing the influence of the battery on the mechanical and dynamical characteristics of dc electric motors with series and parallel excitation, as well as on evaluating the influence of the excitation mode and speed control system on the performance of the battery. The superiority of series excitation over parallel excitation with respect to vehicle performance is demonstrated. It is also shown that pulsed control of the electric motor, as compared to potentiometric control, provides a more effective use of the battery and decreases the cost of recharging. Author

N78-11892# California Univ., Los Angeles. School of Architecture and Urban Planning.
EUROPEAN DEVELOPMENTS IN THE RECOVERY OF ENERGY AND MATERIALS FROM MUNICIPAL SOLID WASTE Final Report
David W. Conn May 1977 53 p refs
(Contract EPA-5-03-4502)
(PB-270219/9; EPA-600/7-77-040) Avail: NTIS HC A04/MF A01 CSCL 13B

Energy and materials recovery from municipal solid waste in Western Europe and the United States were examined and compared. Specific topics studied include: (1) the use of refuse as a supplementary fuel; (2) pyrolysis; and (3) resource recovery. Solid waste/energy processes in Europe (both existing and under development) that appear to offer potential advantages over processes currently employed in the United States. Systems involving household sorting and separate collection, front-end materials/fuel separation, the burning of refuse derived fuel in electricity generating plants and cement kilns, pyrolysis, incineration with heat recovery, and materials recovery from post-incinerator residues are discussed. Results are summarized. GRA

N78-11894# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ALTERNATIVE CONCEPTS FOR UNDERGROUND RAPID TRANSIT SYSTEMS, EXECUTIVE SUMMARY Final Report
Bain Dayman, Jr., Ronald C. Heft, Donald W. Kurtz, Ted W. Macie, and John A. Stalkamp Mar. 1977 38 p
(Contract DOT-AS-60019)
(PB-270102/7; DOT-TST-77-31) Avail: NTIS HC A03/MF A01 CSCL 13B

Construction costs and operating energy requirements of future high-performance underground rail mass-rapid-transit systems were investigated. The alternative design approaches studied include: gravity assist; over/under and short stations; various subway train propulsion configurations; and optimized operational control policies. Comparisons were made of several system designs for a specific route and patronage structure. These comparisons indicate that it is practical to significantly reduce construction costs and operational energy requirements of modern underground systems while improving service by incorporating alternative concepts. GRA

N78-11896# International Institute for Applied Systems Analysis, Laxenburg (Austria).
TECHNOLOGY ASSESSMENT IN A DIALECTIC KEY
Giandomenico Majone Jan. 1977 37 p refs
(IIASA-PP-77-1) Avail: NTIS HC A03/MF A01

Technology and institutions interact dialectically. Institutional factors affect the range of alternatives considered by innovators, the resolution of disputes over the consequences of innovation, and even the efficiency of technical projects. Thus, technological impacts are determined in the arena of institutional choice just as much as in the laboratory and on the drawing board. Examples from the fields of medical care, nuclear power generation, and broadcasting technology are used to illustrate this interdependence. Dialectic thinking, in the Greek sense of a systematic critique of assumptions, arguments, and conclusions, is necessary to counteract institutional and conceptual biases and to support unconventional approaches. As the current interest in adversary proceedings and other dialectic modes of discourse shows, the narrow paradigm of decitionism is being replaced by quasi-jurisprudential methods for assessing the adequacy of arguments, the strength of evidence, and the intrinsic limitations of technical solutions. Author (ESA)

N78-11897# Battelle Inst., Frankfurt am Main (West Germany). Abt. Innovationsforschung.
SCENARIOS FOR CHEMICAL TECHNOLOGY Final Report
Goetz R. Schaude, Harald Legler, and Alexander Schuster-Wolff Bonn Bundesmin. fuer Forsch. u. Technol. Jun. 1977 266 p refs In GERMAN; ENGLISH summary Prepared jointly with Dornier-System and Inst. fuer Systemtech. u. Innovationsforsch.
(Contract BMFT-CVA-1125)
(BMFT-FB-T-77-01) Avail: NTIS HC A12/MF A01

The scenario writing technique was used for the first time as a planning tool for the preparation of the 'Chemical Technology' special research program within the basic program, 'Research and development into the technological means to conserve the supply of raw materials'. Five different scenarios were written with different sets of assumptions in order to outline the alternative situations of the chemical industry (West Germany) in the year 2000 and their effect on the raw materials supply. By using the scenario writing technique it was possible to take into consideration the important surrounding areas, i.e., raw materials markets, trends in economy, energy supply, and environment, to integrate existing forecasts and to obtain within a reasonably short time results that were suitable for practical use. The evaluation of the scenarios resulted in the definition of the problem areas which could be used as guidelines for further R and D sponsoring. Author (ESA)

N78-12116*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
SOLAR POWER SATELLITE: CONCEPT EVALUATION. ACTIVITIES REPORT. VOLUME 1: SUMMARY. VOLUME 2: DETAILED REPORT Activities Report, Jul. 1976 - Jun. 1977
Jul. 1977 130 p
(NASA-TM-74944; JSC-12973-Vol-1; JSC-12973-Vol-2) Avail: NTIS HC A07/MF A01 CSCL 10B

The Johnson Space Center Systems Definition effort from July 1976 to June 1977 presents comparative data of various designs of thermal engine and photovoltaic solar power satellite concepts. The major area of the Solar Power Satellite system examined includes solar cells, transportation, rectenna structure, and environmental issues. A summary of results of the 1977 studies is presented. Author

N78-12160 New Mexico Univ., Albuquerque.
INVESTIGATION OF SULFUR BASED THERMOCHEMICAL CYCLES FOR HYDROGEN PRODUCTION BY WATER DECOMPOSITION Ph.D. Thesis
Mani Natarajan 1976 177 p
Avail: Univ. Microfilms Order No. 77-16110

A high temperature nuclear reactor was assumed to provide the primary energy for sulfur based thermochemical cycles. Flow schemes and mass balances were made for each process and cost evaluation was made by two methods. The chemistry of the reactions in each cycle was examined. An assessment of the engineering problems in the cycles was made and solutions for these problems were proposed. It was concluded that hydrogen could be produced at $10.83/MBTU (average for the three processes) in a plant having a capacity of 1,000,000 standard cubic meters per hour of hydrogen. The electrolytic hydrogen production cost for the same sized plant was found to be $10.32/MBTU. The plant investment cost estimates showed that the capital investment for the three thermochemical plants was in the range $207-270 million. Further analysis showed that an advanced electrolytic hydrogen system might produce hydrogen at $7.91/MBTU and this compares favorably with the best thermochemical system at the present time. Dissert. Abstr.

N78-12163 California Univ., Berkeley.
THE THERMOCHEMICAL DISSOCIATION OF WATER Ph.D. Thesis
John William Flock 1976 114 p
Avail: Univ. Microfilms Order No. 77-15684

Thermodynamic analyses were performed on thermochemical cycles which convert heat to chemical work by dissociating water. These analyses include: (1) the development of the relationship between the ideal work (or heat) requirements, the entropy production (a measure of the irreversibilities), and the actual work requirements of the cycle; (2) the identification of the sources of irreversibilities in chemical processes and the magnitude of the resulting entropy production in the individual operations of a proposed process utilizing chromium and chlorine to dissociate water; and (3) the effect of process changes on the entropy production in these operations. It was found that heat transfer is the major contributor to the irreversibilities in the cycle, and the utilization of waste heat increases the relative efficiency of the cycle, and that the variation of reaction temperature is significant in decreasing the entropy production in the separation operations. Other topics discussed include the availability of chemical elements for use in large scale applications and the use of solvent promotion to increase the efficiency of a water dissociation process based on reactions of molybdenum oxides. Dissert. Abstr.

N78-12243# Transportation Systems Center, Cambridge, Mass.
METHANOL AS AN AUTOMOTIVE FUEL WITH SPECIAL EMPHASIS ON METHANOL-GASOLINE BLENDS Final Report, Jun. - Oct. 1974

A. Landman Apr. 1977 89 p refs
(PB-270401/3; DOT-TSC-OST-74-38; DOT-TSC-OST-77-31)
Avail: NTIS HC A05/MF A01 CSCL 21D

Methanol is characterized and the results of various studies on methanol and methanol-gasoline blends, and their use and effects in engines and vehicles are presented and compared. Cost information, although limited, is given as available. Methanol production processes are described as well as their promise and expansion possibilities in relation to potential requirements. Various raw material sources are considered in the light of future production potential needs. GRA

N78-12244# Federal Energy Administration, Washington, D. C. Office of Energy Resource Development.
FUTURE REFINERY CAPACITY NEEDS, CONSTRUCTION INCENTIVES, AND PROCESSING CONFIGURATIONS
22 Jul. 1977 57 p
(PB-271099; FEA/G-77/235) Avail: NTIS HC A04/MF A01 CSCL 21D

Planned additions to the capacity of U.S. oil refineries will exceed the expansion needed by 1985 to meet the goals of the National Energy Plan. However, because of difficulties associated with obtaining permits, not all of these planned additions may be achieved. Noting that the plan will result in a reduction in demand for residual fuel oil from 3.5 million barrels to 2.0 million barrels per day, the report observes that overall capacity growth requirements will be reduced, and addition of 1 million barrels per day would suffice to meet 1985 demand at reasonable upper limits of refinery utilization. Other topics explored include production incentives such as the entitlements program, import fees, crude equalization taxes, investment tax credits and accelerated depreciation. Projected changes in refinery configuration involving hydrocracking, coking, vacuum distillation and cat cracking are also discussed. Author

N78-12245# Bureau of Mines, Washington, D. C. Div. of Interfuels Studies.
FUELS AND ENERGY DATA: UNITED STATES BY STATES AND CENSUS DIVISIONS, 1974
Lulie H. Crump Dec. 1976 171 p refs
(PB-271093/7; BM-IC-8739) Avail: NTIS HC A08/MF A01 CSCL 21D

Salient information on reserves, production, and consumption of fuels and energy by state is summarized. Reserve and production data are shown for each of the fossil fuels (coal, crude oil, natural gas liquids, and natural gas) and for uranium. The consumption data of each of the major consuming sectors (household-commercial, industrial, transportation, electric power, and miscellaneous) are broken down by energy source (coal, petroleum, natural gas, hydropower, and nuclear). In addition, total energy consumption in the nation in 1974 is compared with consumption in 1973 and 1975. GRA

N78-12246# Consolidation Coal Co., Library, Pa. Research Div.
HIGH-TEMPERATURE DESULFURIZATION OF LOW-Btu-GAS Final Report, Jul. 1973 - Jan. 1976
G. P. Curran, B. J. Pasek, M. Pell, and E. Gorin Apr. 1977 361 p refs
(Contract EPA-68-02-1333)
(PB-271008/5; EPA-600/7-77-031) Avail: NTIS HC A16/MF A01 CSCL 21D

Results of economic studies of a process for desulfurizing low-Btu fuel gas are described and studied. The gas is first desulfurized at high temperature in a fluidized bed of half calcined dolomite. It is then cooled to 700 C and passed through high pressure drop cyclones to remove particulates and alkali. The gas is intended for use as fuel to gas turbines in combined-cycle power generation. The sulfur acceptor is regenerated with steam and CO2. A liquid phase Claus reactor is used to process H2S in the regenerator offgas into elemental sulfur. Experimental data are presented in several areas: (1) desulfurization and regeneration activity of dolomites as a function of cycles; (2) batch studies to determine variable effects and rate data; (3) particulate and alkali removal at high temperature; (4) chance reaction studies; and (5) process improvement studies. GRA

N78-12247# Federal Energy Administration, Washington, D. C. Office of Price Regulations.
CUMULATIVE PRODUCTION/CONSUMPTION EFFECTS OF THE CRUDE OIL PRICE INCENTIVE RULEMAKINGS Draft Environmental Impact Statement
Aug. 1977 640 p refs
(PB-271319/6; FEA/H-77/333; DES-77/7) Avail: NTIS HC A99/MF A01 CSCL 21D

An Environmental Impact Statement which analyzes the effect of Stage II of the EPCA crude oil price regulations is presented. The proposed regulations provide for monthly upward adjustments of the composite price, beginning in March 1976, to take into account the effects of inflation and to provide additional production incentives. It also analyzes the effect of the ECPA, which exempted stripper well oil from price controls and provides for special price treatment for heavy gravity crude oil produced in California and Alaska. GRA

N78-12361 New Mexico Univ., Albuquerque.
INVESTIGATION OF AN EJECTOR HEAT PUMP Ph.D. Thesis
Chowna Thupvongsa 1976 192 p
Avail: Univ. Microfilms Order No. 77-16123

The relative performance of heat driven ejector heat pumps suitable for possible low cost simple solar powered heating and cooling systems was evaluated. A procedure was developed for theoretical analysis of the ejector heat pump cycle using a digital computer. Freon-113 and 114 were selected for evaluation as working fluids because of their favorable phase equilibrium characteristics. Equations for the thermophysical properties of Freon-113 and 114 suitable for computer analysis were developed from published properties data. Finite difference equations for simulation of the ejector performance with Freon-113 and 114 were also developed and solved. The results indicate that Freon-113 and 114 experience a large increase of entropy in the ejector compression process. Thus, the ejector was relatively inefficient for these low density, dry vapor fluids. Dissert. Abstr.

N78-12418*# National Aeronautics and Space Administration, Washington, D. C.
HYBRID DRIVE FOR MOTOR VEHICLES WITH A PREPONDERANTLY INTERMITTENT METHOD OF OPERATION
H. Schreck Dec. 1977 22 p refs Transl. into ENGLISH from Hybridantrieb fuer Kraftfahrzeuge mit Vorwiegend Instationaerer Betriebsweise, 3rd Status Seminar on Motor Vehicle and Traffic Eng. (Cologne-Poll) 1975 17 p Presented at the 3rd Status Seminar on Motor Vehicle and Traffic Eng., Cologne-Poll, 25-26 Nov. 1975 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Original doc. prep. by Technische Hochschule, Aachen
(Contract NASw-2790)
(NASA-TM-75215) Avail: NTIS HC A02/MF A01 CSCL 13I

A flywheel hybrid propulsion system is compared with a conventional propulsion system in a test vehicle under intermittent operation. An energy balance is presented for the conventional propulsion system. Results so far indicate especially high energy conversion of the gyro component under dynamic operation along with favorable internal combustion engine conditions. Author

N78-12419*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
EVALUATION OF COAL FEED SYSTEMS BEING DEVELOPED BY THE ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
R. L. Phen, W. Luckow, L. Mattson, D. Otth, and P. Tsou Sep. 1977 146 p refs Sponsored in part by ERDA
(Contract NAS7-100)
(NASA-CR-155267; JPL-Pub-77-54) Avail: NTIS HC A07/MF A01 CSCL 13I

Development criteria and recommendations for coal feed system selections that include supporting data are presented. Considered are the areas of coal feed coasts, coal feed system reliability, and the interaction of the feed system with the conversion process. Author

N78-12425# General Electric Co., Schenectady, N. Y. Gas Turbine Div.

DEVELOPMENT OF HIGH TEMPERATURE TURBINE SUBSYSTEM TECHNOLOGY TO TECHNOLOGY READINESS STATUS; PHASE 1 Quarterly Report, Jun. - Sep. 1976
A. Caruvana 10 Nov. 1976 340 p refs
(Contract EX-76-C-01-1806)
(FE-1806-6) Avail: NTIS HC A15/MF A01

The requirements of overall plant design descriptions for combined cycle plants utilizing coal derived low Btu fuel gas and coal derived liquid fuel resulted in evaluations of various coal gasification processes including fixed bed and entrained bed. An advanced fixed bed concept was selected which operates at a very low steam to air ratio, achieves a cleaner more tar free operation and utilizes the coal fines mixed with tar. The Foster-Wheeler entrained bed system offers a high throughput with a savings in equipment costs. The availability of an efficient high temperature gas cleanup system would make the system attractive. The Benfield System was selected following evaluation of low temperature gas cleanup systems. Various design concepts are presented which represent the current status of various turbine configurations utilizing different blading cooling concepts. ERA

N78-12459*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NASTRAN USE FOR CYCLIC RESPONSE AND FATIGUE ANALYSIS OF WIND TURBINE TOWERS
C. C. Chamis, P. Manos, J. H. Sinclair, and J. R. Winemiller *In its* Sixth NASTRAN Users' Colloq. 1977 p 213-233 refs (For availability see N78-12443 03-39)
(Contract E(49-26)-1004)
Avail: NTIS HC A20/MF A01 CSCL 20K

A procedure is described which uses NASTRAN coupled with fatigue criteria via a postprocessor to determine the cyclic response and to assess the fatigue resistance (fatigue life) of wind turbine generator towers. The cyclic loads to which the tower may be subjected are entered either in a quasi-static approach though static load subcases (Rigid Format 1) or through the direct dynamic response (Rigid Format 9) features of NASTRAN. The fatigue criteria are applied to NASTRAN output data from either rigid format through an externally written user program embedded in a postprocessor. Author

N78-12506*# Tennessee Univ. Space Inst., Tullahoma. Remote Sensing Div.
THE APPLICATION OF LANDSAT-1 IMAGERY FOR MONITORING STRIP MINES IN THE NEW RIVER WATERSHED IN NORTHEAST TENNESSEE, PART 2 Final Report
F. Shahrokhi, Principal Investigator and Leslie A. Sharber [1977] 80 p refs Original contains imagery. Original photography may be purchased from the EROS Data Center, Sioux Falls, S. D. ERTS
(Contract NAS8-31980)
(E78-10032; NASA-CR-150423) Avail: NTIS HC A05/MF A01 CSCL 08I

The author has identified the following significant results. LANDSAT imagery and supplementary aircraft photography of the New River drainage basin were subjected to a multilevel analysis using conventional photointerpretation methods, densitometric techniques, multispectral analysis, and statistical tests to determine the accuracy of LANDSAT-1 imagery for measuring strip mines of common size. The LANDSAT areas were compared with low altitude measurements. The average accuracy over all the mined land sample areas mapped from LANDSAT-1 was 90%. The discrimination of strip mine subcategories is somewhat limited on LANDSAT imagery. A mine site, whether active or inactive, can be inferred by lack of vegetation, by shape, or image texture. Mine ponds are difficult or impossible to detect because of their small size and turbidity. Unless bordered and contrasted with vegetation, haulage roads are impossible to delineate. Preparation plants and refuge areas are not detectable. Density slicing of LANDSAT band 7 proved most useful in the detection of reclamation progress within the mined areas. For most state requirements for year-round monitoring of surface mined land, LANDSAT is of limited value. However, for periodic updating of regional surface maps, LANDSAT may provide sufficient accuracies for some users.

N78-12526 Iowa State Univ. of Science and Technology, Ames.
DEVOLATILIZATION AND DESULFURIZATION OF IOWA COAL Ph.D. Thesis
Edmund Tao Kang Huang 1977 213 p
Avail: Univ. Microfilms Order No. 77-16960

The devolatilization reaction of coal was studied in nitrogen atmospheres. The ultimate volatile matter released at a given temperature was found to be a function of temperature only. At a constant temperature condition the devolatilization reaction showed three reaction stages. The effective rate constant for each stage obtained at different temperatures was roughly linear on an Arrhenius plot and the effective activation energy for each reaction stage was about 1.2 Kcal/moles. In general, the sulfur reduction increased with temperature and holding time. It was observed in the experiments that some inorganic sulfur was transformed into organic sulfur during the treatment in each of the three gas atmospheres. The most attractive desulfurization process utilizing gas treatment is one that begins with a physical separation step to remove most of the inorganic sulfur and ash. This would be followed by treatment in hydrogen at 700 C. Dissert. Abstr.

N78-12527*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
BUILDING APPLICATION OF SOLAR ENERGY. STUDY NO. 2: REPRESENTATIVE BUILDINGS FOR SOLAR ENERGY PERFORMANCE ANALYSIS AND MARKET PENETRATION
Alan S. Hirshberg 19 Sep. 1975 127 p refs Sponsored by NASA
(NASA-CR-155325; JPL-5040-3) Avail: NTIS HC A07/MF A01 CSCL 10A

The following topics are discussed: (1) Assignment of population to microclimatic zones; (2) specifications of the mix of buildings in the SCE territory; (3) specification of four typical buildings for thermal analysis and market penetration studies; (4) identification of the materials and energy conserving characteristics of these typical buildings; (5) specifications of the HVAC functions used in each typical building, and determination of the HVAC systems used in each building; and (6) identification of the type of fuel used in each building. Author

N78-12528*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
BUILDING APPLICATION OF SOLAR ENERGY. STUDY NO. 4: SCENARIOS FOR THE UTILIZATION OF SOLAR ENERGY IN SOUTHERN CALIFORNIA BUILDINGS, CHANGE 1
E. S. Davis, R. L. French, and A. S. Hirshberg Feb. 1976 72 p refs Sponsored by NASA
(NASA-CR-155326; JPL-5040-10) Avail: NTIS HC A04/MF A01 CSCL 10A

Plausible future market scenarios for solar heating and cooling systems into buildings in the area served by the Southern California Edison Company. A range of plausible estimates for the number of solar systems which might be installed and the electrical energy which might be displaced by energy from these systems are provided. The effect on peak electrical load was not explicitly calculated but preliminary conclusions concerning peak load can be inferred from the estimates presented. Two markets are investigated: the single family market and the large power commercial market. Author

N78-12529*# General Electric Co., Philadelphia, Pa. Valley Forge Space Center.
DESIGN STUDY OF WIND TURBINES 50 kW TO 3000 kW FOR ELECTRIC UTILITY APPLICATIONS. VOLUME 1: SUMMARY REPORT Final Report
Sep. 1976 65 p
(Contracts NAS3-19403; E(49-26)-1010)
(NASA-CR-134934; ERDA/NASA-9403-76/1-Vol-1; Doc-SDS4287-Vol-1) Avail: NTIS HC A04/MF A01 CSCL 10B

Wind turbine configurations that would lead to generation of electrical power in a cost effective manner were considered. All possible overall system configurations, operating modes, and subsystem concepts were evaluated for both technical feasibility and compatibility with utility networks, as well as for economic attractiveness. A design optimization computer code was developed to determine the cost sensitivity of the various design features, and thus establish the configuration and design conditions that would minimize the generated energy costs. The preliminary designs of both a 500 kW unit and a 1500 kW unit operating in a 12 mph and 18 mph median wind speed respectively, were developed. The rationale employed and the key findings are summarized. Author

N78-12531# Energy Research Corp., Danbury, Conn.
NEW MATERIALS FOR FLUOROSULFONIC ACID ELECTROLYTE FUEL CELLS Final Technical Report, 7 Oct. 1974 - 7 Apr. 1977
Michael George and Stanley Januszkiewicz Jun. 1977 49 p refs
(Contract DAAK02-75-C-0045)
(AD-A044414; ERC-0123-F) Avail: NTIS HC A03/MF A01 CSCL 10/2

Hydrogen-air fuel cells were evaluated with both TFMSA monohydrate and dilute TFMSA. Pressurized monohydrate cells were run at power levels comparable to phosphoric acid fuel cells under similar conditions. Fuel cells with from 25 to 60% TFMSA were evaluated at 25 and 70 C. A cell with 50% TFMSA was run for over 2,000 hours at room temperature without acid replenishment. Power densities in excess of 130mW/sq cm could be achieved at ambient temperatures and pressures with low loading catalysts. The evaluation of supported platinum and tungsten carbide catalyst with dilute TFMSA was initiated. Silicon carbide was investigated as a matrix material with TFMSA. Author (GRA)

N78-12532# Missouri Univ., Rolla. Dept. of Engineering Management.
ENERGY SYSTEM ANALYSIS PROCEDURE (ESAP) Final Report
John M. Amos Jun. 1977 134 p refs
(Contract F33615-76-C-5384)
(AD-A044131) Avail: NTIS HC A07/MF A01 CSCL 10/3

Energy is vital to any production program and an energy shortage can substantially affect industrial production. The objective of this research project was to develop a system for analyzing the impact of various degrees of energy reductions (shortages) during crises on industrial production facilities participating in Industrial Preparedness Planning (IPP) programs. The researcher developed an Energy System Analysis Procedure (ESAP) for assessing the effects of energy reduction on production planning. The total energy requirements for manufacturing activities are analyzed for their effects on production. The method involves programming of the plant or facility in question from the viewpoint of physical units. The research recommended that the Air Force implement a system to evaluate the effects of energy reduction of IPP plant capabilities and work to enact an energy priority regulation for plants with the IPP program. Also, the research found that most IPP programs are out of date and are not being updated and reviewed periodically. Author (GRA)

N78-12533# General Accounting Office, Washington, D. C. Energy and Minerals Div.
ROCKY MOUNTAIN ENERGY RESOURCE DEVELOPMENT: STATUS, POTENTIAL, AND SOCIOECONOMIC ISSUES
13 Jul. 1977 127 p
(PB-269969/2; EMD-77-23) Avail: NTIS HC A07/MF A01 CSCL 10A

The status of and potential for energy resource development in the Rocky Mountain area was studied. Socioeconomic problems that may result by 1985 from energy resource development in the area are discussed: (1) Federal, State, and industry actions being taken to resolve the problems, (2) the level and type of effort that might be required; and (3) the roles the States, the Federal Government, and industry should play in mitigating these problems. GRA

N78-12534# Battelle Columbus Labs., Ohio.
A SURVEY OF THE USE OF CERAMICS IN BATTERY AND FUEL CELL APPLICATIONS Final Report, Jan. - Jun. 1977
Eric W. Brooman, Keith R. Shillito, and Walter K. Boyd Jun. 1977 101 p refs
(Contract DAAG46-77-M-0460; DA Proj. 1T1-62105-AH-84)
(AD-A044888; AMMRC-CTR-77-18) Avail: NTIS HC A06/MF A01 CSCL 11/2

A survey has been carried out examining the use of ceramics in battery and fuel cell applications. Brief descriptions and characteristics of batteries are presented, including those operating at near ambient and at elevated temperatures. The current technology of fuel cells is also discussed. Finally, a detailed analysis of the problem areas and related research needs for ceramics in these applications is provided together with recommendations for future work in this area. Author (GRA)

N78-12535# Decisions and Designs, Inc., McLean, Va.
AN ATTITUDINAL STUDY OF THE HOME MARKET FOR SOLAR DEVICES Progress Report, Mar. - Sep. 1977
Vincent N. Campbell, Rex V. Brown, Thomas R. Rhees, and Dominic J. Repici Sep. 1977 73 p refs
(Contract N00014-75-C-0426)
(AD-A045082; TR-77-5-25) Avail: NTIS HC A04/MF A01 CSCL 13/1

This study estimates that 1.1 million American residences would have home and hot water heated with solar energy by 1985 if the total cost averaged $20 a month more than the cost of heating with fossil fuels, and initial costs were no barrier. An additional 7.2 million homes would have hot water alone heated with solar energy by 1985 if the total cost was $5 a month more. These are fairly favorable cost assumptions under current conditions. Almost half (44%) of potential homeowners surveyed would prefer to have their living spaces and hot water heated with solar energy if the total cost averaged $20 per month more than conventional heating and initial costs were no barrier. Although interest runs high, for various economic and technical reasons only about 1 in 75 American families may have both their home and water heated with solar energy by 1985. Any development that makes solar energy cost-competitive with fossil fuels for home heating will increase the level of market penetration. Another key to how quickly Americans will have solar homes is how fast builders and developers use solar energy in new homes and can assure good performance. Author (GRA)

N78-12537# Stanford Univ., Calif. Systems Optimization Lab.
THE STANFORD PILOT ENERGY/ECONOMIC MODEL
T. J. Connolly, G. B. Dantzig, and S. C. Parikh Jul. 1977 50 p refs
(Contracts N00014-75-C-0865; EY-76-S-03-0326; Grant NSF MCS-76-20019)
(AD-A044908; SU-SOL-77-19) Avail: NTIS HC A03/MF A01 CSCL 05/3

The PILOT Energy Modeling Project is concerned with: (1) performing modeling and methodology research dealing with construction and solution of reasonably large scale mathematical programming models of energy/economic systems; (2) using modeling research towards analysis of some of today's important energy questions; and (3) using the modeling and methodology to construct better models for improved analysis of tomorrow's important energy questions. At the core of this project is the development of a multisector, intertemporal linear programming modeling system that describes in physical terms many of the technological interactions within and across the sectors of the American economy. The general aim of the modeling effort is to permit studies to assess (1) how specific energy policies will affect the energy supply/demand picture and (2) how the physical capacity of the economy over the next 30-35 years to provide goods and services to its populace could be affected by changes in energy supply. Intertemporal linear programming models of the energy sector and the economy provide a unique medium for exploring future energy policy options. GRA

N78-12540# ICF, Inc., Washington, D. C.
PROJECT INDEPENDENCE EVALUATION SYSTEM (PIES) DOCUMENTATION. VOLUME 11: FINANCE SUBMODEL FOR THE FEA OIL AND GAS SUPPLY MODEL
Sep. 1976 64 p
(Contract FEA-CO-05-40301-00)

(PB-269948/6; FEA/N-76/421) Avail: NTIS HC A04/MF A01 CSCL 05C

The finance submodel produces industry-wide income statements for the oil and gas producing industries, which permit PIES results to be translated into detailed schedules of oil and gas industry capital requirements. The finance submodel is described in terms of its logic, input data, and output format. GRA

N78-12541# ICF, Inc., Washington, D. C.
PROJECT INDEPENDENCE EVALUATION SYSTEM (PIES) DOCUMENTATION. VOLUME 10: AUTOMATION OF FINDING RATE AND DISCOUNT RATES IN THE FEA GAS SUPPLY MODEL
Sep. 1976 41 p
(Contract FEA-CO-05-50301-00)
(PB-269947/8; FEA/N-76/420-Vol-10) Avail: NTIS HC A03/MF A01 CSCL 05C

The methodology is described which is used to automate, within the model, the laborious calculation of finding rates and discount rates. Early versions of the model required these calculations to be done by hand. GRA

N78-12542# Institute for Energy Analysis, Oak Ridge, Tenn.
ENERGY EMBODIED IN GOODS
David B. Reister Feb. 1977 20 p refs
(Contract EY-76-C-05-0033)
(ORAU/IEA(M)-77-6) Avail: NTIS HC A02/MF A01

The use of cost estimates to reduce uncertainty in net energy analysis was studied. This uncertainty is reduced by estimating average prices for selected goods and services in units of 1967 dollars per ton. When multiplied by energy intensity coefficients, one obtains the energy embodied in 367 different goods in units of Btu per 1967 dollar and, with prices, one can convert these coefficients into units of Btu per ton. This paper also defines the 'atypical product' problem and shows that by using energy intensity coefficients measured in Btu per ton, one obtains more accurate results than by using coefficients measured in Btu per 1967 dollar. ERA

N78-12543# Energy Research and Development Administration, Washington, D. C.
MANAGEMENT PLAN FOR ENHANCED OIL RECOVERY. VOLUME 2: APPENDICES
Feb. 1977 270 p refs
(ERDA-77-15/2-Vol-2-App) Avail: NTIS HC A12/MF A01

Appendices for the management plan for enhanced oil recovery are presented. Included in the 13 appendices are detailed descriptions of candidate enhanced oil recovery (EOR) programs, list of fields and reservoirs in the data base, glossary, EOR models used in the management plan, EOR program strategy for environmental quality assurance, EOR management plan analytical survey, analysis of survey results, and analysis of the sensitivity of the industry base case estimates to the oil price and tax assumptions. ERA

N78-12544# Energy Research and Development Administration, Washington, D. C.
FOSSIL ENERGY RESEARCH PROGRAM OF THE ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION, FY 1978
P. C. White Apr. 1977 378 p refs
(ERDA-77-33) Avail: NTIS HC A17/MF A01

The Fossil Energy (FE) Research, Development, and Demonstration (RD and D) Programs of the Energy Research and Development Administration (ERDA) are expanding in response to the national need to develop adequate amounts of clean fossil fuel from domestic resources. The purpose of this report is to provide additional details on the projects underway and planned in FE, with specific emphasis on the President's FY 1978 Budget Request. The research documented in this report is guided by the following overall program goals: to develop the technology needed to make fossil fuels available in the form and quantity needed and to assure that the Nation's fossil fuels resources are developed at acceptable economic, social, and environmental costs. These major goals have been translated into funding requirements for each of the programs. ERA

N78-12545# TRW Defense and Space Systems Group, Redondo Beach, Calif. Systems Engineering and Integration Div.
PLANNING AND DESIGN OF ADDITIONAL EAST MESA GEOTHERMAL TEST FACILITIES, PHASE 1B. VOLUME 3: APPENDICES
R. O. Pearson 15 Oct. 1976 130 p refs
(Contract EY-76-C-03-1140)
(SAN/1140-1/3-Vol-3-App) Avail: NTIS HC A07/MF A01

Results of a petrophysical study performed on seven wells in the East Mesa area of the Imperial Valley of California are reported. The wells were drilled on and around the geothermal anomaly that constitutes the East Mesa Field. In each case the objective of the petrophysical study was to determine porosities, permeabilities and salinities in requested intervals, together with the selection of the best sand/shale discriminator. The computed results are reported in table and listing form to show average values of porosity, horizontal and vertical permeabilities together with gross interval, net sand, percent sand and darcy-feet tabulations, layered in 250' intervals throughout each well. The second section of this report is devoted to details of the drilling prognosis for the three geothermal wells to be drilled by the Bureau of Reclamation at their East Mesa site. ERA

N78-12546# California Univ., Livermore. Lawrence Livermore Lab.
PERFORMANCE TESTS OF A TOTAL FLOW IMPULSE TURBINE FOR GEOTHERMAL APPLICATIONS
W. J. Comfort 3 Mar. 1977 31 p refs
(Contract W-7405-eng-48)
(UCID-17411) Avail: NTIS HC A03/MF A01

A two phase expander was successfully tested in the laboratory. An engine efficiency of 23 percent for a single nozzle test was measured. Performance predictions of a numerical model agree well with experimental results. Full admission performance, based upon the numerical model and achievable nozzle thrust coefficients indicate that full admission engine efficiency between 38 and 48 percent can be realized with present technology. Droplet size reduction and enhanced two phase flow analysis techniques should make it possible to reach the research goal of 70 percent engine efficiency. ERA

N78-12548# General Accounting Office, Washington, D. C. Energy and Minerals Div.
AN EVALUATION OF THE NATIONAL ENERGY PLAN
25 Jul. 1977 186 p refs
(PB-270172/0; EMD-77-48) Avail: NTIS HC A09/MF A01 CSCL 10A

An analysis and comment on the President's National Energy Plan is presented. The report is intended to assist the Congress in considering the legislation that the administration has proposed to implement the plan. GRA

N78-12549# California State Div. of Oil and Gas, Sacramento.
ECONOMIC STUDY OF LOW TEMPERATURE GEOTHERMAL ENERGY IN LASSEN AND MODOC COUNTIES, CALIFORNIA
Apr. 1977 94 p refs Prepared in part by the California Energy Resources Conservation and Development Commission, Sacramento, and VTN-CSL, Irvine, Calif.
(Grant EDA-07-6-01522)
(PB-270256/1; JOB-2175-3; EDA-77-0113) Avail: NTIS HC A05/MF A01 CSCL 10A

The feasibility of using low cost, low temperature geothermal energy in job-producing industries to increase employment and encourage economic development is investigated. The study, encompassing all of Lassen and Modoc Counties is site-specific, referencing candidate geothermal applications to known hot wells and springs. The emphasis is placed on economically practical and readily achievable applications from known resources. Land-use planning, institutional aspects, geological assessments, technical modeling and socioeconomic impacts are examined. GRA

N78-12550# Rocky Mountain Center on Environment, Denver, Colo.
ENERGY CONSERVATION AND STATE LEGISLATURES. BASED ON THE ENERGY CONSERVATION WORKSHOP FOR REGION 8 STATE LEGISLATORS
Susan Carpenter, comp. Dec. 1976 67 p refs Workshop held at Denver, 10-11 Dec. 1976
(PB-270428/6; FEA-76-8-7) Avail: NTIS HC A04/MF A01 CSCL 10A

The purpose of the workshop was to increase the participants' awareness of the general need for energy conservation, to interest legislators in promoting energy conservation legislation, and to provide information about specific practices which can further conservation efforts. GRA

N78-12551# Florida Solar Energy Center, Cape Canaveral.
SOLAR ENERGY COMMERCIALIZATION AT THE STATE LEVEL: THE FLORIDA SOLAR ENERGY WATER HEATER PROGRAM
Milan Johnson and Thomas F. Tiedemann Mar. 1977 142 p refs
(Contract FEA-CA-05-50053-00)
(PB-270158/9; FSEC-76-3; FEA/G-77/270) Avail: NTIS HC A07/MF A01 CSCL 10A

A detailed study was made of current problems associated with the introduction of commercialization of solar technologies in the state of Florida--particularly domestic water heating. Solar energy-related legislation considered by state legislatures is analyzed, with emphasis on actions recommended to accelerate commercialization and use. The study presents proposed standards and programs consistent with suggested comprehensive Florida solar energy commercialization plans. The use of solar water heaters in state buildings as a potential incentive to a local solar energy industry is briefly examined. Included are detailed instructions for constructing a model solar water heater, directed primarily at high school students; and climatological data. GRA

N78-12552# General Accounting Office, Washington, D. C. Community and Economic Development Div.
EFFECTIVE FUEL CONSERVATION PROGRAMS COULD SAVE MILLIONS OF GALLONS OF AVIATION FUEL
15 Aug. 1977 78 p refs
(PB-271249/5; CED-77-98) Avail: NTIS HC A05/MF A01 CSCL 10A

Federal actions to conserve fuel used by the airlines are discussed and additional fuel saving methods are suggested. GRA

N78-12556# Water Purification Associates, Cambridge, Mass.
WATER CONSERVATION AND POLLUTION CONTROL IN COAL CONVERSION PROCESSES Final Report, Jun. 1975 - Dec. 1976
D. J. Goldstein and David Yung Jun. 1977 486 p refs
(Contract EPA-68-03-2207)
(PB-269568/2; EPA-600/7-77-065) Avail: NTIS HC A21/MF A01 CSCL 13B

Water consumption and environmental impacts of coal conversion processes in Western states are considered. Detailed designs and analyses are given for the Hygas, Synthane, and Solvent Refined Coal (SRC) processes, and for Lurgi combined-cycle power generation. At three proposed sites (in North Dakota, New Mexico, and Wyoming), complete water requirements and effluents including all mining and related off-site uses are given for the power, Hygas, and SRC plants. The Synthane process is analyzed only at the Wyoming Site. GRA

N78-12560# Federal Power Commission, Washington, D. C. Bureau of Power.
THE STATUS OF FLUE GAS DESULFURIZATION APPLICATIONS IN THE UNITED STATES: A TECHNOLOGICAL ASSESSMENT, HIGHLIGHTS
Jul. 1977 83 p
(PB-271361/8) Avail: NTIS HC A05/MF A01 CSCL 07A

An historical survey of the research, development and demonstration of flue gas desulfurization (FGD) is presented. The costs of installing, operating, and maintaining FGD systems were discussed, along with alternative technologies for meeting air pollution control regulations. Also examined were coalwashing, supplementary control systems and tall stacks, solvent refined coal, cpa, gasification, and fluidized bed combustion. The cost of FGD was compared with present and future alternatives. The chemistry and equipment used in FGD systems currently in full scale commercial application were analyzed. Results of FGD systems in planning stages, under construction and operating were presented, while eight discontinued, full scale scrubber applications were discussed in detail. GRA

N78-12561# Federal Power Commission, Washington, D. C.
THE STATUS OF FLUE GAS DESULFURIZATION APPLICATIONS IN THE UNITED STATES: A TECHNOLOGICAL ASSESSMENT, REPORT IN FULL
Jul. 1977 549 p
(PB-271362/6) Avail: NTIS HC A23/MF A01 CSCL 07A
For abstract, see N78-12560.

N78-12647 Johns Hopkins Univ., Baltimore, Md.
PHYSIOLOGICAL STUDIES OF NITROGEN FIXATION BY BLUE-GREEN ALGAE Ph.D. Thesis
Nancy Moller Weare 1974 194 p
Avail: Univ. Microfilms Order No. 77-16555

In a series of experiments which examined the effects of mechanical blending, oxygen and darkness on nitrogenase activity and photosynthesis in the heterocystous blue green alga, Anabaena cylindrica, it was shown that these activites are spatially separated. Photosynthesis occurs in the vegetative cells, but not in the heterocysts, whereas nitrogenase activity is localized in the heterocysts. A model involving the coupling of photosynthetic products from the vegetative cells with nitrogen fixation in the heterocysts was proposed which is consistent with these data as well as other information in the literature. Dissert. Abstr.

N78-12823*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
AN ANALYSIS OF THE BACK END OF THE NUCLEAR FUEL CYCLE WITH EMPHASIS ON HIGH-LEVEL WASTE MANAGEMENT, VOLUME 1
12 Aug. 1977 55 p refs 2 Vol.
(Contract NAS7-100)
(NASA-CR-155319; JPL-Pub-77-59-Vol-1) Avail: NTIS HC A04/MF A01 CSCL 18G

The programs and plans of the U.S. government for the 'back end of the nuclear fuel cycle' were examined to determine if there were any significant technological or regulatory gaps and inconsistencies. Particular emphasis was placed on analysis of high-level nuclear waste management plans, since the permanent disposal of radioactive waste has emerged as a major factor in the public acceptance of nuclear power. The implications of various light water reactor fuel cycle options were examined including throwaway, stowaway, uranium recycle, and plutonium plus uranium recycle. The results of this study indicate that the U.S. program for high-level waste management has significant gaps and inconsistencies. Areas of greatest concern include: the adequacy of the scientific data base for geological disposal; programs for the the disposal of spent fuel rods; interagency coordination; and uncertainties in NRC regulatory requirements for disposal of both commercial and military high-level waste. Author

N78-12824*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
AN ANALYSIS OF THE BACK END OF THE NUCLEAR FUEL CYCLE WITH EMPHASIS ON HIGH-LEVEL WASTE MANAGEMENT, VOLUME 2
12 Aug. 1977 195 p refs 2 Vol.
(Contract NAS7-100)
(NASA-CR-155320; JPL-Pub-77-59-Vol-2) Avail: NTIS HC A09/MF A01 CSCL 18G
For abstract, see N78-12823.

N78-12837 Tennessee Univ., Knoxville.
ON PRESSURE AND HEAT FLUX DISTRIBUTION ALONG MAGNETOHYDRODYNAMIC GENERATOR CHANNEL-DIFFUSER SYSTEMS Ph.D. Thesis

Gabriel Davis Roy 1977 154 p
Avail: Univ. Microfilms Order No. 77-16598

The pressure distribution was investigated along supersonic magnetohydrodynamic (MHD) generators resulting from the interfractions of Lorentz force and Joule heating with the flow. The pressure recovery of diffusers under conditions pertinent to MHD generators was also studied. Static pressure and voltage measurements were made in diagonal conducting wall generators. A quasi one-dimensional analysis with friction, heat transfer, chemical reaction, and normal shock wave is made. The voltage distribution is predicted accurately by the analysis and so is the pressure distribution where the flow is shock-free. Investigations were made of both supersonic and subsonic diffusers with coal combustion gas with high entrance boundary layer blockage factors in the subsonic diffuser. Pressure recoveries and heat transfer rates are presented. Dissert. Abstr.

N78-12907# JHK and Associates, Alexandria, Va.
PRIORITY TREATMENT FOR HIGH OCCUPANCY VEHICLES: PROJECT STATUS REPORT Interim Report, May 1976 - Mar. 1977
M. J. Rothenberg Mar. 1977 41 p
(Contract DOT-FH-11-8242)
(PB-270529/1; FHWA-RD-77-56) Avail: NTIS HC A03/MF A01 CSCL 13B

The current status of 14 preferential treatment projects for buses and carpools in the United States is reviewed. The range of projects covered include bus and carpool lanes physically separated from the flow of other traffic, contra-flow lanes, exclusive median withflow lanes, bypasses of metered freeway ramps, and toll reductions for carpools. Key historical events in the development of each project are cited and observations are made on the effectiveness of each. GRA

N78-12909# Stanford Research Inst., Menlo Park, Calif.
TRANSPORTATION IN AMERICA'S FUTURE: POTENTIALS FOR THE NEXT HALF CENTURY. PART 2. TRANSPORTATION FORECASTS Final Report
David Curry, Richard Carlson, Clark Henderson, Thomas Mandel, and Arnold Mitchell Jun. 1977 343 p refs
(Contract DOT-OS-60160; SRI Proj. 5040)
(PB-270468/2; DOT/TPI/20-77/21-2-Pt-2) Avail: NTIS HC A15/MF A01 CSCL 13B

Contents: transportation demand and energy estimates; transportation trends and issues under three futures for 1995; prospects for 2025 (air, avionics, shipping, pipelines and tunnels, railroads, intercity buses, highways and streets, trucking, automobiles, urban transit and rail, paratransit, pedestrian aids and bikeways, elderly and handicapped services); electric and hybrid automobiles; innovative urban systems; automated highway system; a generic approach to advanced freight systems; tracked levitated vehicles, improved passenger trains and buses; the successful SST; transportation implications of future telecommunications technology; transportation problems and opportunities. GRA

N78-12910# Stanford Research Inst., Menlo Park, Calif.
TRANSPORTATION IN AMERICA'S FUTURE: POTENTIALS FOR THE NEXT HALF CENTURY. PART 1: SOCIETAL Final Report
David Curry, Richard Carlson, Clark Henderson, Thomas Mandel, and Arnold Mitchell Jun. 1977 131 p refs
(Contract DOT-OS-60160; SRI Proj. 5040)
(PB-270467/4; DOT/TPI/20-77/21-1-Pt-1) Avail: NTIS HC A07/MF A01 CSCL 13B

Four potential socioeconomic futures for the United States and their implications for transportation through 2025 are presented. The futures (designated Success,Foul Weather, Disciplined Society, and Transformation) vary in economic performance, climate, institutional structure, and personal values. For each future a narrative account or scenario is given with separate analyses of the energy, demographic, economic, and urban implications of each scenario. Demand forecasts for most modes, technology forecasts for twelve transportation modes and seven specific systems or technologies, and analyses of six critical transportation problems are included. GRA

N78-13056*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF FUEL PROPERTIES ON PERFORMANCE OF SINGLE AIRCRAFT TURBOJET COMBUSTOR AT SIMULATED IDLE, CRUISE, AND TAKEOFF CONDITIONS
Helmut F. Butze and Arthur L. Smith Sep. 1977 21 p refs
(NASA-TM-73780; E-9336) Avail: NTIS HC A02/MF A01 CSCL 21E

The performance of a single-can JT8D combustor was investigated with a number of fuels exhibiting wide variations in chemical composition and volatility. Performance parameters investigated were combustion efficiency, emissions of CO, unburned hydrocarbons and nitrogen oxides, as well as liner temperatures and smoke. The most pronounced effects of changes in fuel composition were observed at simulated cruise and takeoff conditions where smoke and liner temperatures increased significantly as the hydrogen content of the fuel decreased. At the simulated idle condition, emissions of CO and unburned hydrocarbons increased slightly and, accordingly, combustion efficiencies decreased slightly as the hydrogen content of the fuels decreased. Author

N78-13062*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AN OVERVIEW OF AEROSPACE GAS TURBINE TECHNOLOGY OF RELEVANCE TO THE DEVELOPMENT OF THE AUTOMOTIVE GAS TURBINE ENGINE
D. G. Evans and T. J. Miller 1978 52 p refs Presented at Ann. Meeting of the Soc. of Automotive Engineers, Detroit, Mich., 27 Feb. - 3 Mar. 1978
(NASA-TM-73849) Avail: NTIS HC A04/MF A01 CSCL 21E

Technology areas related to gas turbine propulsion systems with potential for application to the automotive gas turbine engine are discussed. Areas included are: system steady-state and transient performance prediction techniques, compressor and turbine design and performance prediction programs and effects of geometry, combustor technology and advanced concepts, and ceramic coatings and materials technology. Author

N78-13065# School of Aerospace Medicine, Brooks AFB, Tex.
ORGANIC COMPOUNDS IN TURBINE COMBUSTOR EXHAUST Progress Report, Dec. 1974 - Sep. 1975
James P. Conkle, William W. Lackey, Charles L. Martin, and Richard L. Miller Sep. 1975 12 p refs
(AD-A045582; SAM-TR-75-340) Avail: NTIS HC A02/MF A01 CSCL 21/2

Trace organic compounds in aircraft turbine combustor exhaust were determined as functions of fuel type and engine operating pressure (power setting). Hydrocarbons were collected by multistage cryogenic sampling. Chemicals were analyzed by a coupled gas chromatograph-mass spectrometer-data system. Results are presented in the context of assessment of biomedical impact of aircraft operations. Author (GRA)

N78-13099*# Boeing Aerospace Co., Seattle, Wash. Space Div.
SOLAR POWER SATELLITE: SYSTEM DEFINITION STUDY. PART 1, VOLUME 1: EXECUTIVE SUMMARY
28 Jun. 1977 32 p
(Contract NAS9-15196)
(NASA-CR-151554; D180-20689-1-Pt-1-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 22B

A study of the solar power satellite system, which represents a means of tapping baseload electric utility power from the sun on a large scale, was summarized. Study objectives, approach, and planning are presented along with an energy conversion evaluation. Basic requirements were considered in regard to space transportation, construction, and maintainability. B.L.P.

N78-13100*# Boeing Aerospace Co., Seattle, Wash. Space Div.
SOLAR POWER SATELLITE. SYSTEM DEFINITION STUDY. PART 1, VOLUME 2: SYSTEM REQUIREMENTS ANI ENERGY CONVERSION OPTIONS
29 Jul. 1977 344 p refs
(Contract NAS9-15196)

(NASA-CR-151555; D180-20689-2-Pt-1-Vol-2) Avail: NTIS HC A05/MF A01 CSCL 22B

Propulsion system requirements for point of departure and earth-to-orbit, or orbit-to-orbit transportation are discussed. The solar photovoltaic and thermal engine configurations are analyzed. A.R.H.

N78-13102*# Boeing Aerospace Co., Seattle, Wash. Space Div.

SOLAR POWER SATELLITE. SYSTEM DEFINITION STUDY. PART 1, VOLUME 4: SPS TRANSPORTATION SYSTEM REQUIREMENTS

1 Aug. 1977 48 p

(Contract NAS9-15196)

(NASA-CR-151557; D180-20689-4-Pt-1-Vol-4) Avail: NTIS HC A03/MF A01 CSCL 22B

The best estimates of space transportation requirements for cargo launch vehicles, personnel launch carriers, high thrust orbit transfer, and electric orbit transfer systems are discussed, along with the rationale for each. A.R.H.

N78-13103*# Boeing Aerospace Co., Seattle, Wash. Space Div.

SOLAR POWER SATELLITE. SYSTEM DEFINITION STUDY. PART 1, VOLUME 5: SPS TRANSPORTATION. REPRESENTATIVE SYSTEM DESCRIPTIONS

28 Jul. 1977 253 p

(Contract NAS9-15196)

(NASA-CR-151558; D180-20689-5-Pt-1-Vol-5) Avail: NTIS HC A12/MF A01 CSCL 22B

Both LEO transportation (earth to low earth orbit) and GEO transportation (low earth orbit to geosynchronous orbit) segments were addressed. LEO options include both a 2 stage winged space freighter vehicle and a 2 stage ballistic recoverable vehicle. Both incorporate LO(2)/RP-1/LH(2) engines on the booster and standard SSME's on the upper stage. The orbit transfer vehicle options included chemical for geosynchronous satellite assembly and self powered electric propulsion for low earth orbit satellite assembly. An exhaust products analysis was conducted for the earth to LEO vehicle since atmospheric pollution could be a concern. Author

N78-13106*# Varian Associates, Palo Alto, Calif.

SOLAR POWER SATELLITE 50 kW VKS-7773 cw KLYSTRON EVALUATION Final Report, 15 Jan. - 15 May 1977

A. D. LaRue Aug. 1977 62 p

(Contract NAS9-15176)

(NASA-CR-151577) Avail: NTIS HC A04/MF A01 CSCL 22B

A test program for evaluating the electrical characteristics of a cw, 50 kW power output klystron at 2.45 GHz is described. The tube tested was an 8-cavity klystron, the VKS-7773 which had been in storage for seven years. Tests included preliminary testing of the tube, cold tests of microwave components, tests of the electromagnet, and first and second hot tests of the tube. During the second hot test, the tuner in the fifth cavity went down to air, preventing any further testing. Cause of failure is not known, and recommendations are to repair and modify the tube, then proceed with testing as before to meet program objectives. Author

N78-13175# Western Michigan Univ., Kalamazoo. Dept. of Chemistry.

FUNDAMENTALS OF NITRIC OXIDE FORMATION IN FOSSIL FUEL COMBUSTION Quarterly Progress Report, 11 Jun. - 10 Sep. 1976

T. Houser Nov. 1976 11 p refs

(Contract EX-76-C-01-2018)

(FE-2018-5) Avail: NTIS HC A02/MF A01

The reaction mechanism that leads to NO formation from fuel nitrogen was studied by determining the rates and mechanisms of pyridine pyrolysis and cyanogen oxidation. It was found that the rate of pyrolysis of C5D5N was about 60 percent of the pyrolysis rate of the normal pyridine. An isotope effect of this size is inconsistent with a nonchain reaction initiated by ring rupture. The oxidation of cyanogen appears to be first order and zero order with respect to cyanogen and oxygen respectively over a wide range of initial concentrations of these reactants. ERA

N78-13209*# General Electric Co., Philadelphia, Pa.

IMPROVED CERAMIC HEAT EXCHANGER MATERIAL Interim Report

H. W. Rauch Nov. 1977 35 p ref

(Contracts NAS3-19698; EC-77-A-31-1011)

(NASA-CR-135292; CONS/9698-1) Avail: NTIS HC A03/MF A01 CSCL 11G

Various ceramic materials in the form of small, monolithic bars were screened as candidate materials in heat exchanger structures for automotive gas turbine engines. Small bar-shaped specimens of the honeycomb were used to measure thermal, chemical, and mechanical properties and for macro- and microstructure examinations. Cylindrical honeycomb specimens about 15.2 cm diameter and 10.2 in. thick are currently being tested in a gas turbine engine. Data obtained from testing the bar-shaped honeycomb specimens of GE-3200 and from testing bar-shaped honeycomb specimens of Corning 9455 were compared. Results indicate that GE-3200 has significantly better resistance to sulfuric acid and to sodium chloride than Corning 9455; thermal expansion of GE-3200 is higher than that of Corning 9455; mechanical properties of GE-3200 are higher in the tangential direction, but lower in the radial direction than Corning 9455; and during thermal cycling between R.T. 1000 C and R.T - 1100 C, GE-3200 tends to elongate while Corning 9455 tends to slightly contract. Overall assessment of GE-3200 properties, ease of material preparation, ready adaptability to honeycomb fabrication, and refractoriness qualify this new material as a candidate for heat exchanger application in automotive gas turbine engines. Author

N78-13212# National Bureau of Standards, Washington, D. C. Recycled Oil Program.

MEASUREMENTS AND STANDARDS FOR RECYCLED OIL Final Report

D. A. Becker Aug. 1977 145 p Presented at a workshop, National Bureau of Standards in Gaithersburg, Md., 22-23 Nov. 1976

(PB-271562/1; NBS-SP-488; LCCN-77-600032) Avail: NTIS HC A07/MF A01 CSCL 11H

The following papers are presented: the NBS workshop objectives and the NBS recycled oil program; burning used oil at a military installation; fuel oil and the Defense Supply Agency; fuel oil specifications; automotive crankcase drainings used for fuel; ASTM test methods for industrial oils; industrial oil recycling at Chrysler; industrial oils-descriptions, additives, and test methods; the use of recycled industrial and hydraulic oils at Ford; industrial lubricants, reclaimed oils, and test methods; DOD experiences in testing tube oils; waste oil recycling--an idea whose time has come; comments on additive response to different base oils; and activities of the ASTM used oil task force. GRA

N78-13233*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

HYDROCARBON GROUP TYPE DETERMINATION IN JET FUELS BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

Albert C. Antoine 1977 13 p refs Presented at 4th Ann. Meeting of the Federation of Analytical Chem. and Spectroscopy Soc. (FACSS 4), Detroit, Mich., 7-11 Nov. 1977

(NASA-TM-73829; E-9416) Avail: NTIS HC A02/MF A01 CSCL 21D

Thirty-two jet and diesel fuel samples of varying chemical composition and physical properties were prepared from oil shale and coal syncrudes. Hydrocarbon types in these samples were determined by a fluorescent indicator adsorption analysis, and the results from three laboratories are presented and compared. Two methods of rapid high performance liquid chromatography were used to analyze some of the samples, and these results are also presented and compared. Two samples of petroleum-based Jet A fuel are similarly analyzed. Author

N78-13237# Kentucky Univ., Lexington. Inst. for Mining and Minerals Research.

PRODUCTION OF AMMONIA USING COAL AS A SOURCE OF HYDROGEN Annual Report
Walden L. S. Laukhuf (Louisville Univ., Ky.) Apr. 1977 49 p refs
(PB-271916/9; IMMR28-PD17-77; AR-2) Avail: NTIS HC A03/MF A01 CSCL 21D

A study was performed to determine an optimum set of operating conditions for a coal gasifier used to provide hydrogen for a 1200-ton per day ammonia synthesis plant. The feedstock was a high sulfur Western Kentucky coal. By using a thermodynamic equilibrium model of a gasifier, it was found that if more steam was sent to the gasifier and less oxygen or air was sent, more hydrogen would be produced. However, based on the amount of hydrogen produced, no optimum operating conditions were determined. Based on economics and the cost to produce one ton of ammonia, optimum gasifier operating conditions were determined. GRA

N78-13239# Eastlund (Ben) Fusion Systems Co., Rockville, Md.
WORKSHOP ON SYNTHETIC FUELS FROM FUSION
Apr. 1977 86 p refs Workshop held at Palo Alto, Calif., 9 Feb. 1976 Sponsored by the Electric Power Research Inst.
(EPRI-ER-439-SR; Conf-760254) Avail: NTIS HC A05/MF A01

Reasons to pursue a program to define and explore the nonelectrical outputs of fusion reactors are discussed. Meeting fuel shortages, early availability of fusion reactors, and increasing overall efficiency of fusion power plants are among the factors considered. The potential ability of fusion reactors to provide thermal energy at temperatures considerably above those currently available from fission reactors and high temperature applications such as chemical processing, thermochemical dissociation of water, and thermally-enhanced electrolysis of water are included. ERA

N78-13241*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PROCEEDINGS OF THE CONFERENCE ON COAL FEEDING SYSTEMS
15 Sep. 1977 726 p refs Proc. held at Pasadena, Calif., 21-23 Jun. 1977 Sponsored by ERDA
(Contract NAS7-100)
(NASA-CR-155331; JPL-Pub-77-55) Avail: NTIS HC A99/MF A01 CSCL 10B

Development of coal feed systems for coal gasification, fluidized bed combustion, and magnetohydrodynamic applications is discussed. Process operations experience, energy conversion efficiency, and environment effects are among the factors considered. For individual titles, see N78-13242 through N78-13270.

N78-13242*# Energy Research and Development Administration, Pittsburgh, Pa. Energy Research Center.
EXPERIENCE IN FEEDING COAL INTO A LIQUEFACTION PROCESS DEVELOPMENT UNIT c37
S. Akhtar, S. Friedman, N. J. Mazzocco, and P. M. Yavorsky *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 41-54 refs (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

A system for preparing coal slurry and feeding it into a high pressure liquefaction plant is described. The system was developed to provide supporting research and development for the Bureau of Mines coal liquefaction pilot plant. Operating experiences are included. J.M.S.

N78-13243*# Petrocarb, Inc., N. Y.
THE PETROCARB PNEUMATIC FEEDING SYSTEM: A PROVEN METHOD FOR FEEDING PARTICULATE SOLIDS AT CONTROLLED RATES c37
H. Reintjes *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 55-63 refs (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

An outline of the principal features of the Petrocarb Pneumatic Feeding System is given. Early development and various commercial applications are included. It is concluded that the Petrocarb Injection System is capable of feeding dry solids into most of the processes being developed for utilizing coal. Author

N78-13244*# Energy Research and Development Administration, Pittsburgh, Pa. Synthane Pilot Plant.
COAL PRESSURIZATION AND FEEDING: USE OF A LOCK HOPPER SYSTEM c37
R. Lewis, R. R. Santore, and D. Dubis *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 65-72 (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

Operation of a synthane gasifier pilot plant is discussed. The specific problems experienced with the operation of the Petrocarb system at the pilot plant are described along with modifications made to improve its performance. J.M.S.

N78-13245*# Beaumont Birch Co., Pittsburgh, Pa.
COAL GASIFICATION: NEW CHALLENGE FOR THE BEAUMONT ROTARY FEEDER c37
J. Stelian *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 73-99 (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

The use of rotary feeders in the coal gasification process is described with emphasis on the efficient conversion of coal to clean gaseous fuels. Commercial applications of the rotary feeder system are summarized. J.M.S.

N78-13246*# Energy Research and Development Administration, Morgantown, W. Va. Energy Research Center.
DEVELOPMENT OF COAL-FEEDING SYSTEMS AT THE MORGANTOWN ENERGY RESEARCH CENTER c37
J. M. Hobday *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 101-133 refs (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

Systems for feeding crushed and pulverized coal into coal conversion reactor vessels are described. Pneumatic methods for feeding pulverized coal, slurry feeders, and coal pumps, methods for steam pickup, and a method for drying a water-coal slurry in a steam fluidized bed subsequent to feeding the coal into a reactor vessel are included. Author

N78-13247*# Kamyr, Inc., Glen Falls, N. Y.
COMPARATIVE DESCRIPTION OF COAL FEEDING SYSTEMS FOR FIXED BED PRESSURE GASIFICATION c37
E. Funk and R. Reimert (Lurgi Mineraloltechnik GmbH, Frankfurt, West Germany) *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 134-163 (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

Coal feeding systems are discussed which are capable of feeding 20-100 T/H and the range of pressure is up to 100 bar. Most emphasis is placed on dry feeding systems. The systems outlined are subdivided into continuous and intermittent and the influence of each system on lock gas losses and reactor design is shown. Finally a cost estimate is presented which indicates the areas of preferred application and permits conclusions to be drawn regarding the economics of the various systems. Author

N78-13248*# Institute of Gas Technology, Chicago, Ill.
SLURRY PUMPING TECHNIQUES FOR FEEDING HIGH-PRESSURE COAL GASIFICATION REACTORS c37
W. G. Bair and P. B. Tarman *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 165-181 Sponsored by ERDA (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

Operating experience in pumping coal and coal char slurries at pressures up to 1500 psig is discussed. The design specifications for the mixing tanks, pumps, piping, and slurry heaters are given along with pressure drop and minimum flow velocity data on water-lignite slurries. Author

N78-13249*# Lockheed Missiles and Space Co., Sunnyvale, Calif. Palo Alto Research Lab.
DEVELOPMENT OF DRY COAL FEEDERS c37

J. H. Bonin, D. E. Cantey, A. D. Daniel, Jr., and J. W. Meyer *In* JPL Proc. of the Conf. on Coal Feeding Systems, 15 Sep. 1977 p 195-239 refs (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

Design and fabrication of equipment of feed coal into pressurized environments were investigated. Concepts were selected based on feeder system performance and economic projections. These systems include: two approaches using rotating components, a gas or steam driven ejector, and a modified standpipe feeder concept. Results of development testing of critical components, design procedures, and performance prediction techniques are reviewed. Author

N78-13250*# Ingersoll-Rand Research, Inc., Princeton, N. J.
DRY COAL FEEDER DEVELOPMENT PROGRAM AT INGERSOLL-RAND RESEARCH, INCORPORATED c37
D. K. Mistry and T. N. Chen *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 240-284 (For availability see N78-13241 04-31)
(Contract EX-76-C-01-1794)
Avail: NTIS HC A99/MF A01 CSCL 13I

A dry coal screw feeder for feeding coal into coal gasification reactors operating at pressures up to 1500 psig is described. Results on the feeder under several different modes of operation are presented. In addition, three piston feeder concepts and their technical and economical merits are discussed. Author

N78-13251*# Foster-Miller Associates, Inc., Waltham, Mass.
FOSTER-MILLER'S DEVELOPMENT OF DRY COAL FEED SYSTEMS c37
J. C. Harding *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 285-323 refs (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

Dry coal feeder systems developed for pressurized conversion processes were carried through a laboratory scale development program. These concepts include: (1) a centrifugal solids feeder; (2) a fluidized piston feeder; (3) a linear pocket feeder; and (4) a compacted coal plug feeder. Results of laboratory model testing of all concepts are reviewed. Author

N78-13252*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
EVALUATION OF ERDA-SPONSORED COAL FEED SYSTEM DEVELOPMENT c37
R. L. Phen, W. K. Luckow, L. Mattson, D. Otth, and P. Tsou *In its* Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 324-355 (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

Coal feeders were evaluated based upon criteria such as technical feasibility, performance (i.e. ability to meet process requirements), projected life cycle costs, and projected development cost. An initial set of feeders was selected based on the feeders' cost savings potential compared with baseline lockhopper systems. Additional feeders were considered for selection based on: (1) increasing the probability of successful feeder development; (2) application to specific processes; and (3) technical merit. A coal feeder development program is outlined. Author

N78-13253*# GARD, Inc., Niles, Ill.
CONTINUOUS HIGH PRESSURE LUMP COAL FEEDER DESIGN STUDY c37
S. F. Fields *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 359-387 refs (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

A continuous lump coal dry feeder was developed for a pressurized fluidized bed combustor. The approach was to adapt the commercially available Fuller-Kinyon pump to feed coal against a pressure differential of 100 psi or more. The pump was modified and tests performed at various pressure differentials, with differently pitched screws, various screw rotational speeds, and various seal lengths and configurations. Successful operation of the modified Fuller-Kinyon pump was generally limited to pressure differentials of 60 psi or less. Although the results are not conclusive, test data and observations were made that indicated that higher pressure differentials could be attained by further modifications of the test setup. In particular, it is recommended that further testing be performed after replacing the 40-horsepower pump motor presently in the test setup with a motor having a significantly high power rating (thereby allowing pump operation with longer seals and at higher pressure differentials than those tested so far). Author

N78-13254*# Babcock and Wilcox Co., Barberton, Ohio. Power Generation Group.
BABCOCK AND WILCOX'S EXPERIENCE WITH TWO-PHASE FLOW MIXTURES OF COAL AND GAS c37
A. G. Bolumen *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 389-410 (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

The performance of pulverized coal injection systems in operation on blast furnaces is described in terms of application to coal gasification, fluidized bed combustion, and magnetohydrodynamics. J.M.S.

N78-13255*# General Electric Co., Schenectady, N. Y.
PRESSURIZED FEEDING ON THE GEGAS SYSTEM c37
A. H. Furman *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 411-450 refs (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

A continuous process to feed coal directly into a pressurized gasifier is described. Coal fines are heated and mixed with a recycled tar binder and extruded through a novel die system against gasifier pressure. Performance data on a 2 in. system is given and scale up to a larger 6 in. system is described. Author

N78-13256*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
COAL EXTRUSION IN THE PLASTIC STATE c37
C. England and P. R. Ryason *In its* Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 451-465 refs (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

Continuous feeding of coal in a compressing screw extruder is described as a method of introducing coal into pressurized systems. The method utilizes the property of many bituminous coals of softening at temperatures from 350 to 425 C. Coal is then fed, much in the manner of common thermoplastics, using screw extruders. Data on the viscosity and extruder parameters for extrusion of Illinois No. 6 coal are presented. Author

N78-13257*# Battelle Columbus Labs., Ohio.
A NOVEL DRY COAL FEEDING CONCEPT FOR HIGH-PRESSURE GASIFIERS c37
H. E. Trumbull and H. C. Davis *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 466-479 (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

A novel dry coal feeding concept was developed for injecting ground coal into high-pressure gasifiers. Significant power savings are projected because the coal is injected directly with a ram and there is no requirement for pumping large volumes of gas or fluid against pressure. A novel feature of the concept is that a new seal zone is formed between the ram and injection tube each cycle. The seal zone comprises a mixture of a small quantity of finely ground coal and a fluid. To demonstrate the feasibility of the concept, coal was injected into a 1000-psi chamber with an experimental device having a 7-1/2-inch-diameter ram and a 28-inch-long stroke. Author

N78-13258*# Solids Flow Control Corp., West Caldwell, N. J.
FEEDING THE FEEDER c37
A. L. Kurylchek *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 480-491 (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

Too often the equipment used to move difficult to handle powdery material from a hopper to process creates a complex of devices whose end result falls short on good performance... simply because equipment design, in many cases, has not kept up with advanced technological concepts in fine powder handling. The Feeder, being the key to an efficient feed system, must be assured a continuous flow from the storage tank...without bridging, arching, spasmodic flow or uncontrolled flushing. The causes and effects of flow problems are discussed and also solutions are offered based on the combination of theoretical and practical experience. Author

N78-13260*# Energy Research and Development Administration, Morgantown, W. Va. Energy Research Center.
GRAVITY FLOW RATE OF SOLIDS THROUGH ORIFICES AND PIPES c34
J. F. Gardner, J. E. Smith, and J. M. Hobday *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 519-536 refs (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 20D

Lock-hopper systems are the most common means for feeding solids to and from coal conversion reactor vessels. The rate at which crushed solids flow by gravity through the vertical pipes and valves in lock-hopper systems affects the size of pipes and valves needed to meet the solids-handling requirements of the coal conversion process. Methods used to predict flow rates are described and compared with experimental data. Preliminary indications are that solids-handling systems for coal conversion processes are over-designed by a factor of 2 or 3. Author

N78-13261*# Energy Research and Development Administration, Morgantown, W. Va. Energy Research Center.
HIGH PRESSURE ROTARY PISTON COAL FEEDER c37
J. F. Gardner, H. T. Gencsoy (West Virginia Univ., Morgantown), and D. C. Strimbeck *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 537-549 (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

This feeder concept uniquely combines the functions of solids feeding, metering, and pressurization into one compact system. Success with the rotary-piston concept would provide a lower-cost alternative to lock-hopper systems. The design of the feeder is presented, with special emphasis on the difficult problem of seal design. Initial tests will be to check seal performance. Subsequent tests will evaluate solids-feeding ability. Author

N78-13262*# Argonne National Lab., Ill.
COAL FEED COMPONENT TESTING FOR CDIF c44
C. Victor Pearson, Burton K. Snyder, and Thomas E. Fornek *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 550-570 (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 10B

Investigations conducted during the conceptual design of the Montana MHD Component Development and Integration Facility (CDIF) identified commercially available processing and feeding equipment potentially suitable for use in a reference design. Tests on sub-scale units of this equipment indicated that they would perform as intended. Author

N78-13263*# Jenike and Johnson, Inc., Billerica, Mass.
STORAGE AND FEEDING OF COAL c37
A. W. Jenike and J. W. Carson *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 571-585 refs (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

Reliable feeding of coal from storage bins to process requires the knowledge of the behavior of coal during flow. The study of the flow of bulk solids was undertaken in the 1950's and led to the development of flow ability testing equipment and of the Mass Flow concept of design for reliable flow. The theory has since been expanded to two-phase, solids-gas system, and has found world wide application in the design of storage and feeding systems. Author

N78-13264*# Bechtel Corp., San Francisco, Calif.
INJECTION OF COAL BY SCREW FEED c37
R. Fisher *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 586-603 ref (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 10B

The use of the screw feeder for injecting solids through a 20 to 30 psi barrier is common practice in the cement making industry. An analytical extrapolation of that design, accounting for pressure holding characteristics of a column of solids, shows that coal can be fed to zones at several hundred psi with minimal or no loss of gas. A series of curves showing the calculated pressure gradient through a moving column of solids is presented. Mean particle size, solids velocity, and column length are parameters. Further study of this system to evaluate practicality is recommended. Author

N78-13265*# Mitre Corp., McLean, Va. Metrek Div.
MATERIAL HANDLING SYSTEMS FOR THE FLUIDIZED-BED COMBUSTION BOILER AT RIVESVILLE, WEST VIRGINIA c37
J. G. Branam and W. W. Rosborough *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 604-623 (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

The 300,000 lbs/hr steam capacity multicell fluidized-bed boiler (MFB) utilizes complex material handling systems. The material handling systems can be divided into the following areas: (1) coal preparation; transfer and delivery, (2) limestone handling system, (3) fly-ash removal and (4) bed material handling system. Each of the above systems are described in detail and some of the potential problem areas are discussed. A major potential problem that exists is the coal drying system. The coal dryer is designed to use 600 F preheated combustion air as drying medium and the dryer effluent is designed to enter a hot electrostatic precipitator (730 F) after passage through a cyclone. Other problem areas to be discussed include the steam generator coal and limestone feed system which may have operating difficulties with wet coal and/or coal fines. Author

N78-13266*# Rockwell International Corp., Canoga Park, Calif.
ROCKETDYNE'S ADVANCED COAL SLURRY PUMPING PROGRAM c37
D. E. Davis, G. S. Wong, and H. H. Gilman (EPRI, Palo Alto, Calif.) *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 624-635 refs (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

The Rocketdyne Division of Rockwell International Corporation is conducting a program for the engineering, fabrication, and testing of an experimental/prototype high-capacity, high-pressure centrifugal slurry feed pump for coal liquefaction purposes. The abrasion problems in a centrifugal slurry pump are primarily due to the manner in which the hard, solid particles contained in the slurry are transported through the hydraulic flow passages within the pump. The abrasive particles can create scraping, grinding, cutting, and sandblasting effects on the various exposed parts of the pump. These critical areas involving abrasion and impact erosion wear problems in a centrifugal pump are being addressed by Rocketdyne. The mechanisms of abrasion and erosion are being studied through hydrodynamic analysis, materials evaluation, and advanced design concepts. Author

N78-13267*# Acton Corp., Cleveland, Ohio.
ACTON MASS FLOW SYSTEM APPLIED TO PFBC FEED c37
E. Homburg *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 636-652 (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

Dense phase pneumatic conveying and the Acton Mass Flow concept are defined with emphasis on the specific advantages to the coal and dolomite feed to the Pressurized Fluidized Bed Combustor. The transport and feed functions are explored with a comparison of designing the process for a combined function or for individual functions. The equipment required to accomplish these functions is described together with a typical example of sizing and air or gas requirements. A general outline of the control system required to obtain a uniform feed rate is provided. The condition of the coal and dolomite and conveying gas as required to obtain reliable transport and feed will be discussed. Author

N78-13269*# Werner and Pfleiderer Corp., Waldwick, N.J.
THE USE OF TWIN SCREW EXTRUDERS FOR FEEDING COAL AGAINST PRESSURES OF UP TO 1500 PSI c37
W. Wiedmann and W. A. Mack (Wiedmann and Pfleiderer, Stuttgart, West Germany) *In* JPL Proc. of the Conf. on Coal Feeding Systems 15 Sep. 1977 p 689-701 (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

Recent tests with a twin-screw, co-rotating extruder which was successfully used to convey and feed coal against pressures of up to 1500 psi are described. Intermeshing and self-wiping, co-rotating twin-screws give greatly improved conveying and pressure built-up capabilities and avoid hangup and eventual decomposition of coal particles in the screw flights. The conveying action of intermeshing, self-wiping, co-rotating extruder systems approaches that of a positive displacement pump. With this feature, it is possible to maintain very accurate control over all aspects of product conveyance in the extruder, i.e., intake, conveyance and pressure buildup. Author

N78-13270*# Rockwell International Corp., Pittsburg, Pa. Flow Control Div.
LOCK HOPPER VALUES FOR COAL GASIFICATION PLANT SERVICE c37
E. Frederick Schoeneweis *In* JPL Proc. of The Conf. on Coal Feeding Systems 15 Sep. 1977 p 702-709 (For availability see N78-13241 04-31)
Avail: NTIS HC A99/MF A01 CSCL 13I

Although the operating principle of the lock hopper system is extremely simple, valve applications involving this service for coal gasification plants are likewise extremely difficult. The difficulties center on the requirement of handling highly erosive pulverized coal or char (either in dry or slurry form) combined with the requirement of providing tight sealing against high-pressure (possibly very hot) gas. Operating pressures and temperatures in these applications typically range up to 1600 psi (110bar) and 600F (316C), with certain process requirements going even higher. In addition, and of primary concern, is the need for reliable operation over long service periods with the provision for practical and economical maintenance. Currently available data indicate the requirement for something in the order of 20,000 to 30,000 open-close cycles per year and a desire to operate at least that long without valve failure. Author

N78-13308# Marconi Communication Systems Ltd., Chelmsford (England).
STUDY OF SATELLITE COMMUNICATIONS SYSTEM SERVING OFF-SHORE OIL AND GAS EXPLOITATION ACTIVITIES IN EUROPEAN SEA AREAS, VOLUME 1 Final Report
Paris ESA Jun. 1977 73 p refs Original contains color illustrations 5 Vol.
(Contract ESA-2701/76-F-WMT(SC))
(CWJ1/C-640003-Vol-1; ESA-CR(P)-972-Vol-1) Avail: NTIS HC A04/MF A01

The provision of a satellite service based on the ECS to meet communication needs of the European offshore energy industry through the 1980's, is discussed. The potential requirement for satellite channels is established. Various types of offshore structure are identified and projections made of the number of structures likely to be deployed in the ECS-1 offshore coverage area through the 1980's. A detached color map of North Sea offshore leases was included in the original document but not made available on microfiche. ESA

N78-13309# Marconi Communication Systems Ltd., Chelmsford (England).
STUDY OF SATELLITE COMMUNICATIONS SYSTEM SERVING OFF-SHORE OIL AND GAS EXPLOITATION ACTIVITIES IN EUROPEAN SEA AREAS, VOLUME 2 Final Report
Paris ESA Jun. 1977 421 p refs 5 Vol.
(Contract ESA-2701/76-F-WMT(SC))
(CWJ1/C-640003-Vol-2; ESA-CR(P)-972-Vol-2) Avail: NTIS HC A18/MF A01

The provision of a satellite service based on the European Communications Satellite to meet communications needs of the European offshore energy industry through the 1980's is described. Transmission systems are reviewed, and a complete theoretical discussion of possible modulation methods as a basis for the overall system performance assessment is presented. ESA

N78-13310# Marconi Communication Systems Ltd., Chelmsford (England).
STUDY OF SATELLITE COMMUNICATIONS SYSTEM SERVING OFF-SHORE OIL AND GAS EXPLOITATION ACTIVITIES IN EUROPEAN SEA AREAS, VOLUME 3 Final Report
Paris ESA Jun. 1977 199 p refs 5 Vol.
(Contract ESA-2701/76-F-WMT(SC))
(CWJ1/C-640003-Vol-3; ESA-CR(P)-972-Vol-3) Avail: NTIS HC A09/MF A01

The provision of a satellite service based on the European Communications Satellite to meet communication needs of the European offshore energy industry through the 1980's is discussed. Environmental conditions are studied. Topics covered include atmospheric attenuation in the 11 to 14.5 GHz band, meteorological environment, and local environmental factors on offshore platforms. A parametric design and cost analysis is presented for offshore and shore stations. Major hardware design conclusions are reduced, particularly in regard to the offshore antenna and pointing control subsystem. ESA

N78-13311# Marconi Communication Systems Ltd., Chelmsford (England).
STUDY OF SATELLITE COMMUNICATIONS SYSTEM SERVING OFF-SHORE OIL AND GAS EXPLOITATION ACTIVITIES IN EUROPEAN SEA AREAS, VOLUME 4 Final Report
Paris ESA Jun. 1977 127 p 5 Vol.
(Contract ESA-2701/76-F-WMT(SC))
(CWJ1/C-640003-Vol-4; ESA-CR(P)-972-Vol-4) Avail: NTIS HC A07/MF A01

The provision of a satellite service based on the European Communication Satellite (ECS) to meet communication needs of the European offshore energy industry through the 1980s is discussed. Predicted channel requirements for the proposed ECS fixed oil platform communications service and for the Marots mobile service are examined separately. An optimization of the overall communication system centered on ECS was carried out involving numerous tradeoffs. The preferred systems concept is described and illustrated. Integration aspects of the proposed ECS communications service with other currently used telecommunications services available to the offshore user are discussed. ESA

N78-13312# Marconi Communication Systems Ltd., Chelmsford (England).
STUDY OF SATELLITE COMMUNICATIONS SYSTEM SERVING OFF-SHORE OIL AND GAS EXPLOITATION ACTIVITIES IN EUROPEAN SEA AREAS. VOLUME 5: SUMMARY Final Report
Paris ESA Jun. 1977 61 p 5 Vol.
(Contract ESA-2701/76-F-WMT(SC))
(CWJ1/C-640003-Vol-5-Summ; ESA-CR(P)-972-Vol-5-Summ)
Avail: NTIS HC A04/MF A01

A summary of a study concerning the provision of satellite services based on the European Communication Satellite to meet communications needs of the European offshore energy industry through the 1980's is presented. The potential requirement for satellite channels is established. An atmospheric propagation model is discussed in terms of topographical and climatic factors governing the attenuation of satellite-earth paths in the 11 to 14.5 GHz band. Environmental factors are related to antenna design. Results of the transmission system analysis are summarized, and the outcome of certain of the system optimization investigations is reported. The preferred offshore terminal configuration is described. ESA

N78-13368*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

PARAMETRIC PERFORMANCE OF A SPIRAL-ARTERY, LIQUID-TRAP-DIODE HEAT PIPE
Richard J. Williams Oct. 1977 39 p refs
(NASA-TM-78448; A-7255) Avail: NTIS HC A03/MF A01 CSCL 20D

A series of parametric investigations are described which determine the effect of various fluid charges on the performance of a 0.635-cm-diam spiral-artery, liquid-trap diode in both the forward and reverse modes. Specific parameters such as forward- and reverse-mode conductances, shutdown times and energies, and recovery to forward-model operation, are evaluated for ethane as a working fluid in the temperature range 170 K to 220 K. Results indicate that the heat pipe will not reliably start up in the forward mode. However, startup can be initiated when preceded by a diode reversal. Also included are data which show the susceptibility of the diode to fluid charge and tilt. The optimum fluid charge was found to be 2.67 g and transport capability at this charge was in excess of 1200 W-cm at 200 K. The diode in the reverse mode exhibited a rapid shutdown (within 9 min) with a shutdown energy of 1150 J (0.32 Wh). Author

N78-13398# Stuttgart Univ. (West Germany). Energy Conversion and Heat Transfer Div.
LIFETESTS OF THE TELECOMMUNICATIONS SATELLITE HEAT PIPES Final Report
W. D. Muenzel, Principal Investigator Paris ESA Jul. 1977 73 p refs
(Contract ESA-1857/73-JS)
(ESA-CR(P)-997) Avail: NTIS HC A04/MF A01

Test results obtained during lifetests of heat pipes throughout a period of three years are described together with the instrumentation and the test setup. Bendable 7 mm O.D. artery heat pipes have been developed for satallite applications. Four of these heat pipes subjected to a stationary lifetest were operating with a heat load of 15 watts at a temperature of 60 C, and another one, the accelerated lifetest heat pipe, was operated in reflux boiler mode at a temperature of about 100 C. A sixth heat pipe underwent a thermal shock test consisting of 3000 cycles between 5 C and 80 C. During the lifetests gas generation within all of the heat pipes was detected, resulting in a steadily increasing length of blocked condenser section. Due to the degrading longterm performance of the Al/SS/NH3 heat pipes, some of these were replaced by one-metal heat pipes made from stainless steel. The lifetest of three heat pipes was discontinued prior to the planned lapse of 3 years. These heat pipes were cut open to analyze working fluid and any deposits on the inner heat pipe surfaces. Author (ESA)

N78-13442# Naval Academy, Annapolis, Md.
PERFORMANCE ANALYSIS OF A MODIFIED INTERNAL COMBUSTION ENGINE Interim Report, 1976 - 1977
Timothy Lee Whited 23 May 1977 88 p refs
(AD-A045378; USNA-TSPR-90) Avail: NTIS HC A05/MF A01 CSCL 21/7

The purpose of this study is to provide optical and other information on the processes undergone in the combustion and balancing chambers of the Naval Academy Heat Balanced Engine (NAHBE). In the NAHBE engine a pressure exchange cap is fitted on top of the piston to form a balancing chamber underneath. The pressure exchange between expansion and compression waves generated by this apparatus permits lower combustion temperatures and pressures, along with a significant decrease in pollutants emitted by the engine. The combustion cycle resulting from the pressure exchange cap is a combination of both the OTTO and Diesel cycles, with added advantages not found in either of these two cycles. Previous laboratory results have indicated: (1) up to 25% reduction of fuel consumption, (2) reduction in peak operating pressures from 660 to 470 psi and exhaust temperature reduction on the order of 50 F, (3) over 90% reduction in pollutants (carbon monoxide, hydrocarbons, and nitrogen oxides), depending on load and compression ratio, (4) multifuel capability (low octane gasoline, fuel oil, alcohol and water, alcohol and charcoal), and (5) significant noise reduction. High-speed photography was utilized for visualization of the processes. GRA

N78-13444# Army Cold Regions Research and Engineering Lab., Hanover, N. H.
MECHANICS OF CUTTING AND BORING. PART 6: DYNAMICS AND ENERGETICS OF TRANSVERSE ROTATION MACHINES
Malcolm Mellor Aug. 1977 45 p
(AD-A045127; CRREL-77-19) Avail: NTIS HC A03/MF A01 CSCL 13/9

The report deals with forces and power levels in cutting machines having a disc or drum that rotates about an axis perpendicular to the direction of advance. The forces on individual cutting tools are related to position on the rotor and to characteristics such as tool layout, rotor speed, rotor size, machine advance speed, and rotor torque. Integration leads to expressions for force components acting on the rotor axis, taking into account tool characteristics, cutting depth of the rotor, and rotor torque. These provide estimates of tractive thrust and thrust normal to the primary free surface. For self-propelled machines, this leads to considerations of traction, normal reaction, weight and balance, and power/weight ratios. Specific energy consumption is analyzed and related to machine characteristics and strength of the material being cut. Power per unit working area is discussed, and data for existing machines are summarized. Power requirements for ejection of cuttings are analyzed, and the hydrodynamic resistance on underwater cuttings is treated. A number of worked examples are given to illustrate the principles discussed in the report. Author (GRA)

N78-13455# Chrysler Corp., Detroit, Mich.
BASELINE GAS TURBINE DEVELOPMENT PROGRAM Quarterly Progress Report
F. W. Schmidt and C. E. Wagner 31 Jan. 1977 101 p refs
(Contract EY-76-C-02-2749)
(COO-2749-17; QPR-17) Avail: NTIS HC A06/MF A01

An experimental upgraded gas turbine powered automobile which meets the 1978 Federal Emissions Standards, has significantly improved fuel economy, and is competitive in performance, reliability, and potential manufacturing cost with the conventional piston engine powered, compact-size American automobile is described. Diagnostic testing and corrective development are included. To date, three upgraded engines were assembled and run in the test cell. Engine 2 was installed in an upgraded vehicle. Special diagnostic instrumentation was installed on Engine 3 to evaluate the compressor, turbine, and hot engine leakage. It was determined that the power deficiency was principally due to problems in the compressor and first stage turbine areas and during this quarter several corrective changes have been initiated. ERA

N78-13524 Florida Univ., Gainesville.
TRANSPORT PROCESSES IN TEFLON-BONDED FUEL CELL ELECTRODES Ph.D. Thesis
Myung-cheen Lee 1976 114 p
Avail: Univ. Microfilms Order No. 77-17032

The structure and properties of Teflon bonded fuel cell electrodes and their components were investigated. Experiments employing scanning electron microscopy and energy dispersive X-ray analysis indicated that the Teflon particles are prolate spheroidal aggregates of approximately spherical molecules. In a commonly used electrode composition these Teflon aggregates are coated with one or more layers of catalyst crystallites. Electrode reactions, ionic hydration, water transport, and their effects on the behavior of fuel cells were studied. It was found that hydration of potassium and hydroxyl ions causes some change in the concentration of electrolyte and its gradient in the electrolyte matrix and the electrode layer. Dissert. Abstr.

N78-13526* National Aeronautics and Space Administration. Pasadena Office, Calif.
HIGH VOLTAGE, HIGH CURRENT SCHOTTKY BARRIER SOLAR CELL Patent
Richard J. Stirn, inventor (to NASA) (JPL) Issued 11 Oct. 1977 5 p Filed 5 Aug. 1974 Supersedes N74-30448 (12 - 20, p 2374) Sponsored by NASA
(NASA-Case-NPO-13482-1; US-Patent-4,053,918; US-Patent-Appl-SN-495021; US-Patent-Class-357-30; US-Patent-Class-357-15; US-Patent-Class-357-16; US-Patent-Class-136-89-SJ) Avail: US Patent Office CSCL 10A

A Schottky barrier solar cell was described, which consists of a layer of wide band gap semiconductor material on which a very thin film of semitransparent metal was deposited to form a Schottky barrier. The layer of the wide band gap semiconductor material is on top of a layer of narrower band gap semiconductor material, to which one of the cell's contacts may be attached directly or through a substrate. The cell's other contact is a grid structure which is deposited on the thin metal film.
Official Gazette of the U.S. Patent Office

N78-13527*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SOLAR CELL HIGH EFFICIENCY AND RADIATION DAMAGE
1977 221 p refs Conf. held at Cleveland, 18-19 May 1977
(NASA-CP-2020) Avail: NTIS HC A10/MF A01 CSCL 10A
Silicon solar cell analysis and fundamental measurements, silicon cell technology, gallium arsenide research and technology, and radiation effects on silicon and gallium arsenide cells, are reported. For individual titles, see N78-13528 through N78-13551.

N78-13528*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SUMMARY OF THE NASA SPACE PHOTOVOLTAIC RESEARCH AND TECHNOLOGY PROGRAM
Henry W. Brandhorst, Jr. *In its* Solar Cell High Efficiency and Radiation Damage 1977 p 3-6 (For availability see N78-13527 04-44)
Avail: NTIS HC A10/MF A01 CSCL 10A
Low cost solar cells and arrays with high end-of-life efficiency are evaluated through two approaches: one, to obtain increased device efficiency at no increase in cost and two, to reduce the manufacturing costs of space solar cells and arrays. Technology efforts encompass high efficiency epitaxial cells, high efficiency wraparound contact solar cells, economical diffusion sources, automated cell fabrication and development of easily applied, durable cover glasses. The examination of ion-implanted profile tailored junctions and additional development of screen printed contact technology to cell development are also considered.
Author

N78-13529*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE GODDARD SPACE FLIGHT CENTER HIGH EFFICIENCY CELL DEVELOPMENT AND EVALUATION PROGRAM
Luther W. Slifer *In its* Solar Cell High Efficiency and Radiation Damage 1977 p 7-23 refs (For availability see N78-13527 04-44)
Avail: NTIS HC A10/MF A01 CSCL 10A
Laboratory tests and flight experiments showed that solar cells can be produced in quantity, that they are suitable for space flight applications, and that the power produced ranged from 20 to 35% more than that of conventional cells. In a benign flight environment, the cells degraded at approximately the same rate as conventional cells. In synchronous orbit, the rate exceeded that of conventional cells, but high efficiency cells still showed significant power advantage after two years. Irradiation test results showed the voltage-temperature coefficients to be comparable to conventional cells. However, current-temperature coefficients were not only higher initially, but also increased significantly with irradiation. Although thin cells with good performance characteristics were made, significant problem areas pertinent to production were disclosed, particularly for cells with thickness of 0.100 mm or less. The overall program led to the use of advanced high efficiency cells on the International Sun-Earth Explorer solar panels.
Author

N78-13530*# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.
A REVIEW OF AIR FORCE SPACE PHOTOVOLTAIC DEVELOPMENT EFFORTS
W. Patrick Rahilly *In* NASA. Lewis Res. Center Solar Cell High Efficiency and Radiation Damage 1977 p 25-31 refs
Avail: NTIS HC A10/MF A01 CSCL 10A
Silicon and gallium arsenide solar cell developments are reviewed. The rationale for these efforts are cited showing the reasons for placing emphasis on survivability as well as high conversion efficiency.
Author

N78-13531*# North Carolina State Univ., Raleigh.
IMPURITY GRADIENTS AND HIGH EFFICIENCY SOLAR CELLS
C. R. Fang and J. R. Hauser *In* NASA. Lewis Res. Center Solar Cell High Efficiency and Radiation Damage 1977 p 33-50 refs Sponsored by NASA (For availability see N78-13527 04-44)
Avail: NTIS HC A10/MF A01 CSCL 10A
One potential means of improving the efficiency of solar cells especially after space irradiation is to incorporate built-in fields into the device through the use of impurity doping gradients. A detailed numerical calculation of solar cell performance has been used to study various types of doping gradients. In general, the predicted improvements in performance have been less than previously reported due to various device effects such as, high injection and the dependence of lifetime on doping density.
Author

N78-13532*# Florida Univ., Gainesville. Dept. of Electrical Engineering.
MEASUREMENT OF MATERIAL PARAMETERS THAT LIMIT THE OPEN-CIRCUIT VOLTAGE IN P-N-JUNCTION SILICON SOLAR CELLS
F. A. Lindholm, A. Neugroschel, and C. T. Sah (Illinois Univ., Urbana-Champaign) *In* NASA. Lewis Res. Center Solar Cell High Efficiency and Radiation Damage 1977 p 51-58 refs (For availability see N78-13527 04-44)
(Grant NsG-3018; Contract E(40-1)-5134)
Avail: NTIS HC A10/MF A01 CSCL 10A
The greatest gains in solar energy conversion efficiency of p-n-junction silicon solar cells come from increasing the open-circuit voltage V sub OC; it is important to understand and characterize the material parameters that limit the V sub OC. Strong experimental evidence exists to support the assertion that either an anomalously large minority carrier charge storage or an anomalously small minority carrier lifetime in the quasi-neutral emitter region limits the open circuit voltage. A method is presented for measuring charge storage and effective lifetime. Static and transient measurements are analyzed using physical models of the solar cell characteristics. This analysis yields the emitter charge storage and life-time, which then can be related to the various physical mechanisms, such as energy band gap shrinkage, that have been proposed earlier as responsible for limiting V sub OC.
Author

N78-13534*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
IMPURITY CONCENTRATIONS AND SURFACE CHARGE DENSITIES ON THE HEAVILY DOPED FACE OF A SILICON SOLAR CELL
I. Weinberg and Lon Hsu (Wayne State Univ.) *In* NASA. Lewis Res. Center Solar Cell High Efficiency and Radiation Damage 1977 p 69-79 refs (For availability see N78-13527 04-44)
Avail: NTIS HC A10/MF A01 CSCL 10A
Increased solar cell efficiencies are attained by reduction of surface recombination and variation of impurity concentration profiles at the n(+) surface of silicon solar cells. Diagnostic techniques are employed to evaluate the effects of specific materials preparation methodologies on surface and near surface concentrations. It is demonstrated that the MOS C-V method, when combined with a bulk measurement technique, yields more complete concentration data than are obtainable by either method alone. Specifically, new solar cell MOS C-V measurements are combined with bulk concentrations obtained by a successive layer removal technique utilizing measurements of sheet resistivity and Hall coefficient.
Author

N78-13535*# Yeshiva Univ., New York.
INVESTIGATION OF THE TOPOGRAPHICAL FEATURES OF SURFACE CARRIER CONCENTRATIONS IN SILICON SOLAR CELL MATERIAL USING ELECTROLYTE ELECTROREFLECTANCE

Fred H. Pollay, Cajetan E. Okeke, and Paul M. Raccah *In* NASA. Lewis Res. Center Solar Cell High Efficiency and Radiation Damage 1977 p 81-90 refs (For availability see N78-13527 04-44)
(Grant NsG-3123)
Avail: NTIS HC A10/MF A01 CSCL 10A

Topographical variations in carrier concentration delta N/N across the surface of n(+) on p diffused silicon solar cell material are studied by utilizing electrolyte electroreflectance with a spatial resolution of 100 microns within approximately 500 A of the surface. The topographical variations of delta N/N approximately 10 - 20% are found to be comparable to Czochralski grown material. The electroreflectance method can also be utilized to investigate other semiconductors such as GaAs. Author

N78-13536*# Spectrolab, Inc., Sylmar, Calif.
ADVANCED HIGH EFFICIENCY WRAPAROUND CONTACT SOLAR CELL
J. A. Scott-Monck, F. M. Uno, and J. W. Thornhill *In* NASA. Lewis Res. Center Solar Cell High Efficiency and Radiation Damage 1977 p 91-94 refs Presented at AIAA Conf. on the Future of Aerospace Power Systems, St. Louis, 1-3 Mar. 1977 Sponsored by NASA (For availability see N78-13527 04-44)
(AIAA-Paper-77-521) Avail: NTIS HC A10/MF A01 CSCL 10A

A significant advancement in the development of thin high efficiency wraparound contact silicon solar cells has been made by coupling space and terrestrial processing procedures. Although this new method for fabricating cells has not been completely reduced to practice, some of the initial cells have delivered over 20 mW/sq cm when tested at 25 C under AMO intensity. This approach not only yields high efficiency devices, but shows promise of allowing complete freedom of choice in both the location and size of the wraparound contact pad area. Author

N78-13537*# Communications Satellite Corp., Washington, D.C.
THE SAWTOOTH COVER SLIDE
A. Meulenberg, Jr. *In* NASA. Lewis Res. Center Solar Cell High Efficiency and Radiation Damage 1977 p 95-98 refs (For availability see N78-13527 04-44)
Avail: NTIS HC A10/MF A01 CSCL 10A

A novel cover slide is reported which increases solar cell output by reducing the reflection of light from the cover slide surface and by redirecting incident light so that none falls on the collection grids of the cell. The new cover slide is fabricated with a sawtooth surface having a periodicity equal to that of the solar cell grids. This configuration refracts the light so that it is directed onto the semiconductor surface between the grid lines. Conventional grid patterns obstruct 7-10 percent of the light incident on the cell; at least half of this loss has been recovered by using the sawtooth cover slide. In addition, surface reflection from the conventional coated cover slide is suppressed by presenting a second surface to any light reflected at the first plane of contact. This double reflection results in a greater reduction of the reflection loss from the cover slide than does an antireflection coating on a flat surface. Author

N78-13538*# Simulation Physics, Inc., Foxborough, Mass.
APPLICATIONS OF ION IMPLANTATION FOR HIGH EFFICIENCY SILICON SOLAR CELLS
John A. Minnucci and Allen R. Kirkpatrick *In* NASA. Lewis Res. Center Solar Cell High Efficiency and Radiation Damage 1977 p 99-108 refs (For availability see N78-13527 04-44)
(Contract F33615-75-C-2006)
Avail: NTIS HC A10/MF A01 CSCL 10A

Ion implantation is utilized for the dopant introduction processes necessary to fabricate a silicon solar cell. Implantation provides a versatile powerful tool for development of high efficiency cells. Advantages and problems of implantation and the present status of developmental use of the technique for solar cells are discussed. Author

N78-13539*# Oak Ridge National Lab., Tenn.
TRANSMUTATION DOPING OF SILICON SOLAR CELLS
R. F. Wood, R. D. Westbrook, R. T. Young, and J. W. Cleland *In* NASA. Lewis Res. Center Solar Cell High Efficiency and Radiation Damage 1977 p 109-116 refs (For availability see N78-13527 04-44)
Avail: NTIS HC A10/MF A01 CSCL 10A

Normal isotopic silicon contains 3.05% of Si-30 which transmutes to P-31 after thermal neutron absorption, with a half-life of 2.6 hours. This reaction is used to introduce extremely uniform concentrations of phosphorus into silicon, thus eliminating the areal and spatial inhomogeneities characteristic of chemical doping. Annealing of the lattice damage in the irradiated silicon does not alter the uniformity of dopant distribution. Transmutation doping also makes it possible to introduce phosphorus into polycrystalline silicon without segregation of the dopant at the grain boundaries. The use of neutron transmutation doped (NTD) silicon in solar cell research and development is discussed. Author

N78-13540*# Solarex Corp., Rockville, Md.
DEVELOPMENTS IN VERTICAL-JUNCTION SILICON SOLAR CELLS
J. Lindmayer, C. Wrigley, and J. Wohlgemuth *In* NASA. Lewis Res. Center Solar Cell High Efficiency and Radiation Damage 1977 p 117-125 refs (For availability see N78-13527 04-44)
(Contract F33615-76-C-2058)
Avail: NTIS HC A10/MF A01 CSCL 10A

Non-reflective vertical junction silicon cells provide high conversion efficiency radiation-resistant solar cells. New techniques of oxidation growth and the use of photolithography enable the use of an orientation dependent etch producing grooves 5 to 10 microns wide over 100 microns deep. These silicon wafers are then processed into solar cells with all of the processes performed at temperatures compatible with producing high efficiency solar cells. Most of the photogenerated carriers are created in the walls where they are within a few microns of the collecting junction. Consequently, degradation of carrier diffusion length due to radiation has a considerably reduced effect on collection efficiency. These 2 cm x 2 cm vertical junction silicon solar cells have exceeded 13% AMO efficiency and have shown superior radiation resistance. Author

N78-13541*# Hughes Aircraft Co., Culver City, Calif. Space and Communications Group.
PROJECT STOP (SPECTRAL THERMAL OPTIMIZATION PROGRAM)
L. J. Goldhammer, R. W. Opjorden, G. S. Goodelle, and J. S. Powe *In* NASA. Lewis Res. Center Solar Cell High Efficiency and Radiation Damage 1977 p 127-132
Avail: NTIS HC A10/MF A01 CSCL 10A

The spectral thermal optimization of solar cell configurations for various solar panel applications is considered. The method of optimization depends upon varying the solar cell configuration's optical characteristics to minimize panel temperatures, maximize power output and decrease the power delta from beginning of life to end of life. Four areas of primary investigation are: (1) testing and evaluation of ultraviolet resistant coverslide adhesives, primarily FEP as an adhesive; (2) examination of solar cell absolute spectral response and corresponding cell manufacturing processes that affect it; (3) experimental work with solar cell manufacturing processes that vary cell reflectance (solar absorptance); and (4) experimental and theoretical studies with various coverslide filter designs, mainly a red rejection filter. The Hughes' solar array prediction program has been modified to aid in evaluating the effect of each of the above four areas on the output of a solar panel in orbit. Author

N78-13542*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
HIGH EFFICIENCY GaAs SOLAR CELLS
Gilbert H. Walker, Edmund J. Conway, and Charles E. Byvik *In its* Solar Cell High Efficiency and Radiation Damage 1977 p 133-138 (For availability see N78-13527 04-44)
Avail: NTIS HC A10/MF A01 CSCL 10A

The present status of the GaAlAs/GaAs heteroface solar cell program is reported. Studies have been concentrated on GaAlAs/GaAs heteroface solar cells; however, some research has been conducted on thin junction, diffused GaAs solar cells. Emphasis has been on obtaining high efficiency (18% to 20%) GaAs solar cells. Two problems that have limited the efficiency of GaAs solar cells are the high recombination velocity of carriers near the surface and the low minority carrier diffusion length in n-GaAs. Author

N78-13543*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THEORETICAL STUDIES OF A NEW DOUBLE GRADED BAND-GAP Al SUB x Ga SUB 1-x As-Al SUB Y Ga SUB 1-y As

James A. Hutchby *In its* Solar Cell High Efficiency and Radiation Damage 1977 p 139-147 refs (For availability see N78-13527 04-44)

Avail: NTIS HC A10/MF A01 CSCL 10A

A new double graded band-gap (DGBG) Al sub x Ga sub l-x As-Al sub z Ga sub l-z As solar cell has potential for providing high efficiency performance throughout the entire life of a solar cell in a space environment. A preliminary theoretical analysis indicates that short circuit current available from an optimized DGBG cell is slightly larger than that of a previously reported single graded band-gap cell. However, the DGBG cell potentially offers a substantial improvement in radiation resistance of the base region. Author

N78-13544*# Hughes Research Labs., Malibu, Calif.

GaAs SOLAR CELL DEVELOPMENT

R. C. Knechtli, S. Kamath, and R. Loo *In* NASA. Lewis Res. Center Solar Cell High Efficiency and Radiation Damage 1977 p 149-157 (For availability see N78-13527 04-44)

Avail: NTIS HC A10/MF A01 CSCL 10A

The motivation for developing GaAs solar cells is based on their superior efficiency when compared to silicon cells, their lower degradation with increasing temperature, and the expectation for better resistance to space radiation damage. The AMO efficiency of GaAs solar cells was calculated. A key consideration in the HRL technology is the production of GaAs cells of large area (greater than 4 sg cm) at a reasonable cost without sacrificing efficiency. An essential requirement for the successful fabrication of such cells is the ability to grow epitaxially a uniform layer of high quality GaAs (buffer layer) on state-of-the-art GaAs substrates, and to grow on this buffer layer the required than layer of (AlGa)As. A modified infinite melt liquid phase epitaxy (LPE) growth technique is detailed. Author

N78-13548*# Boeing Aerospace Co., Seattle, Wash.

RADIATION TESTS OF SEP SOLAR CELLS

Henry Oman *In* NASA. Lewis Res. Center Solar Cell High Efficiency and Radiation Damage 1977 p 187-205 (For availability see N78-13527 04-44)

(Contract NAS8-31670)

Avail: NTIS HC A10/MF A01 CSCL 10A

Solar cells specially designed for Solar Electric Propulsion (SEP) were tested with radiation fluences up to 10 to the 12th power protons having energies of 1.5, 1.0, and 0.5 MeV, and with fluences up to 10 to the 16th power electrons having 1.0 MeV energy. Spectrolab cells having a back-surface field were also irradiated with the same particles and fluences. Cell performances are described by curves in which normalized and absolute values of maximum power, maximum-power voltage, short-circuit current, and open-circuit voltage are plotted as a function of fluence. Author

N78-13551*# Communications Satellite Corp., Washington, D.C.

ULTRAVIOLET DAMAGE IN SOLAR CELL ASSEMBLIES WITH VARIOUS UV FILTERS

A. Meulenberg, Jr. *In* NASA. Lewis Res. Center Solar Cell High Efficiency and Radiation Damage 1977 p 227-229 ref (For availability see N78-13527 04-44)

Avail: NTIS HC A10/MF A01 CSCL 10A

Ultraviolet damage to the new violet and non-reflective type solar cell assemblies, was studied, and potential advantages of using coverslides with no filters or filters with cut-off wavelengths below 0.35 micron were determined. The experiments consisted of three types of tests on fused silica coverslides with 0.35- and 0.30-micron cut-off filters and no cut-off filters, as well as on ceria-doped microsheet coverslides. Ultraviolet irradiation for over 1500 hours at one sun conditions (AMO) was carried out under vacuum of about 1 million torr. Nearly identical results for non-reflective type cells with 0.35-micro cut-off filters or ceria-doped coverslides were obtained. The 0.30-um filtered cell shows greater than average degradation. The unfiltered cell shows an abrupt drop in the first 20 UVSH and very little subsequent degradation. Author

N78-13552*# Alabama A & M Univ., Huntsville. School of Technology.

PARAMETRIC STUDY OF ROCK PILE THERMAL STORAGE FOR SOLAR HEATING AND COOLING PHASE 1 Final Report

Hrishikesh Saha Oct. 1977 49 p refs

(Grant NsG-8041)

(NASA-CR-155336) Avail: NTIS HC A03/MF A01 CSCL 10A

The test data and an analysis were presented, of heat transfer characteristics of a solar thermal energy storage bed utilizing water filled cans as the energy storage medium. An attempt was made to optimize can size, can arrangement, and bed flow rates by experimental and analytical means. Liquid filled cans, as storage media, utilize benefits of both solids like rocks, and liquids like water. It was found that this combination of solid and liquid media shows unique heat transfer and heat content characteristics and is well suited for use with solar air systems for space and hot water heating. An extensive parametric study was made of heat transfer characteristics of rocks, of other solids, and of solid containers filled with liquids. Author

N78-13553*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

CANDIDATE LOCATIONS FOR SPS RECTIFYING ANTENNAS

Anne W. Eberhardt Nov. 1977 92 p refs

(NASA-TM-78146) Avail: NTIS HC A05/MF A01 CSCL 10A

The feasibility of placing 120 Satellite Power System (SPS) rectifying antenna (rectenna) sites across the U.S. was studied. An initial attempt is made to put two land sites in each state using several land site selection criteria. When only 69 land sites are located, it is decided to put the remaining sites in the sea and sea site selection criteria are identified. An estimated projection of electrical demand distribution for the year 2000 is then used to determine the distribution of these sites along the Pacific, Atlantic, and Gulf Coasts. A methodology for distributing rectenna sites across the country and for fine-tuning exact locations is developed, and recommendations on rectenna design and operations are made. Author

N78-13554*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

SOLAR ENERGY BIBLIOGRAPHY

Stephen Gargus, comp. Jul. 1977 32 p

(NASA-TM-X-73398) Avail: NTIS HC A03/MF A01 CSCL 10A

Listings are provided of technical briefs, reports, and papers pertaining to research being performed in the field of solar energy. Author

N78-13555# Lockheed Missiles and Space Co., Palo Alto, Calif.

EXPERIENCE IN UTILIZING AN ADSORPTION SOLAR COOLING PLANT (ASCP) WITH OPEN REGENERATOR OF THE SOLUTION

A. A. Kakabaev, O. Klyshchaeva, A. Khandurdyev, and N. Kurbanov 1977 6 p refs Transl. into ENGLISH from Geliotekhnika (USSR), no. 4, 1977 p 73-76

Avail: NTIS HC A02/MF A01; National Translation Center, John Crerar Library, Chicago, Illinois 60616

Information is provided to clarify the advantages and disadvantages of a ASCP. A specific experience in the use of such a system is described, presenting details of the solar house's architecture, particularly emphasizing the regenerator system. Disadvantages cited include corrosion of the absorber and evaporator tube surfaces, as well as contamination of the solution and its subsequent filtration. Advantages are indicated by specific operating temperatures, the system's comparative simplicity and its high coefficient of solar radiation utilization. Author

N78-13556*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AN IMPROVED SOLAR CONCENTRATOR Patent Application
John G. Simpson, inventor (to NASA) Filed 30 Nov. 1977 15 p
(NASA-Case-MFS-23727-1; US-Patent-Appl-SN-856465) Avail: NTIS HC A02/MF A01 CSCL 10A

A solar energy conversion device is described. The device is embodied in an improved solar concentrator characterized by elongated supporting members arranged in substantial horizontal parallelism with the axes thereof intersecting a common curve and a tensioned sheet of flexible reflective material disposed in engaging relation with the supporting members for imparting thereto a catenary configuration. The supporting members comprise tensioned wires about which a flexible sheet is drawn. The supporting members comprise rods inserted into tubular receptacles transversely related to a flexible sheet whereby the sheet is tensioned by the weight of the rods. The instant invention provides a simple economic and efficient solar energy concentrator particularly suited for use with systems provided for converting solar energy to heat in dwellings and similar structures. NASA

N78-13558# Faucett (Jack) Associates, Inc., Chevy Chase, Md.
ENERGY CONSUMPTION IN COMMERCIAL INDUSTRIES BY CENSUS DIVISION - 1974
Hiliary A. Kaufman, William Anderson, James McElroy, Kay Kennery, and Loe J. Mueller Mar. 1977 365 p
(Contract FEA-CO-03-50346-00)
(PB-268851/3; FEA/B-77/167) Avail: NTIS HC A16/MF A01 CSCL 10A

Secondary data collections are reported that were compiled by many different public and private organizations for the various segments of the commercial sector. Following a common methodology, the data are estimated for the various segments of each of the commercial sectors, and then Census Division and national totals are developed. GRA

N78-13559# ICF, Inc., Washington, D. C.
PROJECT INDEPENDENCE EVALUATION SYSTEM (PIES) DOCUMENTATION. VOLUME 4: FEA MODEL OF OIL AND GAS SUPPLY: DATA VALIDATION AND UPDATE
Sep. 1976 53 p
(Contract FEA-CO-05-50301-00)
(PB-270385/8; FEA/N-76/414-Vol-4) Avail: NTIS HC A04/MF A01 CSCL 08I

A detailed and comprehensive discussion of the oil and gas supply model is presented which is used to construct the oil and gas supply curves. It provides an overview description of the model and the modeling methodology as well as details on the data input requirements. GRA

N78-13560# Northwestern Technological Inst., Evanston, Ill.
HEAT EXTRACTION FROM HOT, DRY ROCK MASSES Progress Report, 1 Aug. 1976 - 31 Jan. 1977
J. Weertman, J. D. Achenbach, Z. P. Bazant, J. Dundurs, and L. M. Keer Mar. 1977 82 p refs
(Grant NSF AER-75-00187)
(PB-271411/1; NSF/RA-770172) Avail: NTIS HC A05/MF A01 CSCL 08I

In analytical studies of three dimensional crack growth and shape, crack orientation was studied and the condition of a circular crack was relaxed. A method is under study to determine the crack shape when the pressure of fluid in the crack is prescribed. The growth and stability of parallel, thermally induced edge cracks were investigated as a function of a thermal wave progressing from a free surface, both analytically and by finite element numerical techniques. The geometrical theory of diffraction in three dimensional elastodynamics was applied to the problem of diffraction by a large crack of a signal emanating from a point source. GRA

N78-13563# National Bureau of Standards, Washington, D. C. Solar Energy Program.
INTERMEDIATE STANDARDS FOR SOLAR DOMESTIC HOT WATER SYSTEMS/HUD INITIATIVE
Jul. 1977 153 p refs
(PB-271758/5; NBSIR-77-1272) Avail: NTIS HC A08/MF A01 CSCL 13A

Standards are presented for the use of solar domestic hot water systems in residential applications. The standards were developed for application in numerous housing programs of the Department of Housing and Urban Development and are to be used in conjunction with the HUD Minimum Property Standards for One and Two Family Dwellings, and Minimum Property Standards for Multifamily Housing. GRA

N78-13564# Draper (Charles Stark) Lab., Inc., Cambridge, Mass.
RESEARCH TOWARD IMPROVED FLYWHEEL SUSPENSION AND ENERGY CONVERSION SYSTEMS Interim Technical Report, 1 Jul. 1975 - 31 Dec. 1975
David Eisenhaure, George Oberbeck, Stephen ODea, and William Stanton Mar. 1976 94 p refs
(Grant NSF AER-75-18813)
(PB-271413/7; R-960; NSF/RA-761119) Avail: NTIS HC A05/MF A01 CSCL 10C

Suspension and energy conversion systems for use in conjunction with flywheel energy storage were studied. A detailed set of system requirements which would allow two-way power flow between a high-speed flywheel shaft and a 60-Hz line was outlined. A special-purpose integrated rotating machine and power-switching stage were designed. A special-purpose low-loss magnetic suspension system was designed which will allow efficient 24-hour cycle energy storage. A computer model of the flywheel and suspension system was developed to aid in the determination of critical suspension and control parameters and evaluation of system performance. GRA

N78-13565# Westinghouse Research Labs., Pittsburgh, Pa.
INVESTIGATION OF METHODS TO IMPROVE HEAT PUMP PERFORMANCE AND RELIABILITY IN A NORTHERN CLIMATE. VOLUME 3: APPENDICES B, C, D Final Report
H. S. Kirschbaum and S. E. Veyo Jan. 1977 480 p
(EPRI Proj. 544-1)
(EPRI-EM-319-Vol-3-App-B; EPRI-EM-319-Vol-3-App-C; EPRI-EM-319-Vol-3-App-D) Avail: NTIS HC A21/MF A01

The potential for improving the performance, reliability, cost, and energy demand of heat pumps for use in northern climates was evaluated. Results of the various analyses are presented. ERA

N78-13567# Westinghouse Electric Corp., Pittsburgh, Pa.
INVESTIGATION OF METHODS TO IMPROVE HEAT PUMP PERFORMANCE AND RELIABILITY IN A NORTHERN CLIMATE. FINAL REPORT, VOLUME 1
H. S. Kirschbaum and S. E. Veyo Jan. 1977 436 p
(EPRI-EM-319-Vol-1) Avail: NTIS HC A19/MF A01

The potential for improving heat pump performance and reliability for application in northern climates was evaluated. Component and subsystem improvements with the potential for implementation by 1980 were identified. Improved systems were then configured and analyzed for their benefits to, and impacts on, consumers, electric utilities, and the manufacturing industry. Air-to-air heat pumps were emphasized and the impacts of storage and/or solar augmentation were investigated. Three utility service territories were selected to illustrate annual life cycle cost optimization for the case of a flat electricity rate structure. Five improved heat pump systems were identified and analyzed for performance, reliability, cost, utility impacts, and development requirements. ERA

N78-13568# Energy Research and Development Administration, Washington, D. C. Div. of Conservation Research and Technology.
ENERGY CONSERVATION R AND D OBJECTIVES WORKSHOP. VOLUME 1: WORKING PAPERS

1977 136 p Presented at Energy Conserv. Res. and Develop. Objectives Workshop, San Diego, Calif., 6 Mar. 1977
(CONF-770305-P1) Avail: NTIS HC A07/MF A01

The Div. of Conservation Research and Technology (CONRT) prepared a series of working papers to familiarize participants with some of the issues that were slated for discussion at the workshops. Included are: an overview of the energy problem and the roles of public and private sector R and D activities; a summary of the CONRT Planning Process by which CONRT selects and evaluates projects and the role workshops play in that process; the national, ERDA, and CONRT objectives that guide federal energy R and D activities; a discussion of some of the socio-economic factors that affect energy R and D activities; an example of the type of discussion that might occur at a workshop; technical papers on combustion and fuels technology, heat cycles, and supporting technologies, and a discussion of strategies for making a shift from oil and natural gas to alternate fuels. ERA

N78-13569# Energy Research and Development Administration, Washington, D. C. Div. of Conservation Research and Technology.
ENERGY CONSERVATION R AND D OBJECTIVES WORKSHOP. VOLUME 2: SUMMARY
D. J. Monetta, ed. 1977 27 p Presented at Energy Conserv. Res. and Develop. Objectives Workshop, San Diego, Calif., 6 Mar. 1977
(CONF-770305-Pt-2) Avail: NTIS HC A03/MF A01

The purpose of the meeting was to test a new method of gathering information for the Div. of Conservation Research and Technology (CONRT) planning process and, to the extent that the first objective was achieved, to actually gather information for CONRT's current planning process. For this experiment, CONRT and the Coast Community College District, the local host of the workshop, assembled representatives from ERDA, industry, the academic community, and the general public to discuss and critique CONRT's activities and planning process. Participants met in general sessions and in three smaller panels devoted to specific areas of interest to CONRT. The first workshop proceedings are described, the results are summarized, and major conclusions and recommendations are presented. ERA

N78-13571# Battelle Pacific Northwest Labs., Richland, Wash.
INVESTIGATION OF INTERNATIONAL ENERGY ECONOMICS
D. E. Deonigi, M. Clement, T. J. Foley, and S. A. Rao Mar. 1977 94 p
(Contract EY-76-C-06-1830)
(BNWL-2134) Avail: NTIS HC A05/MF A01

A program was designed to coordinate the capabilities of five research groups to evaluate international economics. This program is designed to be general, flexible, and capable of evaluating a diverse collection of potential energy (nuclear and nonnuclear related problems). For example, the newly developed methodology could evaluate the international and domestic economic impact of nuclear-related energy sources, but also existing nonnuclear and potential energy sources such as solar, geothermal, wind, etc. Major items to be included would be the cost of exploration, cost of production, prices, profit, market penetration, investment requirements and investment goods, economic growth, change in balance of payments, etc. In addition, the changes in cost of producing all goods and services would be identified for each new energy source. ERA

N78-13572# Institute of Gas Technology, Chicago, Ill.
DEVELOPMENT OF AN INDUSTRY-GOVERNMENT COOPERATIVE ENERGY CONSERVATION PROGRAM FOR SMALL MANUFACTURERS, PHASE 1. PROJECT 8978 Final Report
M. E. Fejer and P. A. Ketels Nov. 1976 28 p
(Contract EY-76-C-02-2852)
(COO-2852-2) Avail: NTIS HC A03/MF A01

Energy conservation programs are evaluated. The approach being taken in this program is one in which the trade association representing the various small manufacturers agree to cooperate in providing the necessary contacts and data for evaluating their respective industries. The program is divided into three phases; three associations volunteered to participate. ERA

N78-13573# Brookhaven National Lab., Upton, N. Y.
RESIDENTIAL ENERGY DEMAND ANALYSIS: DATA AND METHODOLOGY
W. Marcuse, Steven C. Carhart, and Shirish Mulherkar Oct. 1976 35 p refs Presented at the Joint Natl. Meeting of the Operations Res. Soc. of Am. and the Inst. of Management Sci., Miami, Fla., 3-6 Nov. 1976
(Contract EY-76-C-02-0016)
(BNL-21920; Conf-761167-1) Avail: NTIS HC A03/MF A01

An energy system and optimization model has been used for technology assessment and policy analysis by the Energy Research and Development Administration. Most supply technologies and end-use conversion devices are characterized in the model. Extension of the model to incorporate a more detailed characterization of end-use devices, utilizing systems (e.g., housing type and class of insulation), and use factors is needed to assess conservation research and development options. This paper describes the first stage of these extensions to energy end-use demands in the residential sector. Upon completion of this work, extension to commercial, industrial and transportation sectors will be pursued. ERA

N78-13574# Battelle Pacific Northwest Labs., Richland, Wash.
OUR ENERGY FUTURE: WHERE IS REALITY
R. D. Widrig Nov. 1976 12 p Presented at the Natl. Sci. Teachers Assoc. Conf., Seattle, 5 Nov. 1976
(Contract E(45-1)-1830)
(BNWL-SA-6029; Conf-761171-1) Avail: NTIS HC A02/MF A01

Electric power generation in the northwest on United States is discussed. The main considerations are: decisions made today will stand for ten years or more and are irreversible; only coal and nuclear power are options available in the Northwest; coal and nuclear power must be utilized to alleviate power outages leading to rationing and allocation measures; and conservation of electricity will benefit all. ERA

N78-13575# Stanford Research Inst., Menlo Park, Calif.
FUEL AND ENERGY PRICE FORECASTS. VOLUME 2: DATA BASE Final Report
Feb. 1977 309 p refs
(EPRI-EA-433-Vol-2) Avail: NTIS HC A14/MF A01

The data base for the energy model as of August 1976 encompasses the following: (1) a network used to describe the production processing, transportation, and end-use consumption of energy materials; (2) the economics of energy conversion processes that require at least one fuel as a primary feedstock and produce at least one primary energy product and end-use conversion, (3) a description of how the relationship between the marginal cost of primary sources (excluding economic rent) and cumulative production of these resources-coal, domestic crude oil, natural gas, imported oil and gas, nuclear fuel, shale oil, geothermal, biomass, and hydropower-are developed; (4) initial energy balances: specification of flow at each mode of the network in energy balance required by the energy model; (5) a model to project usable energy (end-use) demand as a function of usable energy prices (marginal costs) and other variables such as GNP or economic activity by sector, population growth, and mandatory or technologically induced changes in energy use; and (6) the dynamics of the energy market. ERA

N78-13576# Oak Ridge National Lab., Tenn.
CONSENSUS FORECAST OF US ENERGY SUPPLY AND DEMAND TO THE YEAR 2000
J. A. Lane Feb. 1970 31 p refs
(Contract W-7405-eng-26)
(ORNL/TM-5369) Avail: NTIS HC A03/MF A01

Methods used in forecasting energy supply and demand are described, and recent forecasts are reviewed briefly. Forecasts to the year 2000 are displayed in tables and graphs and are used to prepare consensus forecasts for each form of fuel and energy supply. Fuel demand and energy use by the consuming sector are tabulated for 1972 and 1975 for the various fuel forms. The distribution of energy consumption by use sector, as projected for the years 1985 and 2000 in the ERDA-48 planning report (Secenario V), is normalized to match the consensus energy supply forecasts. The results are tabulated listing future demand for each fuel and energy form by each major energy-use category. Recent estimates of U.S. energy resources are also reviewed briefly and are presented in tables for each fuel and energy form. The outlook for fossil fuel resources to the year 2040, as developed by the Institute for Energy Analysis at the Oak Ridge Associated Universities, is also presented. ERA

N78-13577# Sandia Labs., Albuquerque, N. Mex.
SYSTEM DYNAMICS MODEL OF NATIONAL ENERGY USAGE
D. W. Sasser Dec. 1976 87 p refs
(Contract EY-76-C-04-0789)
(SAND-76-0415) Avail: NTIS HC A05/MF A01
A system dynamics model of energy usage is presented with particular application to the national level, although the model could be used at other levels with suitable modifications. The model simulates: growth in the energy usage sectors of industry, residential-commercial, transportation, and other electric utilities, and the depletion of the primary energy sources of coal, oil, natural gas, and uranium. The sectors in the model are highly coupled through numerous feedback loops which reflect the influence of each sector of the energy economy upon the others. The model is versatile in the sense that new energy technology can be introduced with minimal effort. A detailed description of the model is given, a number of examples of its application are described. ERA

N78-13578# Oak Ridge National Lab., Tenn.
CONSENSUS FORECAST OF US ELECTRICITY SUPPLY AND DEMAND TO THE YEAR 2000
J. A. Lane Feb. 1976 11 p
(Contract W-7405-eng-26)
(ORNL/TM-5370) Avail: NTIS HC A02/MF A01
Recent forecasts of total electricity generating capacity and energy demand as well as for electricity produced from nuclear energy and hydroelectric power are presented in tables and graphs to the year 2000. A forecast of the distribution of type of fuel and energy source that will supply the future electricity demand is presented. Use of electricity by each major consuming sector is presented for 1975. Projected demands, for electricity in the years 1985 and 2000, as allocated to consuming sectors, are derived and presented. ERA

N78-13579# General Electric Co., Schenectady, N. Y. Corporate Research and Development Div.
DEMONSTRATION OF AN INDUCTOR MOTOR/ ALTERNATOR/FLYWHEEL ENERGY STORAGE SYSTEM Technical Quarterly Progress Report, 28 Sep. - 28 Dec. 1976
28 Dec. 1976 36 p
(Contract EY-76-C-02-4010)
(COO-4010-2; TQPR-2) Avail: NTIS HC A03/MF A01
The concept, consisting of a high-speed composite flywheel combined with an integral inductor-type motor/alternator, offers the possibility of a small, lightweight package with high energy storage capability. The basic technology demonstrated in this program have application to a number of flywheel energy storage systems. The demonstration unit has a nominal rating of 20 kVA. The program will develop a flywheel energy storage system sized for a 3000 lb battery electric van. The design and fabrication of the inductor motor/alternator/flywheel; and design and fabrication of the solid state power conditioner and control breadboard are discussed. ERA

N78-13580# Battelle Columbus Labs., Ohio.
HEAT SOURCE COMPONENT DEVELOPMENT PROGRAM Quarterly Report, Jan. - Mar. 1977
W. M. Pardue, comp. Apr. 1977 61 p
(Contract W-7405-eng-92-TAS-94)
(BMI-X-679) Avail: NTIS HC A04/MF A01
Experimental programs to develop components for advanced radioisotope heat source applications in advanced static and dynamic power conversion systems are reported. Specific components development efforts are described for improved selective and nonselective vents for helium release from the fuel containment, and and improved reentry member and an improved impact member, singly and combined. The unitized reentry-impact member is under development to be used as a bifunctional ablator. Finally, thermochemical supporting studies are described. ERA

N78-13581# Lincoln Lab., Mass. Inst. of Tech., Lexington.
PHOTOVOLTAIC POWER IN LESS DEVELOPED COUNTRIES
D. V. Smith 24 Mar. 1977 92 p refs
(Contract EY-76-C-02-4094)
(COO-4094-1) Avail: NTIS HC A05/MF A01
The potential of solar photovoltaic power in the third world (less developed countries) is analyzed. Application of irrigation systems powered by photovoltaics in Bangladesh, Chad, India, and Pakistan, plus an economic analysis of a photovoltaic-powered village in northern India indicate solar energy is competitive with the least-cost fossil-fuel alternatives. The most cost-effective method for specific geographical locations can be determined by field testing based on the case history data reported. ERA

N78-13582# Westinghouse Electric Corp., Pittsburgh, Pa.
EVALUATION OF A PHOTOVOLTAIC CENTRAL POWER STATION
D. A. McCutchan, P. F. Pittman, R. R. Ferber, G. C. Ruschak, Jr., and C. R. Chowaniec 1977 18 p ref Presented at the 39th Ann. Meeting of the Am. Power Conf., Chicago, 18-20 Apr. 1977; Sponsored by Illinois Inst. of Technology
(Contract EY-76-C-04-2744)
(CONF-770403-8) Avail: NTIS HC A02/MF A01
The solar plant consists of an array subsystem, which includes the cells and their supporting surface, a supporting structure and tracking equipment, and a power conversion subsystem, principally composed of solid state inverters and transformers. Many design variations were examined for each of these components. Since solar cells are expensive, the array design effort explored the use of lenses and mirrors to concentrate the solar radiation on the cells. Low cost solar tracking arrays were designed to increase the daily energy yield. Because the conversion efficiency of photovoltaic cells decreases with temperature, forced air and water cooling were considered in addition to natural convection cooling. The annual energy output was calculated for each plant concept in Phoenix, using the solar cell technology expected to be available in about 1990: for the silicon single-crystal cell used in the space program, a 16 percent conversion efficiency and the 1985 ERDA cost goal of 500$/k Wp (peak) for this cell (1975$) was postulated. ERA

N78-13583# General Atomic Co., San Diego, Calif.
SOLAR COLLECTOR FIELD SUBSYSTEM PROGRAM ON THE FIXED MIRROR SOLAR CONCENTRATOR Final Report, 28 Mar. - 30 Sep. 1976
G. H. Eggers 31 Dec. 1976 128 p
(Contract EY-76-C-04-0789)
(GA-A-14209-Rev) Avail: NTIS HC A07/MF A01
The preliminary design of a fixed mirror solar concentrator (FMSC) is described. A fluid loop was designed to route the heat transfer fluid from the supply system through the heat-receiver assembly and back to the source. The preliminary design includes pumps, valves, and pipe sizing and a specification of operating modes. Overall system design considerations were addressed through further development of tools to analyze heat receiver performance (with the SOLCOL code), and to calculate overall system static performance (with the SUNPOW code), which included quite detailed modeling of the FMSC and its insolation loss mechanisms. This effort is also described. A collector design was established that optimizes the energy collection under the specific insolation conditions and latitude of Albuquerque. ERA

N78-13584# Colorado School of Mines, Golden. Dept. of Geophysics.
RESEARCH ON THE PHYSICAL PROPERTIES OF GEOTHERMAL RESERVOIR ROCKS. SUMMARY REPORT ON COLLECTION OF SAMPLES OF VOLCANIC ROCKS FOR PETROPHYSICAL STUDIES

L. T. Grose 31 Aug. 1976 5 p
(Contract EY-76-S-02-2908)
(COO-2908-1; PR-1) Avail: NTIS HC A02/MF A01

Rock samples were collected from the Snake River Plain volcanic depression of Idaho, the Columbia Plateau's volcanic basin located in southeastern Washington, northeastern Oregon, and western Idaho, the Modoc volcanic province of northeastern California, the volcanic fields of south central Nevada, and the Jemez volcanic field of north central New Mexico. Strategy governing sample selection is described. From each field, 64 individual rock samples, each being several kilograms in size, were collected. ERA

N78-13585# Energy Research and Development Administration, Washington, D. C. Div. of Solar Energy.
INTERIM POLICY OPTIONS FOR COMMERCIALIZATION OF SOLAR HEATING AND COOLING SYSTEMS
Apr. 1977 71 p
(ERDA-77-62) Avail: NTIS HC A04/MF A01

The major incentive policy options available to accelerate market penetration of solar heating and cooling systems are reviewed. The policies described provide alternative methods for enhancing the impact of the solar heating and cooling demonstration program. Feasible policy designed to overcome existing barriers to commercial acceptance and market penetration are identified and evaluated. This report is divided into the following seven sections, each dealing with a key problem area relating to the widespread use of SHAC systems: economic and financial incentives; the solar energy public utility interface; legal and regulatory issues; ERDA patent policy; building codes, standards and warranties; marketing, manpower, consumer and environmental issues; and regional aspects of the incentives program. ERA

N78-13586# Oak Ridge National Lab., Tenn.
COAL TECHNOLOGY PROGRAM Progress Report, Mar. 1977
May 1977 37 p
(Contract W-7405-eng-26)
(ORNL/TM-5883) Avail: NTIS HC A03/MF A01

Subbituminous coal was hydrocarbonized at 1100 F and 300 psig in a recirculating fluidized bed. A two-dimensional pyrolysis behavior study of an eastern bituminous coal (Pittsburgh seam) indicated that swelling is significantly more pronounced at very low heating rates. Several activities in progress are related to inspection techniques for wear- and process-resistant coatings. Experimental investigations of fireside corrosion on tubing from a fluidized bed combustor have proceeded with metallographic examination and analyses of the scale formed during the test exposure. Methods for nondestructively determining remaining tube wall thickness and scale thickness were developed. Failure prevention and analysis work was aimed at several parts from a solvent refined coal plant. ERA

N78-13588# Middleton Associates, Toronto (Ontario).
CANADA'S RENEWABLE ENERGY RESOURCES: AN ASSESSMENT OF POTENTIAL
Peter Middleton, Ronald Argue, Robert Argue, T. Burrell, and George Hathaway Apr. 1976 528 p refs
(NP-21901) Avail: NTIS (US Sales Only) HC A23/MF A01; ERDA Depository Libraries

Rising costs of conventional, frontier, and nuclear energy production and the prospect of future shortages have prompted a resurgence of interest in alternative, renewable energy technologies. Principal sources of renewable energy (solar radiation, wind, and biomass), as well as waves, thermal gradients, and, sensible heat sources are reviewed to establish, in general terms, their significance in the Canadian context. Next, the technical characteristics, efficiency, costs, impacts, and state of the art of sixteen harnessing or conversion technologies are presented as an information base upon which to build an assessment of potential. A method of comparing the life cost of a renewable energy system to that of the likely conventional alternative is proposed and applied in cases where adequate technical and economic data are available. ERA

N78-13589# Foster Associates, Inc., Washington, D.C.
FUEL AND ENERGY PRICE FORECASTS. VOLUME 1: REPORT Final Report
R. Schantz, W. Mikutowicz, and W. Foster Apr. 1977 264 p refs Sponsored by Electric Power Research Inst. 2 Vol.
(EPRI-EA-411-Vol-1) Avail: NTIS HC A12/MF A01

Fuel and energy prices are studied over the period 1985 to 2000 in 1975 constant dollars, on a regional basis, for the United States. The major sources of energy analyzed include crude oil and major petroleum products, coal and coal-based synthetic fuels, gas, and uranium. It was stipulated that price projections were to be developed within a given set of aggregate energy and electricity demand projections. Delivered energy prices were estimated for four major end-use sectors: residential/commercial, industrial, electric utility, and transportation. Two major findings of the study are: The real prices of all sources of energy will increase over the forecast period. ERA

N78-13590# Foster Associates, Inc., Washington, D.C.
FUEL AND ENERGY PRICE FORECASTS. VOLUME 2: SCHEDULES Final Report
R. Schantz, W. Mikutowicz, and W. Foster Apr. 1977 190 p Sponsored by Electric Power Research Inst. 2 Vol.
(EPRI-EA-411-Vol-2) Avail: NTIS HC A09/MF A01

A compilation of schedules on information contained in two chapters of Vol. 1 is presented. Chapter 3 projected prices for major sources of energy, and chapter 4, inter-energy prices projected for major consuming sectors. ERA

N78-13592# Illinois Univ., Urbana. Center for Advanced Computation.
NET ENERGY EFFECTS AND RESOURCE DEPLETION: AN ALL-OIL ECONOMY
P. S. Penner and D. Amado Apr. 1977 43 p refs
(Contract EY-76-S-02-2865)
(COO-2865-6) Avail: NTIS HC A03/MF A01

The impact over time as a resource is depleted and requires increasing inputs to produce a unit of output is examined. Focus is on oil extraction, starting with conventional onshore drilling and proceeding through offshore, secondary, and tertiary recovery techniques. A hypothetical single-fuel economy is constructed, in which the entire U.S. economy depends solely on crude petroleum for its energy supply. The net energy effect (increase in energy cost of energy) is analyzed. With constant 3% growth in GNP and no net energy effects, the economy would run out of oil in eleven years. Use of synthetic fuels is considered. ERA

N78-13593# Energy Research and Development Administration, Washington, D. C. Div. of Solar Energy.
SOLAR PROGRAM ASSESSMENT: ENVIRONMENTAL FACTORS. PHOTOVOLTAICS
Mar. 1977 65 p refs
(ERDA-77-47/3) Avail: NTIS HC A04/MF A01

The major environmental issues associated with further development of photovoltaic systems are presented and prioritized. To provide a background for this environmental analysis, the basic concepts of the technology are reviewed, as are its economic and resource requirements. The potential effects of this new technology on the full range of environmental concerns (i.e., air and water quality, biosystems, safety, social/institutional structures, etc.) then are discussed in terms of both their relative significance and possible solutions. Although the development of photovoltaics will contribute to certain environmental problems common to any construction project or energy producing technology, only those impacts unique to the solar portion of the technology is discussed in depth. Finally, an environmental work plan is presented. ERA

N78-13594# Eagle-Picher Co., Joplin, Mo. Couples Dept.
ELECTRIC VEHICLE PROPULSION BATTERIES: DESIGN AND COST STUDY FOR NICKEL/ZINC BATTERY MANUFACTURE, TASK A
1977 85 p
(Contract W-31-109-eng-38)
(ANL-K-77-3542-1) Avail: NTIS HC A05/MF A01

A 700-pound nickel--zinc battery was configured. Containing 64 individual cells, the unit was selected for minimum weight from computed packaging possibilities. Unit volume was projected to be 4.77 cubic feet. Capacity of the cells delivering 100+ volts was set at 245 ampere-hours. Selection was made primarily because of the compatibility with expressed vehicle requirements of a lower-current system. Manufacturing costs were computed for a unit using sintered positive electrodes at $86/kWh, pilot plant rate, and $78/kWh, production plant rate. Based on a lower than anticipated cost differential between sintered and nonsintered positive electrodes and certain other performance differences, the sintered electrode was chosen for the battery design. Capital expenditures for a production rate of 10,000 batteries per year are estimated to be $2,316,500. ERA

N78-13597# Bechtel Corp., San Francisco, Calif.
CONCEPTUAL DESIGN OF A BATTERY ENERGY STORAGE TEST (BEST) FACILITY
Aug. 1975 160 p refs Sponsored in part by Elec. Power Res. Inst.
(Contract W-31-109-eng-38)
(EPRI-255-TR-2; ERDA-31-109-38-2962-TR-2) Avail: NTIS HC A08/MF A01

Design criteria for a battery energy storage test facility are presented. Systems to provide for functions such as battery cooling, building heating-ventilating-air-conditioning, station auxiliary power, and safety are described. Economic and environmental factors are included. J.M.S.

N78-13599*# Thermo Electron Engineering Corp., Waltham, Mass.
ADVANCED THERMIONIC TECHNOLOGY PROGRAM Progress Report
Apr. 1977 21 p
(Contracts NAS3-20302; EY-76-C-02-3056)
(NASA-CR-155299; COO-3056-23; TE-4217/4220-123-77; PR-22) Avail: NTIS HC A02/MF A01 CSCL 01B

Topics include surface studies (surface theory, basic surface experiments, and activation chamber experiments); plasma studies (converter theory and enhanced mode conversion experiments); and component development (low temperature conversion experiments, high efficiency conversion experiments, and hot shell development). ERA

N78-13600# Oklahoma Univ., Norman. School of Chemical Engineering and Materials Science.
DEVELOPMENT OF WORKING FLUID THERMODYNAMIC PROPERTIES INFORMATION FOR GEOTHERMAL CYCLES: PHASE 1 Semiannual Report, 1 Sep. 1976 - 28 Feb. 1977
K. E. Starling, C. M. Sliepcevich, L. W. Fish, K. M. Goin, K. H. Aboul-Fotouh, K. H. Kumar, T. J. Lee, S. J. Milani, and K. L. Zemp 1977 26 p refs
(Contract EY-76-S-05-5249)
(ORO-5249-1) Avail: NTIS HC A03/MF A01

The following elements of research were performed: (1) the collection and processing of data for pure components; (2) the evaluation of the generalized Modified Benedict-Webb-Rubin (MBWR) equation of state for halogenated hydrocarbon saturated thermodynamic properties; (3) the determination of the pure component parameters of the MBWR for four polar fluids; and (4) the investigation of modifications of the MBWR for improved prediction of properties of polar fluids. A primary conclusion is that the MBWR will predict properties for polar fluids with small to moderate dipole moments (less than 1.6 Debyes) but needs modification for fluids with larger moments. ERA

N78-13603# Sandia Labs., Albuquerque, N. Mex.
ENERGY STORAGE NEEDS FOR WIND POWER SYSTEMS
J. W. Reed 1977 20 p refs Presented at the Am. Assoc. for the Advan. of Sci. Conf., Denver, 20 Feb. 1977
(Contract EY-76-C-04-0789)
(SAND-76-9058; Conf-770210-6) Avail: NTIS HC A02/MF A01

Long term hourly wind observations at several representative U. S. locations have been used to show that a totally independent and perfectly reliable wind energy system would require an impractically large storage capacity, primarily to cover year-to-year and annual cycles of available wind energy. As reliability is allowed to decrease, a considerable reduction in storage capability is possible. This is demonstrated by statistical results for several climatic regimes. ERA

N78-13604# Sandia Labs., Albuquerque, N. Mex.
CONTROL SYSTEM FOR WIND-POWERED GENERATORS
G. J. Kroth May 1977 15 p
(Contract EY-76-C-04-0789)
(SAND-77-0287) Avail: NTIS HC A02/MF A01

An automatic control system is designed. It responds to electrical representations of data such as bearing temperature, vibration, wind velocity, turbine velocity, torque, or any other pertinent data. It responds by starting or stopping the turbine, controlling the loading, or sounding an alarm. A microprocessor-based controller capable of these functions is described. ERA

N78-13606# InterTechnology Corp., Warrenton, Va.
INTERTECHNOLOGY CORPORATION REPORT OF SOLAR ENERGY SYSTEMS INSTALLATION COSTS FOR SELECTED COMMERCIAL BUILDINGS
Dec. 1976 208 p
(Contract EY-76-C-02-2688)
(COO-2688-76-13) Avail: NTIS HC A10/MF A01

The installation of solar collector and thermal energy storage subsystems in specific non-residential building applications are presented. Both existing projects and those under construction were surveyed. Survey summary sheets for each project encountered are provided as a separate appendix. Subsequently, the rationale used to select the projects studied in-depth is presented. The results of each of the detailed studies are then provided along with survey summary sheets for each of the projects studied. Installation cost data are summarized and the significance of the differences and similarities between the reported projects is discussed. After evaluating the data obtained from the detailed studies, methods of reducing installation labor costs are postulated based on the experience of the study. Some of the methods include modularization of collectors, preplumbing and preinsulating, and collector placement procedures. ERA

N78-13607# Gould, Inc., Rolling Meadows, Ill. Nickel-Zinc Battery Project.
DEVELOP NICKEL-ZINC BATTERY SUITABLE FOR ELECTRONIC VEHICLE PROPULSION. TASK A: DESIGN AND COST STUDY
15 Feb. 1977 127 p refs
(Contract W-31-109-eng-38)
(ANL-K-77-3558-1; Rept-762-003-1) Avail: NTIS HC A07/MF A01

A three-month design and cost study for the use of nickel-zinc batteries in electric vehicles is presented. Battery configuration is analyzed, and expected performance is set forth. Current development problems concern component materials and capacity decline on cycling, electrolyte maintenance, and thermal characteristics. The manufacturing process is outlined, and estimates are made for cost, materials requirements, and capital needs. ERA

N78-13609# Resource Planning Associates, Inc., Washington, D. C.
STATE ENERGY CONSERVATION PROGRAM SOURCEBOOK. VOLUME 1: OVERVIEW AND GUIDE
Jan. 1977 26 p
(Contract FEA-CR-04-60802-00)
(PB-271798/1; FEA/D-76/470-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 10A

Background information is presented about the state energy conservation program and instructions for using the source book in the development and preparation of state plans are provided. GRA

N78-13610# Federal Energy Administration, Washington, D. C. Office of State Energy Conservation Programs.

STATE ENERGY CONSERVATION PROGRAM SOURCEBOOK. VOLUME 2: STATE ENERGY CONSERVATION PLAN HANDBOOK
Jan. 1977 221 p
(PB-271799/9; FEA/D-76/471-Vol-2) Avail: NTIS HC A10/MF A01 CSCL 10A

Procedures to be followed in applying for financial assistance for the implementation of state plans are included in this handbook. Detailed descriptions of the required program measures and a description of additional program measures are also presented. Suggested procedures for calculating energy savings for the program measures are delineated. GRA

N78-13611# Federal Energy Administration, Washington, D. C. Office of State Energy Conservation Programs.
STATE ENERGY CONSERVATION PROGRAM SOURCEBOOK. VOLUME 3: GRANTS-IN AID MANAGEMENT HANDBOOK
Jan. 1977 38 p
(PB-271800/5; FEA/D-76/472-Vol-3) Avail: NTIS HC A03/MF A01 CSCL 10A

Procedures are presented for the administration of grants under the state energy conservation program. This handbook is designed as an aid for the states in applying for, and managing, their grant from FEA. GRA

N78-13612# Resource Planning Associates, Inc., Washington, D. C.
STATE ENERGY CONSERVATION PROGRAM SOURCEBOOK. VOLUME 4: PROGRAM MEASURES AND ABSTRACTS
Jan. 1977 259 p
(Contract FEA-CR-04-60802-00)
(PB-271801/3; FEA/D-76/473-Vol-4) Avail: NTIS HC A12/MF A01 CSCL 10A

A listing of measures that can be undertaken for conserving energy in each sector is presented. Abstracts of federal, state, local government, and private industry programs are also provided. GRA

N78-13613# Resource Planning Associates, Inc., Washington, D. C.
STATE ENERGY CONSERVATION PROGRAM SOURCEBOOK. VOLUME 6: BIBLIOGRAPHY
Jan. 1977 62 p
(Contract FEA-CR-04-60802-00)
(PB-271802/1; FEA/D-76/475-Vol-6) Avail: NTIS HC A04/MF A01 CSCL 10A

Abstracts of some available energy conservation publications are provided along with references to other publications. GRA

N78-13614# National Governors' Conference, Washington, D. C. Subcommittee on Energy Conservation.
FEDERAL ENERGY CONSERVATION PROGRAMS, A STATE PERSPECTIVE
Connie B. Q. Laughlin May 1977 50 p refs refs
(PB-271283/4; NATGOV-77/03071) Avail: NTIS HC A03/MF A01 CSCL 10A

The implementation of energy conservation programs mandated by the Energy Conservation and Production Act and the Energy Policy and Conservation Act is examined. The report concludes that state energy conservation efforts are hampered by the fragmentation of federal programs among a number of different agencies. The programs also lack the flexibility needed in light of differing needs and capabilities within the states. GRA

N78-13615# Massachusetts Inst. of Tech., Cambridge. Energy Lab.
SOLAR ENERGY DEHUMIDIFICATION EXPERIMENT ON THE CITICORP CENTER BUILDING Final Report
Jun. 1977 175 p refs
(Grant NSF PTP-75-05156)
(PB-271174/5; MIT-EL-77-005; NSF/RA-760003) Avail: NTIS HC A08/MF A01 CSCL 13A

The technical and economic feasibility of using solar energy to reduce conventional energy consumption of a large urban commercial building were studied. Specifically, solar assisted dehumidification of ventilation air to reduce conventional air conditioning requirements for the Citicorp Center in New York City was investigated. A detailed computer simulation of yearly operation was made on an hourly basis using New York City temperature, humidity and solar data. Several system configurations were examined and were defined, each operating in its most efficient fashion. GRA

N78-13616# Oklahoma Univ., Norman. Science and Public Policy Program.
ENERGY FROM THE WEST: A PROGRESS REPORT OF A TECHNOLOGY ASSESSMENT OF WESTERN ENERGY RESOURCE DEVELOPMENT. VOLUME 1: SUMMARY REPORT Final Report, Jul. 1975 - Mar. 1977
Irvin L. White, Michael A. Chartock, R. Leon Leonard, Steven C. Ballard, and Martha W. Gilliland Jun. 1977 185 p refs
(Contract EPA-68-01-1916)
(PB-271752/8; EPA-600/7-77-072a-Vol-1) Avail: NTIS HC A09/MF A01 CSCL 08I

The development of six energy resources in eight western states during the period from the present to the year 2000 was studied. The purpose and conduct of the study are described, and results of the analyses conducted during the first year are summarized. Plans for the remainder of the project are outlined. GRA

N78-13617# Oklahoma Univ., Norman. Science and Public Policy Program.
ENERGY FROM THE WEST: A PROGRESS REPORT OF A TECHNOLOGY ASSESSMENT OF WESTERN ENERGY RESOURCE DEVELOPMENT. VOLUME 2: DETAILED ANALYSIS AND SUPPORTING MATERIALS Final Report, Jul. 1975 - Mar. 1977
Irvin L. White, Michael A. Chartock, R. Leon Leonard, Steven C. Ballard, and Martha W. Gilliland Jun. 1977 842 p refs
(Contract EPA-68-01-1916)
(PB-271753/6; EPA-600/7-77-072b-Vol-2) Avail: NTIS HC A99/MF A01 CSCL 08I

A progress report is presented of a three year technology assessment of the development of six energy resources in eight western states. Detailed analytical results are provided along with an analysis of the likely impacts of deploying typical energy resource development technologies at sites representative of the kinds of conditions likely to be encountered in the eight state study area. The impacts likely to occur if western energy resources are developed at three different levels from the present to the year 2000 were also examined. GRA

N78-13618# Oklahoma Univ., Norman. Science and Public Policy Program.
ENERGY FROM THE WEST: A PROGRESS REPORT OF A TECHNOLOGY ASSESSMENT OF WESTERN ENERGY RESOURCE DEVELOPMENT. VOLUME 3: PRELIMINARY POLICY ANALYSIS Final Report, Jul. 1975 - Mar. 1977
Irvin L. White, Michael A. Chartock, R. Leon Leonard, Steven C. Ballard, and Martha W. Gilliland Jun. 1977 194 p refs
(Contract EPA-68-01-1916)
(PB-271754/4; EPA-600/7-77-072c-Vol-3) Avail: NTIS HC A09/MF A01 CSCL 08I

The political and institutional context of policymaking for western energy resource development is described, and a detailed discussion of selected related problems and issues is presented. GRA

N78-13619# Oklahoma Univ., Norman. Science and Public Policy Program.
ENERGY FROM THE WEST: A PROGRESS REPORT OF A TECHNOLOGY ASSESSMENT OF WESTERN ENERGY RESOURCE DEVELOPMENT. VOLUME 4: APPENDICES Final Report, Jul. 1975 - Mar. 1977
Irvin L. White, Michael A. Chartock, R. Leon Leonard, F. Scott Lagrone, and C. Patrick Bartosh Jul. 1977 219 p refs
(Contract EPA-68-01-1916)
(PB-272243/7; EPA-600/7-77-072d-Vol-4) Avail: NTIS HC A10/MF A01 CSCL 08I

This progress report presents two appendices on air quality modeling and energy transportation costs. GRA

N78-13620# Energy Research and Development Administration, Washington, D. C.
PROCEEDINGS OF A SEMINAR ON INTERNATIONAL ENERGY
1975 228 p Seminar held at Washington, D. C., 9-10 Jun. 1975 Prepared in cooperation with NSF, and R and D Assoc., Marina Del Rey, Calif.
(ERDA-79) Avail: NTIS HC A11/MF A01
The following issues were discussed: identifying policy problems, developing options, clarifying the issues, understanding the possible consequences of actions, and making the information available to the policymakers. Separate abstracts are included here for the three sessions: Policy issues of Concern to Government Decision-Makers, Analytical Capabilities; and Information Needs and Availability. The discussions following each session are included after the formal presentations. ERA

N78-13621# Puerto Rico Water Resources Authority, San Juan. Electrical Planning and Research Div.
IMPACT OF SOLAR HEATING AND COOLING ON ELECTRIC UTILITIES Final Report
Nestor R. Ortiz, Rafael Lavina, Jr., Jesus A. Sanchez, Wenceslao Torres, and Jose A. Intron 29 Dec. 1976 92 p
(Grant NSF APR-75-18301)
(PB-271415/2; NSF/RA-760595) Avail: NTIS HC A05/MF A01 CSCL 13B
The possible effect of solar heating and cooling systems on the base load, peak demand, generating system, transmission system, and financial structure of the Puerto Rico Water Resources Authority was investigated. Heating and cooling loads were defined in terms of their number, their energy consumption, and their load pattern. Estimates of their load were validated through load survey measurments on a selected statistical sample. The effect of solar heating and cooling on the utility was found to be of minor significance although a revision of the existing rate structure would be required within three or four years. GRA

N78-13623# NATO Committee on the Challenges of Modern Society, Brussels (Belgium).
CCMS SOLAR ENERGY PILOT STUDY: REPORT OF THE ANNUAL MEETING
Redfield W. Allen (Maryland Univ., College Park) and Sheila Blum (Maryland Univ., College Park) May 1977 223 p Meeting held at Copenhagen, 13-15 Sep. 1976 Sponsored in part by ERDA
(PB-271797/3; NATO/CCMS-54) Avail: NTIS HC A10/MF A01 CSCL 10A
Presentations made by representatives of participating countries are reported. National solar heating and cooling programs were described and summaries of special reports prepared during 1976 in accordance with the CCMS system reporting format were presented as were previews of upcoming projects. Summaries of major topics covered during the general discussion session are also included, as are additional sections on pilot study activities. GRA

N78-13624# Bureau of Mines, Pittsburgh, Pa. Mining and Safety Research Center.
GEOLOGY AND GAS CONTENT OF COALBEDS IN VICINITY OF BUREAU OF MINES, BRUCETON, PA. Report of Investigations, 1977
Curtis H. Elder and Meherwan C. Irani 1977 28 p refs
(PB-271875/7; BM-RI-8247) Avail: NTIS HC A03/MF A01 CSCL 08I
Degasification test boreholes drilled to depths of 1,238 and 1,212 feet on Bureau of Mines property at Bruceton, Pa. provided detailed geologic information and geologic sections that were correlated with regional stratigraphic cross-sections prepared by the Pennsylvania Geological Survey. Gas content determinations and coal analyses were made on the Upper Freeport, Middle Kittanning, Clarion, Brookville, and Mercer coalbeds. Gas content of the coalbeds ranged from 53 to 165 cu ft per ton. Formation pressure and gas flow tests were conducted on selected coalbed intervals in borehole No. 1. Formation pressures ranged from 292 to 473 psig. The Middle Kittanning coalbed was hydraulically stimulated using very heavy gelled water. Gas production remained low owing to gel residue and formation water inhibiting the flow of gas. Gas contents in Clarion, Upper Brookville, and Mercer coalbeds were anomalously low owing to proximity of porous sandstones that act as reservoirs for gas migrating home coalbeds. GRA

N78-13631# Environmental Protection Agency, Ann Arbor, Mich. Mich. Standards Development and Support Branch.
FORD-EPA EMISSION LABORATORY CORRELATION STUDY
Apr. 1976 27 p
(PB-270699/2; CORR-76-2) Avail: NTIS HC A03/MF A01 CSCL 14B
A specific emissions correlation program between the EPA vehicle Emission Laboratory and the Ford Motor Company AEO facility was completed. Examination of the Ford mass simulator results, gas cross check results, and emission and fuel economy comparisons do not indicate any serious correlation problem between laboratories. GRA

N78-13632# Environmental Protection Agency, Ann Arbor, Mich. Mich. Standards Development and Support Branch.
EPA-BMW CORRELATION PROGRAM
May 1975 12 p
(PB-270559/8; CORR-75-2) Avail: NTIS HC A02/MF A01 CSCL 14B
Exhaust emission and gas cylinder analysis data were gathered at the EPA laboratory and at the new BMW test facility in Farmington. The laboratories agreed closely in the measurement of CO. Although there were significant differences in the measured levels of HC, NOx, and CO2, it is believed that these discrepancies were caused by differences in dynamometer type and ambient conditions. Because of the limited amount of testing done, it was not possible to generate ambient correlation factors for the exhaust emissions. GRA

N78-13633# Environmental Protection Agency, Ann Arbor, Mich. Standards Development and Support Branch.
TYPICAL VEHICLE DIURNAL
Gary M. Wilson and Thomas Rarick Oct. 1976 62 p refs
(PB-270690/1; EVAP-76-3) Avail: NTIS HC A04/MF A01 CSCL 13B
Fuel evaporative emissions, as a result of the daily range in temperature to which the fuel tank is exposed, were studied. Evaporative diurnal losses were simulated by artificially heating the fuel tank over a one hour period, such that the tank fuel underwent a temperature excursion from 60 to 84 F. An evaluation of the differences between a real life diurnal and a simulated test procedure was made using data gathered from an instrumented fuel tank. The mechanisms involved in the evolution of hydrocarbon vapors from a vehicle fuel tank were of primary concern. GRA

N78-13644# Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.
PATHWAYS OF TRACE ELEMENTS IN THE ENVIRONMENT
Richard J. Raridon 1977 19 p refs Presented at Assoc. Acad. Sci. Advan. of Sci. Conf., Denver, 21 Feb. 1977
(Contract W-7405-eng-26)
(CONF-770210-3) Avail: NTIS HC A02/MF A01

Applications of computer models for air transport (ATM) and hydrologic transport (HTM) to determine the pathways of trace elements, in the environment are discussed. Computed data and measured data are compared for potentially toxic contaminants found in gaseous wastes from fossil-fuel power plants. It is pointed out that meteorological data are required for the air transport model and that for each source it is necessary to know the emission rate, source height, and location relative to the receptor point. Results of studies on ground level SO2 concentrations as a function of distance from a proposed fossil-fuel power plant, the environmental impact of an existing power plant on its surroundings, and in monitoring a 98 hectare watershed for nutrient elements (K, Na, Ca, Mg, N, and P) are discussed. ERA

N78-13645# Research Corp. of New England, Wethersfield, Conn.
TIME-VARIABLE AIR POLLUTANT EMISSION STRATEGIES FOR INDIVIDUAL POWER PLANTS Final Report
Glenn R. Hilst, Richard J. Londergan, and Thomas G. Hopper Apr. 1977 51 p refs
(Grant NSF AEN-75-15168; Proj. 487-1)
(EPRI-EA-418) Avail: NTIS HC A04/MF A01

A basis is provided for the evaluation of the feasibility, operational characteristics, and potential cost savings of sophisticated time-variable emissions control systems. Emphasis is on SO2 emissions from a fossil-fuel power plant. The study utilizes two years of data from a site in the Northern Great Plains region. The data are applied to models for defining and evaluating time histories of pollutant emissions which satisfy all relevant air quality standards and minimize the operational costs of emissions control. Under conservative assumptions as to plant size, effective stack height. The potential for significant cost savings is shown through the use of time variable emissions control systems. ERA

N78-13648# National Oceanic and Atmospheric Administration, Washington, D. C. Marine Assessment Div.
ANALYSIS OF BRINE DISPOSAL IN THE GULF OF MEXICO. 3: CAPLINE SECTOR
Charles A. Burroughs, ed. May 1977 201 p refs
(Contract FEA-CG-13-70040-00)
(PB-271292/5; NOAA-77072523) Avail: NTIS HC A10/MF A01 CSCL 13B

As proposed by the Federal Energy Administration, storage caverns for crude oil will be leached out of salt domes along the Capline Sector of the Louisiana Coast. The saturated brine produced as the caverns are solution mined will be disposed of in the Gulf of Mexico. The potential environmental impact of this disposal is reported and an extensive summary was made of physiographic, meteorological, and oceanographic conditions of the Capline Sector. A comprehensive review is included of ecological conditions of the area. GRA

N78-13650# IIT Research Inst., Chicago, Ill.
CYANIDE REMOVAL FROM PETROLEUM REFINERY WASTEWATER USING POWDERED ACTIVATED CARBON Final Report, Sep. 1975 - Feb. 1977
James E. Huff and Jeffrey M. Bigger Jun. 1977 110 p refs Sponsored by EPA Prepared in cooperation with Ill. Inst. for Environ. Quality, Chicago.
(PB-270862/6; IIEQ-77-08) Avail: NTIS HC A06/MF A01 CSCL 13B

The feasibility of using powered activated carbon (PAC) and cupric chloride for removal of cyanide in refinery wastewaters was investigated. GRA

N78-13657# Environmental Protection Agency, Seattle, Wash.
THE ALASKAN OIL DISPOSITION STUDY: POTENTIAL AIR QUALITY IMPACT OF A MAJOR OFF-LOADING TERMINAL IN THE PACIFIC NORTHWEST
David C. Bray Mar. 1977 123 p refs
(PB-271261/0; EPA-910/9-77-044) Avail: NTIS HC A06/MF A01 CSCL 13B

The air quality impact of a marine oil transfer terminal for Alaskan oil is evaluated. An evaluation of specified sites with regard to present emissions and air quality; the determination of the potential emissions associated with a major crude oil offloading facility; and a preliminary modeling analysis to assess the potential air quality problems which might be associated with the operation of such a port are included. GRA

N78-13681# Naval Weapons Center, China Lake, Calif.
COSO GEOTHERMAL CORROSION STUDIES Final Report
Stephen A. Finnegan Oct. 1977 92 p refs
(AD-A045511; NWC-TP-5974) Avail: NTIS HC A05/MF A01 CSCL 11/6

This report documents the results of geothermal corrosion studies conducted at the Coso Thermal Area, Naval Weapons Center, China Lake, California. Nine different common construction-grade piping materials were tested for periods up to about one year in three distinctive low-pressure, medium temperature environments (acid-sulfate steam, groundwater-diluted steam, and hot mineralized alkaline water) under anaerobic and aerobic conditions. Exposed specimens were analyzed principally by optical microscopy and X-ray diffraction techniques, and selectively by scanning electron microscopy, X-ray fluorescence, and atomic absorption spectroscopy. Corrosion/erosion modes, rates, and principal insoluble corrosion products were established and mechanisms based on established theory proposed to account for the modes of deterioration. Corrosion results were compared for the three fluid systems, and specific materials were then recommended for use in each of the fluid types found at the Coso Thermal Area. Author (GRA)

N78-13849# Joint Publications Research Service, Arlington, Va.
TRANSLATIONS ON EASTERN EUROPE: SCIENTIFIC AFFAIRS, NO. 566
6 Dec. 1977 37 p Transl. into ENGLISH from Selected Foreign Periodicals (Hungary)
(JPRS-70283) Avail: NTIS HC A03/MF A01

Scientific research efforts in Hungary and Romania are reviewed, including articles concerning the programs of the Biological Research Center of Hungary, a review of the central party science policy in Hungary, and equipment developments and recovery maximization techniques of the Romanian petroleum industry. J.H.

N78-13890# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HIGH-TEMPERATURE, HIGH-POWER-DENSITY THERMIONIC ENERGY CONVERSION FOR SPACE
James F. Morris 23 Nov. 1977 17 p refs
(NASA-TM-73844; E-9431) Avail: NTIS HC A02/MF A01 CSCL 20I

Theoretic converter outputs and efficiencies indicate the need to consider thermionic energy conversion (TEC) with greater power densities and higher temperatures within reasonable limits for space missions. Converter-output power density, voltage, and efficiency as functions of current density were determined for 1400-to-2000 K emitters with 725-to-1000 K collectors. The results encourage utilization of TEC with hotter-than-1650 K emitters and greater-than-6W sq cm outputs to attain better efficiencies, greater voltages, and higher waste-heat-rejection temperatures for multihundred-kilowatt space-power applications. For example, 1800 K, 30 A sq cm TEC operation for NEP compared with the 1650 K, 5 A/sq cm case should allow much lower radiation weights, substantially fewer and/or smaller emitter heat pipes, significantly reduced reactor and shield-related weights, many fewer converters and associated current-collecting bus bars, less power conditioning, and lower transmission losses. Integration of these effects should yield considerably reduced NEP specific weights. Author

N78-13903# McDonnell-Douglas Astronautics Co., St. Louis, Mo.
MAJOR FEATURES OF D-T TOKAMAK FUSION REACTOR SYSTEMS Interim Report
J. W. Davis and G. L. Kulcinski (Wisconsin Univ., Madison) Feb. 1976 34 p refs
(EPRI-472-1) Avail: NTIS HC A03/MF A01

A set of tables were compiled to summarize and compare various designs of fusion-fission reactors based on the Tokamak configuration. The designs range from present-day experimental devices to conceptual commercial power units and are comprised of four near-term (approximately or less than 1985), five mid-term (approximately or less than 1990), and ten long-range (approximately 2000-2020) reactor designs. Besides the usual plasma physics parameters, individual tables characterize the reactor geometry and power plant system, the blanket and shield, the primary coolant systems, tritium breeding and inventory requirements, neutronics (including energy deposition and after heat), radiation damage, magnetic parameters, power cycles, and economic and resource requirements. ERA

N78-13967# Occidental Research Corp., La Verne, Calif.
PRYOLSIS OF INDUSTRIAL WASTES FOR OIL AND ACTIVATED CARBON RECOVERY Final Report, Aug. 1972 - Mar. 1975
F. B. Boucher, E. W. Knell, G. T. Preston, and G. M. Mallan May 1977 192 p
(Grant EPA-S-801202)
(PB-270961/6; EPA-600/2-77-091) Avail: NTIS HC A09/MF A01 CSCL 13B

A flash pyrolysis process was developed which can produce up to two barrels of synthetic fuel oil from a ton of dry cellulosic solids. The results are presented of a four-phase laboratory, pilot plant, product evaluation and engineering evaluation program to study the pyrolytic conversion of Douglas fir bark, rice hulls, grass straw and animal feedlot waste to synthetic fuel oil and char. A wax by-product was obtained from the pyrolysis of fir bark and grass straw. Excellent pilot plant material balances were obtained for oil production runs on Douglas fir bark and rice hulls, and these were satisfactorily combusted in a standard test boiler. Tree bark char was satisfactorily compressed to produce excellent quality charcoal briquettes. The economic evaluation shows that a 1200 dry ton/day tree bark conversion plant could be built and operated with a profit of about $10/ton of dry bark. GRA

N78-13970# Pennsylvania Univ., Philadelphia. Transportation Studies Center.
A STUDY OF EFFICIENCY INDICATORS OF URBAN PUBLIC TRANSPORTATION SYSTEMS Final Report
Anthony R. Tomazinis Jan. 1977 324 p refs
(Contract DOT-OST-50228)
(PB-270940/0; DOT-TST-77-47) Avail: NTIS HC A14/MF A01 CSCL 13B

A research project was undertaken on efficiency problems of urban public transportation systems (UPTS). The UPTS are first divided into three major system components, i.e. primary services, support functions, and the network. Then each system is divided by mode, and each component by each distinct function carried within the system component. The inputs to the system are also divided by type, i.e. labor, capital, and energy, and according to the contributor, i.e. the operator, the direct user, the society at large, and the government at all levels. Input units are also traced in terms of money costs and physical units. Efficiency analysis is then explored in a hierarchical manner exploring three types of relationships, i.e. system inputs vs. system outputs; component inputs vs. component inputs; and component outputs vs. component outputs. Efficiency indicators are then discussed as to the type of useful service they may offer in various types of efficiency analysis problems. GRA

N78-13975# Municipality of Metropolitan Seattle, Wash.
MAGIC CARPET EVALUATION STUDY Final Report
May 1977 110 p Sponsored by UMTA
(PB-271214/9; UMTA-WA-09-0012-77-1) Avail: NTIS HC A06/MF A01 CSCL 13B

The fare-free zone, Magic Carpet, evaluation project is described. It consists of a series of surveys aimed at measuring the effectiveness of downtown free buses in achieving improvement of downtown air quality, reduction of traffic congestion, conservation of gasoline, and stimulation of retail trade. Surveys indicate that fare-free bus service is responsible for attracting at least $5,000,000 in retail sales. The findings have encouraged the Seattle and Metro Councils to continue this service for at least two more years, at a cost to the city of $100,000 per year. GRA

N78-13976# Trans Systems Corp., Vienna, Va.
ASSESSMENT OF BATTERY BUSES Final Report, Mar. - Jul. 1977
Jul. 1977 156 p refs
(Contract DOT-UT-70056)
(PB-271321/2; TS-102; UMTA-VA-06-0044-77-1) Avail: NTIS HC A08/MF A01 CSCL 13F

A comprehensive assessment is given of the performance of electric battery buses operating in passenger-carrying services in the United States, Europe, Japan, and Australia. The survey assessed 16 different systems from 15 suppliers, operating under 18 public transit authorities. These operations varied from single demonstration vehicles to a fleet of 20 buses which provide all the transit service on three routes. The scope of this report includes description of buses and propulsion systems, analysis of data and conclusions about the problems and constraints in the procurement and operation of electric buses. The study also addresses hybrid propulsion systems such as trolley-battery and diesel-battery hybrids. GRA

N78-14170 Stanford Univ., Calif.
DIELECTRIC RELAXATION IN POLYMERS AT LOW TEMPERATURES Ph.D. Thesis
Richard Alan Thomas 1977 99 p
Avail: Univ. Microfilms Order No. 77-18257

The dielectric loss tangent of a number of solids was measured calorimetrically at liquid helium temperatures and over the audio frequency range to gain a better understanding of the dielectric relaxation mechanisms which give rise to dielectric loss at low temperatures and to examine and test insulating materials that are possible candidates for use in the construction of a superconducting ac power transmission line. The apparatus used is capable of measuring calorimetrically loss tangents as small as 0.6 microradian with a resolution of ten percent of the value at voltages up to ten kilovolts. The conditions necessary to obtain polyethylene exhibiting an intrinsically low dielectric loss tangent of only about five microradians were determined. Dissert. Abstr.

N78-14177*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE AND EMISSIONS OF A CATALYTIC REACTOR WITH PROPANE, DIESEL, AND JET A FUELS
David N. Anderson Sep. 1977 26 p refs Presented at the Fall Meeting, Western States Section of the Combust. Inst., Stanford, Calif., 17-18 Oct. 1977
(Contract EC-77-A-31-1011)
(NASA-TM-73786; CONS/1011-20; E-9349) Avail: NTIS HC A03/MF A01 CSCL 21D

Tests were made to determine the performance and emissions of a catalytic reactor operated with propane, No. 2 diesel, and Jet A fuels. A 12-cm diameter and 16-cm long catalytic reactor using a proprietary noble metal catalyst was operated at an inlet temperature of 800 K, a pressure of 300,000 Pa and reference velocities of 10 to 15 m/s. No significant differences between the performance of the three fuels were observed when 98.5 percent purity propane was used. The combustion efficiency for 99.8-percent purity propane tested later was significantly lower, however. The diesel fuel contained 135 ppm of bound nitrogen and consequently produced the highest NOx emissions of the three fuels. As much as 85 percent of the bound nitrogen was converted to NOx. Steady-state emissions goals based on half the most stringent proposed automotive standards were met when the reactor was operated at an adiabatic combustion temperature higher than 1350 K with all fuels except the 99.8-percent purity propane. With that fuel, a minimum temperature of 1480 K was required. Author

N78-14181# Oak Ridge National Lab., Tenn.
ENERGY SOURCES OF POLYCYCLIC AROMATIC HYDROCARBONS
M. R. Guerin 1977 77 p refs Presented at Conf. on Polycyclic Hydrocarbon Carcinogenesis, New Orleans, 24 Jan. 1977 Sponsored in part by EPA
(Contract W-7405-eng-26)
(Conf-770130-2) Avail: NTIS HC A05/MF A01

Combustion is the predominant end-process by which fossil fuels are converted to energy. Combustion, particularly when inefficient, is also the primary technological source of polycyclic aromatic hydrocarbons (PAHs) released into the environment. The need for liquid fuels to supply the transportation industry and for nonpolluting fuels for heat and power generation provide the incentive to commercialize processes to convert coal to substitute natural gas and oil. These processes represent a potentially massive new source of environmental PAHs. Insuring an adequate supply of energy with minimum impact on the environment and on health is one of the most important, urgent, and challenging goals currently facing science and technology. Polycyclic aromatic hydrocarbon related carcinogenesis is among the most important of possible occupational- and environmental-health impacts of much of the current and projected national energy base. ERA

N78-14182# Los Alamos Scientific Lab., N. Mex.
SYNTHETIC FUEL PRODUCTION FROM SOLID WASTES Final Report
Roy C. Feber and Michael J. Antal (Princeton Univ., N. J.) Sep. 1977 87 p refs
(Contract EPA-IAG-D5-0646)
(PB-272423/5; EPA-600/2-77-147) Avail: NTIS HC A05/MF A01 CSCL 21D

Potential catalysts for the commercial practice of the gasification of chars produced by the pyrolysis of municipal or industrial wastes are evaluated. The potential for synthetic fuel production from solid wastes and the feasibility of providing the heat required for the gasification reactions by coupling a chemical reactor to a solar collector are also examined. A small scale, fixed bed, flow through reactor was assembled, and a number of potential catalysts were tested on chars from a number of sources. Several possible schemes for coupling a solar collector and a gasification reactor are suggested, and economic analyses of the systems are attempted. It is concluded that feasible, economically attractive systems are possible. GRA

N78-14419# Westinghouse Electric Corp., Lester, Pa.
HIGH TEMPERATURE TURBINE TECHNOLOGY PROGRAM. PHASE 1: PROGRAM AND SYSTEM DEFINITION. TOPICAL REPORT: OVERALL PLANT DESIGN DESCRIPTION, LOW BTU COMBINED CYCLE ELECTRIC POWER PLANT
Jan. 1977 211 p
(Contract EX-76-C-01-2290)
(FE-2290-18) Avail: NTIS HC A10/MF A01

A systems design is described for a combined cycle based on a high temperature turbine technology 2600 F combustion turbine operating with a low Btu coal-derived gaseous fuel. The information presented includes material on cycle and plant configuration, site plan, and the control system. In addition, the design requirements of the power plant are defined to include an integrated program on maintenance and reliability. Techniques available to analyze power plant equipment and systems from a reliability and availability viewpoint are described. Finally, a dissertation on various plant operating modes is presented along with a segment on a cycle utilizing an alternate high temperature hot fuel gas cleanup system. ERA

N78-14420# Westinghouse Electric Corp., Lester, Pa.
HIGH TEMPERATURE TURBINE TECHNOLOGY PROGRAM. PHASE 1: PROGRAM AND SYSTEM DEFINITION. TOPICAL REPORT: OVERALL PLANT DESIGN DESCRIPTION LIQUID FUEL COMBINED CYCLE ELECTRIC POWER PLANT
Jan. 1977 123 p
(Contract EX-76-C-01-2290)
(FE-2290-19) Avail: NTIS HC A06/MF A01

A combined cycle plant which utilizes an advanced 2600 F inlet temperature combustion gas turbine engine and burns a coal-derived liquid fuel is described. The plant is intended to serve the base and intermediate loads of a utility system. This operation requires that the equipment be capable of cyclic duty and of starting and accelerating to a full load condition in approximately one hour. The plant is comprised of two air-cooled dual liquid fuel combustion gas turbine engines, each rated at a gross output of 122,663 KW. The 1200 F exhaust heat of each combustion turbine is recovered in an unfired Heat Recovery Steam Generator (HRSG) generating steam at 1800 psig/1000 F/1000 F. The combined heat balance of the plant after allowing 7150 KW for total plant auxiliary power, shows a HHV heat rate of 6966 Btu/KwHr at a net plant output of 383,206 KW. This heat rate translates to an overall efficiency of 49 percent. ERA

N78-14421# Westinghouse Electric Corp., Lester, Pa.
HIGH TEMPERATURE TURBINE TECHNOLOGY PROGRAM. PHASE 1: PROGRAM AND SYSTEM DEFINITION. TOPICAL REPORT: PHASE 3, PRELIMINARY TURBINE SUBSYSTEM TECHNOLOGY READINESS VERIFICATION PROGRAM PLAN Topical Report
Jan. 1977 79 p
(Contract EX-76-C-01-2290)
(FE-2290-21) Avail: NTIS HC A05/MF A01

A proposed plan is presented for the development of the high temperature gas turbine subsystem and the development and integration of the remaining elements required for the timely development of a coal gasification combined-cycle power plant. ERA

N78-14426# Kusko (Alexander), Inc., Needham Heights, Mass.
FLYWHEEL PROPULSION SIMULATION Final Report
Alexander Kusko and Charles M. King May 1977 196 p refs
(Contract DOT-TSC-1180)
(PB-272259/3; UMTA-MA-06-0044-77-1; DOT-TSC-UMTA-77-15) Avail: NTIS HC A09/MF A01 CSCL 13F

The analytical models and digital computer simulations that can be used for the evaluation of flywheel-electric propulsion systems employed with urban transit vehicles operating over specified routes and with predetermined velocity profiles were developed and described. The computer simulation was divided into two sections. The first section simulates the dynamic behavior of the vehicle enroute, computes the energy and power requirements, and the power losses of each of the propulsion system components. The second section uses thermal models to compute the temperature rises of each of the propulsion system components. The simulations can be used to determine the suitability of a given flywheel electric propulsion system for an intended mission. Author

N78-14451# California Univ., Livermore. Lawrence Livermore Lab.
[BIBLIOGRAPHY OF EARTH SCIENCE REPORTS FOR 1976] Annual Report
B. Hornady and A. Duba 20 May 1977 85 p
(Contract W-7405-eng-48)
(UCID-17476-76) Avail: NTIS HC A05/MF A01

This compilation lists abstracts of papers, internal reports, and talks presented during 1976 at national and international meetings by members of the Earth Sciences Division, Lawrence Livermore Laboratory. Subjects include: coal gasification, gas stimulation, geothermal fields, oil shale retorting, radioactive waste management, geochemistry, geophysics, seismology, explosive phenomenology, and miscellaneous studies. ERA

N78-14452* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
IN-SITU LASER RETORTING OF OIL SHALE Patent
Harvey S. Bloomfield, inventor (to NASA) Issued 6 Dec. 1977 5 p Filed 28 Jan. 1977 Supersedes N77-18429 (15 - 09, p 1176)
(NASA-Case-LEW-12217-1; US-Patent-4,061,190; US-Patent-Appl-SN-763753; US-Patent-Class-166-259; US-Patent-Class-166-248) Avail: US Patent Office CSCL 08I

Oil shale formations are retorted in situ and gaseous hydrocarbon products are recovered by drilling two or more wells into an oil shale formation underneath the surface of the ground. A high energy laser beam is directed into the well and fractures the region of the shale formation. A compressed gas is forced into the well that supports combustion in the flame front ignited by the laser beam, thereby retorting the oil shale. Gaseous hydrocarbon products which permeate through the fractured region are recovered from one of the wells that were not exposed to the laser system. Official Gazette of the U.S. Patent Office

N78-14497*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ENERGY AND REMOTE SENSING
R. A. Summers (ERDA, Washington, D. C.), W. L. Smith (ERIM), and N. M. Short *In* ERIM Proc. of the 11th Intern. Symp. on Remote Sensing of Environment, Vol. 1 1977 p 467-481 refs (For availability see N78-14464 05-43)
Avail: NTIS HC A99/MF A01 CSCL 10B

Effective implementation of the President's National Energy Plan and the Nuclear Power Policy Statement require application of the best remote sensing tools available. The potential contributions of remote sensing, particularly LANDSAT data, have yet to be clearly identified and exploited. These contributions investigated fall into the following categories: (1) exploration; (2) exploitation; (3) power plant siting; (4) environmental assessment and monitoring; and (5) transportation infrastructure. Author

N78-14566*# Canada Centre for Remote Sensing, Ottawa (Ontario).
USE OF AERIAL THERMOGRAPHY IN CANADIAN ENERGY CONSERVATION PROGRAMS
J. Cihlar, R. J. Brown, G. Lawrence (Ontario Centre for Remote Sensing), J. N. Barry (Lapp Limited, Toronto, Canada), and R. B. James (Office of Energy Conservation, Ottawa) *In* ERIM Proc. of the 11th Intern. Symp. on Remote Sensing of Environment, Vol. 2 1977 p 1197-1206 refs (For availability see N78-14529 05-43)
Avail: NTIS HC A99/MF A01 CSCL 08B

Recent developments in the use of aerial thermography in energy conservation programs within Canada were summarized Following a brief review of studies conducted during the last three years, methodologies of data acquisition, processing, analysis and interpretation was discussed. Examples of results from an industrial oriented project were presented and recommendations for future basic work were outlined Author

N78-14610# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
APPLICATION OF REMOTE SENSING TO GEOTHERMAL ANOMALY MAPPING IN THE CALDAS NOVAS COUNTY, GOIAS M.S. Thesis [APLICACAO DE SENSORIAMENTO REMOTO NO ESTUDO DE ANOMALIA GEOTERMAL NO MUNICIPIO DE CALDAS NOVAS, GOIAS]

Celio Eustaquio DosAnjos Oct. 1977 173 p refs In PORTUGUESE; ENGLISH summary
(INPE-1129-TPT/070) Avail: NTIS HC A08/MF A01

The geothermal anomaly of Caldas Novas county in the state of Goias was mapped. Systematic research was carried out combining geological mapping with surface and subsurface temperature measurements. LANDSAT-1 images of the region were studied allowing the placement of the area in regional geological context. The origins and evolution of the geothermal anomaly were also considered. Geological mapping was done to the scale of 1:60 using USAF aerial photography. Regional temperature mapping was done using trend surface analysis. Through the correlation of these data, four different areas were localized which have a high potential for hot water prospecting. Author

N78-14626+ National Center for Scientific and Technical Documentation, Brussels (Belgium).
UNCONVENTIONAL ENERGY SOURCES. A SELECT BIBLIOGRAPHY
E. H. Lapeysen, comp. Feb. 1974 64 p refs
(NCWTD-CNDST-Bib-6) Avail: NTIS HC A04

A total of 680 references to articles covering economics, statistics, and prospects; geothermal energy; prospects towards new policies; solar energy; and tidal energy and wind power are listed. There are no subject or author indexes. ESA

N78-14627+ National Center for Scientific and Technical Documentation, Brussels (Belgium).
WIND POWER SYSTEMS. A SELECT BIBLIOGRAPHY
Eduard H. Lapeysen, comp. Jan. 1977 58 p refs
(NCWTD-CNDST-Bib-7) Avail: NTIS HC A04

The list includes 331 reports, articles, conference papers, and other documents concerning wind energy policy, conversion, technology, and transfer. A subject index is included. ESA

N78-14628*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
REAL-TIME AND ACCELERATED OUTDOOR ENDURANCE TESTING OF SOLAR CELLS
Americo F. Forestieri and Evelyn Anagnostou Aug. 1977 26 p refs Presented at 1977 Photovoltaics Solar Energy Conf., Luxembourg, 27-30 Sep. 1977; sponsored by Comm. of the European Communities Sponsored in part by ERDA
(Contract E(49-26)-1022)
(NASA-TM-73743; E-9310; ERDA/NASA/1022/77/17) Avail: NTIS HC A03/MF A01 CSCL 10A

Real-time and accelerated outdoor endurance testing was performed on a variety of samples of interest to the National Photovoltaic Conversion Program. The real-time tests were performed at seven different sites and the accelerated tests were performed at one of those sites in the southwestern United States. The purpose of the tests were to help evaluate the lifetime of photovoltaic systems. Three types of samples were tested; transmission samples of possible cover materials, sub-modules constructed using these materials attached to solar cells, and solar cell modules produced by the manufacturers for the ERDA program. Results indicate that suitable cover materials are glass, FEP-A and PFA. Dirt accumulation and cleanability are important factors in the selection of solar cell module covers and encapsulants. Author

N78-14629*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
US TERRESTRIAL SOLAR CELL CALIBRATION AND MEASUREMENT PROCEDURES
Henry W. Brandhorst, Jr. Sep. 1977 16 p refs Presented at 1977 Photovoltaics Solar Energy Conf., Luxembourg, 27-30 Sep. 1977; sponsored by Comm. of the European Communities Sponsored in part by ERDA
(Contract E(49-26)-1022)
(NASA-TM-73788; E-9353; ERDA/NASA/1022/77/20) Avail: NTIS HC A02/MF A01 CSCL 10A

A workshop was held in the fall of 1976, to evaluate and revise interim terrestrial solar cell calibration and measurement procedures. The revisions made to the interim testing procedures are described. The calibration of reference cells and the design of their holders are covered. Considerations include view angle and optical and thermal matching. Atmospheric factors which affect the calibration and performance of solar cells are discussed. The most critical atmospheric parameter appears to be water vapor. Techniques for matching reference cells to cells or arrays under test are described. Data showing errors in performance under artificial sunlight simulators due to mismatch of reference and test cells are presented. Finally, measurement procedures and data transformations needed to obtain the performance of solar cells and arrays in outdoor natural sunlight are described. Author

N78-14630*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SOLAR ENERGY METER
R. M. Masters Sep. 1977 12 p ref Sponsored in part by ERDA
(Contract E(49-26)-1022)
(NASA-TM-73791; E-9358; ERDA/NASA/1022/77/21) Avail: NTIS HC A02/MF A01 CSCL 10A

An instrument was developed to continually integrate the energy available in incident light on a specifically oriented surface. The unit was designed for outdoor use in remote locations and is capable of operation over a temperature range of -20 to +60 C with good accuracy. The unit is weather resistant, requires low power, has a high input impedance, is inexpensive, and has a visual readout and an analog output for recording. Author

N78-14632*# Grumman Aerospace Corp., Bethpage, N.Y.
THERMAL ENERGY STORAGE HEAT EXCHANGER: MOLTEN SALT HEAT EXCHANGER DESIGN FOR UTILITY POWER PLANTS Final Report, Jul. 1976 - Jul. 1977
Angelo Ferarra, George Yenetchi, Robert Haslett, and Robert Kosson Oct. 1977 207 p refs
(Contract NAS3-20117)
(NASA-CR-135244) Avail: NTIS HC A10/MF A01 CSCL 10C

The use of thermal energy storage (TES) in the latent heat of molten salts as a means of conserving fossil fuels and lowering the cost of electric power was evaluated. Public utility systems provided electric power on demand. This demand is generally maximum during late weekday afternoons, with considerably lower overnight and weekend loads. Typically, the average demand is only 60% to 80% of peak load. As peak load increases, the present practice is to purchase power from other grid facilities or to bring older less efficient fossil-fuel plants on line which increase the cost of electric power. The widespread use of oil-fired boilers, gas turbine and diesel equipment to meet peaking loads depletes our oil-based energy resources. Heat exchangers utilizing molten salts can be used to level the energy consumption curve. The study begins with a demand analysis and the consideration of several existing modern fossil-fuel and nuclear power plants for use as models. Salts are evaluated for thermodynamic, economic, corrosive, and safety characteristics. Heat exchanger concepts are explored and heat exchanger designs are conceived. Finally, the economics of TES conversions in existing plants and new construction is analyzed. The study concluded that TES is feasible in electric power generation. Substantial data are presented for TES design, and reference material for further investigation of techniques is included. Author

N78-14633*# Grumman Aerospace Corp., Bethpage, N.Y.
THERMAL ENERGY STORAGE HEAT EXCHANGER: MOLTEN SALT HEAT EXCHANGER DESIGN FOR UTILITY POWER PLANTS Topical Report, Jul. 1976 - Jul. 1977
Angelo Ferarra, George Yenetchi, Robert Haslett, and Robert Kosson Oct. 1977 36 p refs
(Contract NAS3-20117)
(NASA-CR-135245) Avail: NTIS HC A03/MF A01 CSCL 10C

Sizing procedures are presented for latent heat thermal energy storage systems that can be used for electric utility off-peak energy storage, solar power plants and other preliminary design applications. Author

N78-14634# Sandia Labs., Albuquerque, N. Mex.
OPTIMUM OPERATING CONDITIONS FOR A CYLINDRICAL PARABOLIC FOCUSING COLLECTOR/RANKINE POWER GENERATION CYCLE SYSTEM
M. W. Edenburn 1977 18 p refs Presented at 12th Intersociety Energy Conversion Eng. Conf., Wash., D. C., 28 Aug. 1977
(Contract EY-C-04-0789)
(SAND-75-6132; Conf-770804-2) Avail: NTIS HC A02/MF A01

System operating temperatures, boiler pressure, and associated parameters which maximize solar to electric conversion efficiency and which minimize collector/storage/power cycle system costs were determined for an electrical generation system which uses cylindrical parabolic focusing collectors as a source of heat, a stratified liquid unit for storage, and a Rankine power generation cycle for electrical generation. To perform a parametric study of the system, the analysis used an experimentally verified solar energy collector model to predict collector energy output as a function of inlet temperature, outlet temperature and fluid flow rate; a Rankine cycle model to predict cycle efficiency and heating fluid outlet temperature as a function of peak superheat temperature and boiler pressure; and a daily cycling storage unit model. The study shows that electrical generation efficiency is maximized by using a peak superheat temperature of 635 K (683 F); but, when storage cost is considered, the minimum cost system uses a peak superheat temperature of 686 K (775 F) and a boiler pressure of 2.76 MN/sq m. ERA

N78-14636# Solarex Corp., Rockville, Md.
NONREFLECTING VERTICAL JUNCTION SILICON SOLAR CELL OPTIMIZATION Interim Report, May 1976 - May 1977
John Wohlgemuth, J. Lindmayer, and A. Scheinine Jul. 1977 83 p refs
(Contract F33615-76-C-2058; AF Proj. 3145)
(AD-A046150; AFAPL-TR-77-38) Avail: NTIS HC A05/MF A01 CSCL 10/2

This work on nonreflective vertical-junction silicon solar cells has resulted in high conversion efficiency radiation resistant solar cells. New techniques of oxidation growth and the use of photolothography enable the use of an orientation dependent etch to produce grooves 5-10 microns wide and over 100 microns deep. These silicon wafers have been processed into solar cells with all of the processes performed at temperatures compatible with producing high efficiency solar cells. A theoretical calculation of the generated current for the vertical junction structure was performed. It indicates the decreased dependence on carrier diffusion length and, therefore, the reduced effect of radiation damage on collection efficiency for vertical junction solar cells. Vertical junction solar cells 2 cm x 2 cm in size have been fabricated with AMO conversion efficiencies greater than 13%. These cells have shown superior radiation resistance. Author (GRA)

N78-14639# Oak Ridge National Lab., Tenn.
MOLTEN CARBONATE FUEL CELL RESEARCH AT ORNL
J. Braunstein, H. R. Bronstein, S. Cantor, D. Heatherly, and C. E. Vallet May 1977 25 p refs
(Contract W-7405-eng-26)
(ORNL/TM-5886) Avail: NTIS HC A02/MF A01

The activities described include a literature survey on molten carbonates, design, acquisition and installation of apparatus for experimental studies of molten carbonates, initial experiments on materials compatibility with molten carbonates, electrolysis experiments for the determination of transference numbers, and theoretical studies of transport behavior and the coupling of mass flows in molten carbonate mixtures. Significant accomplishments were the theoretical prediction of a possibly appreciable change in the alkali ion ratio at molten carbonate fuel cell electrodes, operated at high current densities, as a result of mobility differences of the alkali ions; design, construction and assembly of an electrolysis cell, and initiation of measurements of composition profiles in mixed alkali carbonate electrolytes; initiation of differential scanning calorimetry of pure alkali carbonates for quantitative measurement of transition enthalpies, eventually leading to new, more reliable values of the enthalpies and free energies of formation of the pure and mixed carbonates. ERA

N78-14641# Energy Research and Development Administration, Washington, D. C. Div. of Conservation Research and Technology.
MODELING AND ANALYSIS OF INDUSTRIAL ENERGY USAGE Workshop Summary Report 21-23 Jun. 1976
1976 123 p refs
(Contract EX-76-C-10-3835)
(MTR-7329) Avail: NTIS HC A06/MF A01

A program plan for promoting the use and dissemination of advanced modeling techniques to achieve energy conservation was developed. Seven working sessions were conducted concurrently to draft specific recommendations for government, industry, and university participation in selected aspects of the program. Conclusions and recommendations developed in each working session are presented. ERA

N78-14642# Sandia Labs., Albuquerque, N. Mex.
SOLAR IRRIGATION PROGRAM PLAN, REVISION
Robert L. Alvis and S. G. Vandevender Jun. 1977 33 p refs
(Contract EY-76-C-04-0789)
(SAND-77-0730-Rev) Avail: NTIS HC A03/MF A01

The Energy Research and Development Administration (ERDA) solar irrigation program is described. The updated goals of the plan are listed, the participants named, and their responsibilities outlined. ERDA has the program responsibility, and ERDA field offices the contractural responsibility. Three solar irrigation experiments planned, system analyses to be conducted, and the participants of the program are discribed. This document is intended to be used as a program guide for accomplishing the program goals. ERA

N78-14643# Energy Research and Development Administration, Washington, D. C. Div. of Solar Energy.
PROGRAM RESEARCH AND DEVELOPMENT ANNOUNCEMENT (PRDA). SOLAR COLLECTOR MATERIALS AND FLUIDS FOR SOLAR HEATING AND COOLING APPLICATIONS
10 May 1977 53 p
(PRDA-EG-77-D-29-0003) Avail: NTIS HC A04/MF A01

Research proposals are solicited in the following areas: (1) development of superior liquid coolants; (2) development of corrosion inhibitors for aqueous coolants; (3) development of freeze protection methods; (4) nonglass glazings and surface coating; (5) solar anti-reflective coatings and etching and infrared reflective coatings for glass; (6) glazing breakage; (7) development of selective surfaces; (8) low cost innovative absorbers; (9) development of improved sealants; (10) development of improved breathing control techniques; and (11) development of improved insulation materials. ERA

N78-14644# Battelle Pacific Northwest Labs., Richland, Wash.
GEOCITY: A COMPUTER CODE FOR CALCULATING COSTS OF DISTRICT HEATING USING GEOTHERMAL RESOURCES
C. L. McDonald, C. H. Bloomster, and S. C. Schulte Feb. 1977 80 p refs
(Contract EY-76-C-06-1830)
(BNWL-2208) Avail: NTIS HC A05/MF A01

A computer simulation model (GEOCITY) developed to study the economics of district heating using geothermal energy is described. The cost of district heating based on climate, population, resource characteristics, and financing conditions is calculated. The principal input variables are minimum temperature, heating degree days, population size and density, resource temperature and distance from load center, and the interest rate. From this input data the model designs the transmission and district heating systems. From this design, GEOCITY calculates the capital and operating costs for the entire system, including the production and disposal of the geothermal water. The distribution system model calculates the cost of heat by simulating the design and the operation of the district heating system. The reservoir model calculates the cost of energy by simulating the discovery, development, and operation of a geothermal resource and the transmission of this energy to a distribution center. ERA

N78-14645# General Electric Co., Philadelphia, Pa. Space Div.
WIND ENERGY MISSION ANALYSIS, EXECUTIVE SUMMARY
18 Feb. 1977 28 p
(Contract EY-76-C-02-2578)
(COO-2578-1-1) Avail: NTIS HC A03/MF A01

High-potential applications, functional, performance, operational, and cost goals for wind energy conversion systems and the impact of the wide-scale deployment of such systems on energy users were evaluated. The institutional and nontechnical problems associated with the acceptance of wind energy were also studied. Emphasis was placed on identifying and exploring high-aggregate energy users who have significant potential to utilize wind energy in place of other alternatives. ERA

N78-14646# General Electric Co., Philadelphia, Pa. Space Div.
WIND ENERGY MISSION ANALYSIS Final Report
18 Feb. 1977 252 p refs
(Contract EY-76-C-02-2578)
(COO-2578-1-2) Avail: NTIS HC A12/MF A01

The development of wind energy systems in the U.S. is discussed under the following headings: baseline power systems, assessment of wind potential, identification of high potential applications, electric utilities, residential application, paper industry application, agriculture application, and remote community applications. ERA

N78-14647# General Electric Co., Philadelphia, Pa. Space Div.
WIND ENERGY MISSION ANALYSIS, APPENDICES A-J Final Report
18 Feb. 1977 504 p
(Contract EY-76-C-02-2578)
(COO-2578-1-3) Avail: NTIS HC A22/MF A01

Information is presented concerning meteorological data and supporting analyses, gross energy consumption patterns and end-use analysis, as well as analysis for industrial applications of wind energy conversion systems (WECS). Also presented is an analysis for residential applications of WECS, an analysis for application of WECS to communities remote from utility grids, an analysis for agricultural applications of WECS, a regional evaluation of the economics of wind turbine generation to the U. S. electric utility district, impact of storage on WECS, financial analysis techniques, and system spacing. ERA

N78-14648# Honeywell, Inc., Minneapolis, Minn. Systems and Research Center.
OPTIMIZATION OF COATINGS FOR FLAT PLATE SOLAR COLLECTORS, PHASE 2 Progress Report, 28 Jun. - 31 Dec. 1976
R. J. H. Lin Jan. 1977 78 p refs
(Contract EY-76-C-02-2930)
(COO-2930-4) Avail: NTIS HC A05/MF A01

Optical coatings that would enhance the economic feasibility of flat plate solar collectors were studied. Etched and dipcoated antireflection coatings and selective absorbing plated and paint coatings that are low cost, and optically efficient coatings were investigated. A selective paint coating, applied by dip coating, was developed with solar absorptance of 0.92 and room temperature emittance of 0.13. The coating cost was estimated at less than 5 cents/sq ft, a factor of at least 10 lower than the selective plated coatings investigated. Black chrome was shown to endure at least 30 days in an accelerated humidity test with no degradation. The black chrome coating life was estimated to be greater than 20 years. ERA

N78-14649# Virginia Univ., Charlottesville. Dept. of Mechanical Engineering.
ANNUAL COLLECTION AND STORAGE OF SOLAR ENERGY FOR THE HEATING OF BUILDINGS Progress Report, May - Nov. 1976
J. Taylor Beard, J. W. Dickey, F. A. Iachetta, and L. U. Lilleleht Jan. 1977 32 p
(Contract EY-76-S-05-5136)
(ORO-5136-76/1; Rept-1) Avail: NTIS HC A03/MF A01

The system is composed of an energy storage sub-system which stores hot water in an underground pool and of a solar collector sub-system which acts not only to collect solar energy throughout the year but also to limit the evaporative and convective heat losses from the storage system. A storage sub-system was constructed using the initial design specifications. A structural failure of that storage pool occurred in August resulting from a leak in the pool liner which caused a failure of the pool structure. A revised design of the storage pool sub-system was implemented and construction was completed. The collector sub-system was designed and constructed. ERA

N78-14650# JBF Scientific Corp., Washington, D. C.
SUMMARY OF CURRENT COST ESTIMATES OF LARGE WIND ENERGY SYSTEMS
Feb. 1977 64 p
(Contract EX-76-C-01-2521)
(DSE/2521-1) Avail: NTIS HC A04/MF A01

The Federal Wind Energy Program, over the past two years has substantially extended the state of knowledge about the costs and performance of large Wind Energy Conversion Systems (WECS). Much of this progress was achieved as a result of a series of ERDA sponsored studies dealing with the system design, mission analysis, and regional applicability of WECS. This report reviews these studies, summarizes the most pertinent results, and provides a view of the current status and uncertainties surrounding the economics of generating energy from the wind for electric utility applications. ERA

N78-14651# Brookhaven National Lab., Upton, N. Y. Dept. of Applied Science.
PROSPECTS FOR THE UTILIZATION OF WASTE HEAT IN LARGE SCALE DISTRICT HEATING SYSTEMS
J. Karkheck and J. Powell 1977 27 p refs Presented at Conf. on Waste Heat Management and Util., Miami Beach, Fla., 9 May 1977
(BNL-22559; Conf-770516-2) Avail: NTIS HC A03/MF A01

Analyses of model district heating systems for nine U.S. urban areas, including projected heat costs, are presented. In addition, projections of nationwide levels of implementation of district heating systems are discussed. Results show that about half of the current population could be served through district heating at heat cost levels equal to the effective heat cost of imported oil. ERA

N78-14652# General Atomic Co., San Diego, Calif.
LARGE CLOSED-CYCLE GAS TURBINE PLANT
C. F. McDonald 1977 265 p refs Presented at AGARD lecture series on closed-cycle gas turbines, Brussels, Belgium, 9 May 1977
(Contract EY-76-C-03-0167-046)
(GA-A-14311; Conf-770540-1) Avail: NTIS HC A12/MF A01

An application of the closed-cycle gas turbine for electrical power generation is a plant with a high temperature gas cooled reactor (HTGR) as the heat source, and this paper presents the design studies for a 1200 MW(e) plant. The GT-HTGR plant combines the existing HTGR core with a closed-cycle helium gas turbine power conversion system which operates on the same helium used as the reactor coolant. In this series of lectures a summary is given of the design evolution for a large nuclear closed-cycle gas turbine power plant study for U.S. utility central stations. The presentation includes a background on closed-cycle gas turbines, the incentives for the GT-HTGR, cycle selection, plant configuration studies, performance, selection of a reference plant design, component design activities, and a description of the waste heat binary power plant. Included also are development and testing alternatives, and related international programs in the closed-cycle gas turbine field. ERA

N78-14653# Los Alamos Scientific Lab., N. Mex.
HEAT PIPE REACTORS FOR SPACE POWER APPLICATIONS
D. R. Koenig, W. A. Ranken, and E. W. Salmi 1977 9 p Presented at AIAA meeting, St. Louis, Missouri, 3 Mar. 1977
(Contract W-7405-eng-36)
(LA-UR-77-296; Conf-770302-2) Avail: NTIS HC A02/MF A01

A family of heat pipe reactors design concepts has been developed to provide heat to a variety of electrical conversion systems. Three power plants are described that span the power range 1-500 kW(e) and operate in the temperature range 1200 to 1700 K. The reactors are fast, compact, heat-pipe cooled, high-temperature nuclear reactors fueled with fully enriched refractory fuels, UC-ZrC or UO_2. Each fuel element is cooled by an axially located molybdenum heat pipe containing either sodium or lithium vapor. ERA

N78-14654# RCA Advanced Technology Labs., Camden, N. J.
SOLAR DRIVEN AIR CONDITIONING SYSTEM Semiannual Status Report
B. Shelpuk and M. Crouthamel Jan. 1977 34 p
(Contract EY-76-C-02-2938)
(COO/2938-77/1; ATL-CR-77-01) Avail: NTIS HC A03/MF A01

The feasibility of building a solar driven air conditioner on the basis of the Vuilleumier thermodynamic cycle was studied. The technology used was applied initially in an aerospace requirement for a reliable, long lived cryogenic refrigerator for an infrared detection system. The extension of this technology to an air conditioning application was explored but found unsuitable because the low temperature heat source, gas flow friction through the machine, and void volume effects interacted in subtle ways to degrade performance. Various combinations of design variables which affect performance required simulation on a computer. New materials and structures were required to replace the standard cryogenic components which were deficient when used in the air conditioning application. The feasibility for cooling based on the VM thermodynamic cycle was analytically shown to be on a sound thermodynamic basis. ERA

N78-14655# Delaware Univ., Newark.
CONSUMER DEMAND ANALYSIS: SOLAR HEATING AND COOLING OF BUILDINGS Final Report
Jerome E. Scott Sep. 1976 238 p refs
(Contract EY-76-C-02-2598)
(COO-2598-1) Avail: NTIS HC A11/MF A01

The acceptability of solar heating and cooling to homebuyers was investigated. The study assesses the extent of homeowner awareness of solar technologies, estimates the acceptability of elevated first costs including willingness to trade higher initial costs for life cycle savings, and investigates the impact of solar aesthetics. Also explored are areas of potential concern to homeowners in evaluating a solar alternative. The socioeconomic and attitudinal characteristics of individuals more likely to purchase a solar home rather than a conventional home were studied. The results are based on group depth interviews and personal interviews with active homeseekers, top executives of large residential development firms, and architects. The sample was split evenly between Denver, Colorado and the Philadelphia, Pa./Wilmington, Del. areas. Implications of the results for the commercialization of solar energy and possible public policy decisions are discussed. ERA

N78-14656# Battelle Columbus Labs., Ohio.
SURVEY OF THE APPLICATIONS OF SOLAR THERMAL ENERGY SYSTEMS TO INDUSTRIAL PROCESS HEAT. VOLUME 1: SUMMARY Final Report
Jan. 1977 88 p refs Prepared in cooperation with Honeywell, Inc., Minneapolis
(Contract W-7405-eng-92)
(TID-27348/1-Vol-1) Avail: NTIS HC A05/MF A01

Process heat requirements of 20 industries were identified and characterized according to quantity, temperature range, and form. Concepts for solar thermal energy systems were evaluated with respect to expected performance and cost in industrial applications. A preliminary assessment was made of related nontechnical issues, i.e., economic, institutional, legal, and environmental. A summary is included of the methodology and results of the entire project. ERA

N78-14657# Iowa State Univ. of Science and Technology, Ames. Engineering Research Inst.
ENHANCED SINGLE-PHASE HEAT TRANSFER FOR OCEAN THERMAL ENERGY CONVERSION SYSTEMS Final Report
A. E. Bergles and M. K. Jensen Apr. 1977 113 p refs
(Contract W-7405-eng-26)
(ORNL/Sub-77/14216/1; HTL-13; ISU-ERI-AMES-77314)
Avail: NTIS HC A06/MF A01

The utilization of enhanced heat transfer surfaces for both the boiler and condenser was investigated in order to reduce the size and cost of OTEC systems. It was found that single phase, forced convection heat transfer can be enhanced by a wide variety of techniques which do not require external power to generate and sustain. These techniques are: rough surfaces, extended surfaces, displaced enhancement devices, and swirl flow devices. The world literature was surveyed to locate representative data for those techniques. A computer search for an extensive collection of general literature on heat transfer enhancement was utilized. Heat transfer and friction factor data are presented for various techniques and subgroups of techniques, particularly those data which demonstrate the maximum reported improvements in heat transfer coefficients. ERA

N78-14658# Institute of Gas Technology, Chicago, Ill.
ALTERNATIVE ENERGY TRANSMISSION SYSTEMS FROM OTEC PLANTS, PROJECT 8980 Quarterly Progress Report, Oct. - Dec. 1976
A. Talib, B. Yudow, C. Blazek, S. Foh, A. Konopka, and N. Biederman Feb. 1977 90 p refs
(Contract EX-76-C-01-2426)
(DSE/2426-8; QPR-2) Avail: NTIS HC A05/MF A01

Energy carriers necessary in transporting energy from OTEC plants to the energy user were investigated. A study of both chemical and electrical energy carriers provided a technical and economic evaluation of concepts for converting OTEC energy to a storable, transportable form and shipping it to a shore based receiving terminal. The first concept deals with an onboard electrical system used to produce high temperature heat and shipping this thermal energy to shore in some form of thermal storage system. The second concept is to use OTEC energy to produce carbonaceous fuels using electrolytic hydrogen produced onboard and carbon dioxide extracted from a sea water or delivered from shore based facility. ERA

N78-14660# Oak Ridge National Lab., Tenn.
OUTLINE FOR OPTIMIZING AND EVALUATING PROPOSED OTEC SYSTEMS
R. N. Lyon 1977 16 p Presented at 4th Ocean Thermal Energy Conversion Conf. New Orleans, 22 Mar. 1977
(Contract W-7405-eng-26)
(CONF-770331-2) Avail: NTIS HC A02/MF A01

The need to begin the development of a general modeling and optimization method for ocean thermal energy conversion systems for assistance in making a wide variety of administrative and design decisions is emphasized. Concepts that should be included in the model are outlined. ERA

N78-14661# Oak Ridge National Lab., Tenn.
ANALYTICAL AND EXPERIMENTAL STUDIES OF OTEC HEAT TRANSFER PROBLEMS AT OAK RIDGE NATIONAL LABORATORY
1977 27 p refs Presented at 4th Ocean Thermal Energy Conversion Conf., New Orleans, 22 Mar. 1977
(Contract W-7405-eng-26)
(CONF-770331-1) Avail: NTIS HC A03/MF A01

The analysis, planning, and implementation of a program to develop advanced heat exchangers for ocean thermal energy conversion (OTEC) are described. An analysis of the NH3 binary cycle and the current state of commercial heat exchanger technology indicated that the goals of this program should be to improve the seawater heat transfer coefficients by a factor of 2, the ammonia heat transfer coefficients by a factor of 2 to 4, and to be able to control fouling factors at a value of 0.0003 or below. These improvements coupled with qualifying aluminum for this seawater/ammonia service would go far toward assuring the economic viability of the OTEC concept. A single tube ammonia heat transfer loop has been built and operated to evaluate the heat transfer characteristics of fluted tubes. Preliminary ammonia condensation results are presented. ERA

N78-14662# Battelle Pacific Northwest Labs., Richland, Wash.
OCEAN THERMAL ENERGY CONVERSION SYSTEM BIOFOULING AND CORROSION PROBLEMS
L. D. Perrigo and G. A. Jensen Sep. 1976 31 p refs Presented at Western Region Conf., San Diego, 27 Sep. 1976
(Contract EY-76-C-01-1830)
(BNWL-SA-5970; Conf-7609135-1) Avail: NTIS HC A03/MF A01

The Energy Research and Development Administration (ERDA) is sponsoring a program to explore the possibilities for beneficially using the temperature difference between warm surface water of the tropical oceans and the deeper colder water to operate a heat engine. As much as 4 to 6% of the expected demand for power in the United States by 2020 could be supplied by this source. One of the major technical hurdles that must be overcome is the solution to biofouling problems that are expected to impede efficient heat transfer in the power plant evaporator and condenser systems. There are allied problems in the corrosion of materials that must also solved. The results of work to develop a biofouling device and the corrosion behavior of aluminum in ammonia-sea water mixtures are reported. ERA

N78-14663# Naval Postgraduate School, Monterey, Calif.
NATURE OF PRIMARY ORGANIC FILMS IN THE MARINE ENVIRONMENT AND THEIR SIGNIFICANCE FOR OCEAN THERMAL ENERGY CONVERSION (OTEC) HEAT EXCHANGE SURFACES
E. C. Haderlie Feb. 1977 42 p refs
(Contract EY-76-C-01-2515)
(BNWL-2283) Avail: NTIS HC A03/MF A01

The development of bacterial slime films on the heat exchanger surfaces of OTEC power plants is likely to be of critical importance in determining if OTEC closed cycles systems are technically and economically viable. The present state of knowledge is surveyed requiring the nature and behavior of primary films in the marine environment. Areas where further research is needed are indicated. ERA

N78-14664# Sandia Labs., Albuquerque, N. Mex.
PARAMETER STUDY FOR A CENTRAL-RECEIVER POWER STATION
F. Biggs and C. N. Vittitoe 1977 15 p refs Presented at U.S.-USSR Workshop on Solar Energy Appl., Moscow (USSR), 20 Jun. 1977
(Contract EY-76-C-04-0789)
(SAND-77-0667C; Conf-770630-1) Avail: NTIS HC A02/MF A01

The interaction between alignment and focusing strategies and heliostat errors are described and illustrated. Some descriptions of astigmatic aberrations are developed and are used to suggest an evaluation criterion for concentrators. Finally, an analysis of measurements for evaluation heliostat reflectors is given. ERA

N78-14665# Sandia Labs., Albuquerque, N. Mex.
HELIOS: A COMPUTATIONAL MODEL FOR SOLAR CONCENTRATORS
F. Biggs and C. N. Vittitoe 1977 17 p refs Presented at U.S.-USSR Workshop on Solar Energy Appl., Moscow, 20 Jun. 1977
(Contract EY-76-C-02-0789)
(SAND-77-0642C; Conf-770630-2) Avail: NTIS HC A02/MF A01

HELIOS is a computer code for mathematically simulating the behavior of the flux pattern from the concentrator field for a solar central receiver power station. Statistical methods are used to incorporate nondeterministic factors. The code is described, and some examples of its output are given. ERA

N78-14666# Southern California Edison Co., Rosebud.
INTEGRATION OF SOLAR THERMAL POWER PLANTS INTO ELECTRIC UTILITY SYSTEMS
G. W. Braun, ed. and J. W. Ballance, ed. Sep. 1976 23 p
(Contract EY-76-C-03-1117)
(TID-27627/1) Avail: NTIS HC A02/MF A01

The findings of a study designed to fill the need for an electric utility to evaluate solar thermal power plants are summarized. Calculations are described which were used to compute the economic value of solar power plants to an electric utility under assumptions that are valid today. Topics covered are: reliability evaluation, economic evaluation, storage, system operation, and cost and design considerations. ERA

N78-14667# Southern California Edison Co., Rosebud.
INTEGRATION OF SOLAR THERMAL POWER PLANTS INTO ELECTRIC UTILITY SYSTEMS
Sep. 1976 135 p refs
(Contract EY-76-C-03-1117)
(TID-27627/2) Avail: NTIS HC A07/MF A01

The operation of solar power plants as a part of a large electric utility system was studied using the Southern California Edison Company loss of load probability and production cost simulation computer programs. Solar generation was evaluated in the context of an electric system having high percentages of baseload type generation, represented by nuclear. A solar generation model was developed which included effects of hourly solar input variations, cloud induced forced outages, use of energy storage, and peak shaving dispatch. The contribution of solar generation to the system's ability to serve forecast loads was determined for varying amounts of installed solar capacity and for varying thermal energy storage capabilities associated with the solar units. Breakeven costs for solar generation were calculated based on financial assumptions consistent with those Edison presently uses in generation resource planning. ERA

N78-14668# Grumman Aerospace Corp., Bethpage, N.Y. Research Dept.
INVESTIGATION OF DIFFUSER-AUGMENTED WIND TURBINES. PART 1: EXECUTIVE SUMMARY Final Report
R. A. Oman, K. M. Foreman, and B. L. Gilbert Jan. 1977 21 p
(Contract EY-76-C-02-2616)
(COO-2616-2-Pt-1) Avail: NTIS HC A02/MF A01

The Diffuser Augmented Wind Turbine (DAWT) is one of the advanced concepts being investigated to improve the economics of wind energy conversion. The project is aimed at increasing the output and reducing the cost, the off-duty time, and the technical risk of wind energy conversion systems. The DAWT appears to be best suited to large systems for commercial power production because it permits a significant increase in the unit power output without extending the size of rotating machinery into the range where rotor dynamics cause excessive costs. ERA

N78-14669# Grumman Aerospace Corp., Bethpage, N.Y. Research Dept.
INVESTIGATION OF DIFFUSER-AUGMENTED WIND TURBINES. PART 2: TECHNICAL REPORT Final Report
R. A. Oman, K. M. Foreman, and B. L. Gilbert Jan. 1977 105 p refs
(Contract EY-76-C-02-2616)
(COO-2616-2-Pt-2) Avail: NTIS HC A06/MF A01

Information on diffuser-augmented wind turbines is presented concerning the development of efficient and compact diffusers.

economic analysis, and the analytical demonstration of two-stage constant speed rotor concepts. ERA

N78-14670# Sandia Labs., Albuquerque, N. Mex. Systems Analysis Dept.
APPROACH FOR EVALUATING ALTERNATIVE FUTURE ENERGY SYSTEMS: A DYNAMIC NET ENERGY ANALYSIS
J. L. Mitchiner, V. L. Dugan, and S. G. Varnado May 1977 34 p refs
(Contract EY-76-C-04-0789)
(SAND-77-0489) Avail: NTIS HC A03/MF A01

Realistic analysis of future energy systems is a difficult, but crucial, component of assuring future energy supplies. The procedure proposed is a dynamic, net energy assessment that is a resource-based method for evaluating future energy systems. The model is system, site, and application specific and is equally applicable to general system characterizations and specific designs. The implications of possible resource and societal constraints on energy development are investigated. ERA

N78-14672# Oak Ridge National Lab., Tenn.
POWER CONVERSION SYSTEM OF THE 21ST CENTURY
A. P. Fraas and G. Samuels 1977 25 p refs Presented at Amer. Soc. of Civil Eng. Spring Convention, Dallas, Texas, 25 Apr. 1977
(Contract W-7405-eng-26)
(CONF-770448-1) Avail: NTIS HC A02/MF A01

Exhaustion of our fossil-fuel reserves coupled with cost considerations will overcome emotional objections and lead to the use of nuclear fission and/or fusion as our prime energy source. In speculating on the power conversion systems best suited to use with fission or fusion reactors, a good case can be made for the thesis that these will employ a potassium or cesium vapor cycle operating with a turbine inlet temperature of 1400 to 2000 F (760 to 1100 C) that will reject its heat at around 1000 F (540 C) to a conventional steam system. The latter in turn will reject its heat at around 300 F (150 C) for use in industrial processes and district heating systems. Railroads will be electrified and automobiles and trucks will run on high energy storage batteries. Excess waste heat can be employed to distill sewage to provide fresh water, and to evaporate sewage sludge to dryness to sterilize it and yield good fertilizer. ERA

N78-14674# Electric Power Research Inst., Palo Alto, Calif.
COAL AND NUCLEAR GENERATING COSTS
C. L. Rudasill Apr. 1977 38 p
(EPRI-PS-455-SR) Avail: NTIS HC A03/MF A01

Costs of producing electricity from coal and nuclear power stations, using currently available technology, analyzed based on the results of contracted studies made by several consulting organizations. The analysis was made on a regional basis to consider differences in coal characteristics, transportation differences, and labor and local material costs in various parts of the country. The major factors that affect coal and nuclear generation costs were investigated on a consistent basis. The overall results of the study indicate that: (1) both coal and nuclear generation can be economically attractive in all regions; (2) nuclear generation shows an average economic advantage in all regions, particularly in the east, where higher delivered coal prices prevail; and (3) any new base-load generating technology must achieve levelized busbar costs of 35 to 45 mills per kilowatt hour to compete with existing technology on an economic basis. ERA

N78-14675# Brookhaven National Lab., Upton, N. Y.
REGIONAL REFERENCE ENERGY SYSTEMS
A. L. Hermelee Jun. 1977 464 p refs
(Contract EY-76-C-02-0016)
(EPRI-EA-462) Avail: NTIS HC A20/MF A01

A regional energy systems formulation incorporating an integrative view of the energy system such that all resources, technologies, and uses of energy are set forth in a uniform manner is presented here. This approach, based on the Reference Energy System (RES), is broadly applicable to the assessment of energy technologies and policies at a regional level. Reference energy systems have been developed for each of the nine census regions and summaries of the regional data for the entire United States are given. RES's were formulated for the base year 1972 and projections were developed for 1980, 1985, and 2000. ERA

N78-14676# Brookhaven National Lab., Upton, N. Y. Dept. of Applied Science.
ELECTROCHEMICAL CHARACTERISTICS OF Zr O2-Y2 O3 SOLID ELECTROLYTES FOR FUEL CELLS
H. S. Issacs, P. G. Russell, and L. J. Olmer 1977 11 p refs Presented at the Meeting of the Electrochem. Soc., Philadelphia, 8 May 1977
(Contract EY-76-C-02-0016)
(BNL-22881; Conf-770531-9) Avail: NTIS HC A02/MF A01

A wide range of techniques, now available for the study of electrochemical characteristics of solid oxide fuel cells, were developed for investigating aqueous electrochemical systems. In particular a-c methods can be used for determining the types and kinetic parameters of processes which control the rates of reaction. An investigation of the temperature and potential behavior of electrodes, electrolytes and cells constructed from platinum coated ZrO_2-Y_2O_3 electrolytes is reported. ERA

N78-14679# Systems Consultants, Inc., Washington, D. C.
APPLICATION OF NEAR-TERM FOSSIL TECHNOLOGIES TO THE ENERGY SUPPLY/DEMAND PROFILES OF THE U.S. STATES AND REGIONS
Jan. 1977 186 p refs
(Contract EX-76-C-01-2442)
(FE-2442-1) Avail: NTIS HC A09/MF A01

Critical energy problems were surveyed based on energy supply and utilization. Areas with highest severity were the North Central, and the West South Central, the Middle Atlantic, the South Atlantic and New England. The following near-term technologies are most likely to have a major impact on the supply/demand energy characteristics of the regions: direct combustion of coal in atmospheric fluidized beds; low-Btu gas from coal for power generation and combined cycles; power plant technology; high-Btu gasification in entrained and fluidized beds; improved railroad coal-handling facilities; direct combustion by fuel substitution; low-Btu gas for process heat; improved underground and surface coal extraction techniques; coal slurry and coal-gas pipeline transport systems; and conservation in the residential/commerical and vehicular transportation sectors. ERA

N78-14680# Energy Research and Development Administration, Washington, D. C. Div. of Solar Energy.
SOLAR PROGRAM ASSESSMENT: ENVIRONMENTAL FACTORS. SOLAR HEATING AND COOLING OF BUILDINGS
Mar. 1977 79 p refs
(ERDA-77-47/1) Avail: NTIS HC A05/MF A01

The major environmental issues associated with the further development of solar heating, heating and cooling, and domestic hot water systems are presented. To provide a background for this environmental analysis, the basic concepts of the technology are reviewed, as are its material resource requirements. The potential effects of this technology on the full range of environmental concerns (i.e., air and water quality, biosystems, safety, social/institutional structures, etc.) are then discussed in terms of both their relative significance and possible solutions. Although the further development of solar heating and cooling will contribute in some ways to environmental problems common to any construction project or space conditioning technology (e.g., noise from cooling towers), only those problems unique to the solar portion of the technology will be discussed in depth. Finally, an environmental work plan is presented, listing research and development proposals and a National Environmental Policy Act (NEPA) document work plan which might help clarify and/or alleviate specific environmental problems. ERA

N78-14681# Energy Research and Development Administration, Washington, D. C. Div. of Solar Energy.
SOLAR PROGRAM ASSESSMENT: ENVIRONMENTAL FACTORS
Mar. 1977 75 p refs
(ERDA-77-47/4) Avail: NTIS HC A04/MF A01
For abstract, see N78-14680.

N78-14682# Energy Research and Development Administration, Washington, D. C. Div. of Solar Energy.
SOLAR PROGRAM ASSESSMENT: ENVIRONMENTAL FACTORS. WIND ENERGY CONVERSION
Mar. 1977 42 p refs
(ERDA-77-47/6) Avail: NTIS HC A03/MF A01

The major environmental issues associated with the further development of Wind Electric Conversion (WEC) systems are presented and prioritized. To provide a background for this environmental analysis, the basic concepts of the technology are reviewed, as are its resource requirements. The potential effects of this technology on the full range of environmental concerns are then discussed in terms of both their relative significance and possible solutions. Although the development of WEC will in some ways contribute to environmental problems common to any construction project or energy producing technology, only those impacts unique to the solar/wind portion of the technology are discussed in depth. ERA

N78-14683# Energy Research and Development Administration, Washington, D. C. Div. of Solar Energy.
SOLAR PROGRAM ASSESSMENT: ENVIRONMENTAL FACTORS. OCEAN THERMAL ENERGY CONVERSION
Mar. 1977 55 p refs
(ERDA-77-47/8) Avail: NTIS HC A04/MF A01

The environmental problems which may arise with the further development of Ocean Thermal Energy Conversion (OTEC), are presented. To provide a background for this environmental analysis, the history and basic concepts of the technology are reviewed, as are its economic and resource requirements. The potential effects of this new technology on the full range of environmental concerns (i.e., air etc.) are then discussed in terms of both their relative significance and possible solutions. Although the emerging solar technologies will contribute to environmental problems common to any construction project or energy-producing technology (e.g., air pollutants from steel production), only those impacts unique to the solar aspects of the technology are discussed in depth. Finally, an environmental work plan is presented listing research and development proposals and a work plan which might help clarify and/or mitigate specific environmental concerns. ERA

N78-14684# Central Technical Inst. TNO, Apeldoorn (Netherlands).
SURVEY OF RESEARCH AND DEVELOPMENT ACTIVITIES IN THE NETHERLANDS ON HEAT PUMPS FOR RESIDENTIAL HEATING
H. VanDerRee 21 Sep. 1976 35 p refs In DUTCH; ENGLISH summary Presented at the Ver. van Exploitanten van Electriciteitsbedrijven in Ned. (VEEN), 21 Sep. 1976
(CTI-76-09497) Avail: NTIS HC A03/MF A01

A survey is given of projects at various institutes and private companies. Design and implementation are described for each project, particular attention being paid to the scope of the activities. It is concluded that, at the moment, efforts among all kinds of institutions fritter away to an ever increasing extent, and a strong plea is put in for coordination. Another point that emerges from the survey is that it is by no means clear what modification of heat pump will gain the upper hand in the Netherlands. On the whole the competitive power of the heat pump is still very low compared to that of the conventional heating system with natural gas. Some outlines are given for further investigations. Author (ESA)

N78-14685# Laboratorio di Ricerca e Technologia per lo Studio del Plasma nello Spazio, Frascati (Italy).
PHOTOVOLTAIC SOLAR PANELS AND SOLAR MODULES [PANNELLI E MODULI SOLARI FOTOVOLTAICI]
G. V. Pallottino May 1977 24 p refs In ITALIAN
(LPS-77-12) Avail: NTIS HC A02/MF A01

The possibilities offered by photovoltaic cells to convert, directly, solar energy into electric energy are discussed briefly. Research being carried out to reduce the production costs of such cells is reviewed. The principle characteristics of solar panels and modules for terrestrial use are reviewed. ESA

N78-14686# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany). Inst. fuer Raumsimulation.
SOME EXPERIMENTAL RESULTS ON SELECTIVE ABSORBING SURFACES FOR LOW TEMPERATURE SOLAR COLLECTORS
Georg Paul Goerler 27 May 1977 50 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-432)
(DLR-FB-77-23) Avail: NTIS HC A03/MF A01; DFVLR, Cologne DM 25

The efficiency of a flat plate solar collector can be greatly enhanced by the use of a selectively absorbing layer, that is, a surface with high absorptance for the solar spectrum and low emittance for thermal radiation. From various methods known from literature for realizing coatings with these properties, the process of electroplating selective black nickel coatings was chosen and studied in detail. One result of this investigation was that the effectiveness of these layers results from optical interference. With the production of black nickel two-layer coatings on a copper substrate one obtains surfaces with an absorptance as high as 0.95, when weighted with the terrestrial solar spectrum. The simultaneous emittance is in the order of 0.05. The superiority of absorber plates with such values, in comparison with nonselective solar collectors is outlined using the results of a numerical calculation. Author (ESA)

N78-14687# Resource Planning Associates, Inc., Cambridge, Mass.
WESTERN ENERGY RESOURCES AND THE ENVIRONMENT: GEOTHERMAL ENERGY
May 1977 117 p refs
(Contract EPA-68-01-4100)
(PB-271561/3; EPA-600/9-77-010) Avail: NTIS HC A06/MF A01 CSCL 08I

Geothermal energy is addressed from an environmental research and development perspective. Various geothermal energy systems are discussed which serve as present or potential energy sources. These include hydrothermal convection systems, such as geysers and hot springs, hot igneous systems, and conduction dominated systems. Special inserts describe how geothermal resource systems are created and developed. GRA

N78-14698# Oak Ridge National Lab., Tenn.
CHARACTER AND TRANSFORMATION OF POLLUTANTS FROM MAJOR FOSSIL FUEL ENERGY SOURCES
D. S. Shriner, S. B. McLaughlin, and C. F. Baes Jun. 1977 44 p refs
(Contract W-7405-eng-26)
(ORNL/TM-5919) Avail: NTIS HC A03/MF A01

Factors influencing ecosystem effects of air pollutants from major fossil fuel energy sources were investigated. Chemical speciation of major effluents, the variations in source term associated with type of source, and other factors which influence the characteristics of the effluent at the source/atmosphere interface were discussed. The major current and potential sources of energy-derived pollutant burdens, and projected future patterns of energy production were reviewed. In addition, factors controlling transformation of pollutants during atmospheric transport were described. The most critical controlling factors were identified, as were the major effluent constituents for which transformation was most significant. The chemical species which ultimately reach the atmosphere/vegetation interface were described with regard to their relative potential for effects on terrestrial ecosystems. ERA

N78-14725# Massachusetts Inst. of Tech., Cambridge. Dept. of Earth and Planetary Sciences.
MICROCRACK TECHNOLOGY FOR GEOTHERMAL EXPLORATION AND ASSESSMENT
Gene Simmons 1 Jul. 1977 167 p refs
(Grant NSF AER-75-09588)
(PB-271940/9; NSF/RA-770179) Avail: NTIS HC A08/MF A01 CSCL 08I

An investigation to determine if the data obtained from microcracks in rocks can be useful in geothermal exploration, and to demonstrate how to use this data for reservoir assessment was initiated. The microcracks and various physical properties of cores of six geothermal areas were studied: Dunes, Heber, and Coso Hot Springs in California; Raft River, Idaho; Marysville, Montana; and Roosevelt Hot Springs, Utah. The fractures in the core samples and their characteristics were studied by a variety of techniques. The open fracture content was examined by differential strain analysis (DSA). The DSA technique provided a precise measure of fracture porosity as a function of pressure. Author

N78-14729# Geological Survey, Denver, Colo.
BOREHOLE GRAVITY SURVEY TO DETERMINE DENSITY VARIATIONS IN THE DEVONIAN SHALE SEQUENCE OF LINCOLN COUNTY
James W. Schmoker May 1977 19 p refs
(Contract EX-76-C-01-2287)
(MERC/CR-77/7) Avail: NTIS HC A02/MF A01

In situ bulk densities of the devonian shale section in Lincoln County, West Virginia, were determined using the U.S. Geological Survey-LaCoste and Romberg borehole gravity meter. Densities from two gamma-gamma logs, run by different companies, were also available. A cumulative difference of .034 g/cu cm/1000 ft exists between the two gamma-gamma logs. The two intervals of lowest density derived from the borehole gravity data show higher densities on both gamma-gamma logs, possibly indicative of the deeper investigation radius of the borehole gravity meter. In most intervals, higher gamma ray intensity correlated with lower density, indicating that organic content is the primary variable affecting both bulk density and uranium concentration. ERA

N78-14762# California Univ., Livermore. Lawrence Livermore Lab.
WIND STUDIES IN COMPLEX TERRAIN
D. M. Hardy May 1977 39 p refs Presented at Amer. Wind Energy Assoc. Meeting, Boulder, Colo., 13 May 1977
(Contract W-7405-eng-48)
(UCRL-79430) Avail: NTIS HC A03/MF A01

The development and application of general methods of wind energy assessment for hilly or mountainous areas are described. The island of Oahu, Hawaii is being used as an initial study area to develop procedures useful there and in other mountainous regions. Numerical model calculations and field measurements are employed in studying the spatial and temporal variations of wind energy. Field measurement and model results show very significant wind energy spatial variations occur as a result of complex terrain. Applications of the methodology in identifying locations of wind enhancement with multi-megawatt power collection potential are described. ERA

N78-14939# Gellman Research Associates, Inc., Jenkintown, Pa.
THE ROLE OF SCIENTIFIC AND TECHNICAL INFORMATION IN CRITICAL PERIOD MANAGEMENT, VOLUME 1 Final Report
May 1977 152 p refs
(Contract NSF 76-05499)
(PB-272178/5) Avail: NTIS HC A08/MF A01 CSCL 05A

The role of scientific and technical information in the resolution of domestic crises was examined. A study was designed to be an exploratory effort, which would provide insight into the use of scientific and technical information and develop hypotheses which could be employed in future experiments or analyses. The method used to conduct the studies included the preparation and analysis of four ex post case histories of domestic crises. The crises examined include: (1) Penn Central bankruptcy, (2) Oil Embargo of 1973-74, (4) Emergency blackout of September 20, 1970 in parts of New York City; and (4) the Apollo 13 incident. Author

N78-14940# Gellman Research Associates, Inc., Jenkintown, Pa.
THE ROLE OF SCIENTIFIC AND TECHNICAL INFORMATION IN CRITICAL PERIOD MANAGEMENT, VOLUME 2 Final Report
May 1977 389 p refs
(Contract NSF 76-05499)
(PB-272179/3) Avail: NTIS HC A17/MF A01 CSCL 05A

For abstract, see N78-14939.

N78-14951# Swain, (John W.), Wellesley, Mass.
ASSESSMENT IN INDUSTRIAL HAZARDOUS WASTE MANAGEMENT PETROLEUM RE-REFINING INDUSTRY Final Report, Jan. - Nov. 1976
John W. Swain Jun. 1977 162 p refs
(PB-272267/6; EPA/SW-144c) Avail: NTIS HC A08/MF A01 CSCL 13B

A description is given of hazardous waste generation and management in the petroleum re-refining industry - the re-refining of waste oils for use as lubricants and as fuel. The industry's wastes contain such potentially hazardous contaminants as heavy metals, phenols and potentially carcinogenic aromatic hydrocarbons. The report surveys industry characteristics, quantity and character of its potentially hazardous wastes, treatment and disposal technology, and attendant costs. Projections for the production of re-refined oil and generation of wastes have been made for 1977 and 1983. GRA

N78-14952# Michigan Technological Univ., Houghton.
ENERGY AND PROTEIN PRODUCTION FROM PULP MILL WASTES Progress Report, 15 Dec. 1976 - 15 Mar. 1977
M. F. Jurgensen and J. T. Patton Mar. 1977 8 p
(Contract EY-76-S-02-2983)
(COO-2983-3) Avail: NTIS HC A02/MF A01

The feasibility of producing protein and methane from pulp mill waste materials was demonstrated. Ozonated spent sulfite liquor, SSL, was shown to be a suitable substrate for biosynthesis. Sustained production of methane was obtained by biological conversion of ozonated SSL. Total methane production approximated 2 volumes of gas per volume of ozonated SSL after approximately 3 days reaction time. A study of the effect of pH on ozonation indicated that low pH's favotr the breakdown of SSL into organic fragments that are more easily assimilated by microorganisms. Approximately one half as much ozone was required to effect maximum degradation at pH4 as compared to pH8. Even with this lower dosage of ozone the resulting product was more amenable to bioconversion. ERA

N78-14954# California Univ., Berkeley. Lawrence Berkeley Lab.
INVESTIGATION OF THE FEASIBILITY OF A DUAL MODEL ELECTRIC TRANSPORTATION SYSTEM
J. G. Bolger and F. A. Kirsten May 1977 159 p refs
(Contract W-7405-eng-48)
(LBL-6301) Avail: NTIS HC A08/MF A01

A study is reported which explores the feasibility of a highway transportation system that electromagnetically transfers energy to vehicles from powered roadways for high-speed or long-range travel, and uses energy stored in the vehicles for other travel. The energy coupling between roadway and vehicle is functionally similar to a transformer. The roadway energy source is imbedded flush with the roadway surface. When vehicle's energy pickups are suspended over the source, energy is magnetically coupled through the clearance gap between source and pickup. Analyses and modeling indicated that adequate power can be efficiently coupled by the system. The economics of the system appear to be favorable, and no implementational problems were identified that would make the system impractical. ERA

N78-15059*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE ERDA/LeRC PHOTOVOLTAIC SYSTEMS TEST FACILITY

Americo F. Forestieri Sep. 1977 12 p refs Presented at 1977 Photovoltaics Solar Energy Conf., Comm. of the European Communities, Luxembourg, 27-30 Sep. 1977
(Contract E(49-26)-1022)
(NASA-TM-73787; ERDA/NASA-1022/77/19) Avail: NTIS HC A02/MF A01 CSCL 14B

A test facility was designed, and built to provide a place where photovoltaic systems may be assembled and electrically configured, to evaluate system performance and characteristics. The facility consists of a solar cell array of an initial 10-kW peak power rating, test hardware for several alternate methods of power conditioning, a variety of loads, an electrical energy storage system, and an instrumentation and data acquisition system. Author

N78-15086*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PIPING DESIGN CONSIDERATIONS IN A SOLAR-RANKINE POWER PLANT c44
F. L. Lansing *In its* The Deep Space Network, Vol. 39 15 Jun. 1977 p 168-176 refs (For availability see N78-15067 06-12)
Avail: NTIS HC A09/MF A01 CSCL 10B

Two of the main parameters in sizing the piping of a solar power plant are the working pressure of the vapor leaving the solar collectors, and the type of working fluid used. Numerical examples for each case are given using the graphical Moody friction charts and the analytical Darcy-Weisbach equation. Different working pressures of steam vapor in the solar collector-turbine pipe connection indicate their major role in the design. The size variation was found not to be in linear proportion to vapor density variations. On the other hand, high molecular weight organic fluids such as R-11 and R-113, when compared with water, show insignificant changes in piping sizes. Author

N78-15148*# Analytical and Computational Mathematics, Inc., Houston, Tex.
ORBITAL MOTION OF THE SOLAR POWER SATELLITE
O. F. Graf, Jr. May 1977 116 p refs
(Contract NAS9-15171)
(NASA-CR-151603; ACM-TR-105) Avail: NTIS HC A06/MF A01 CSCL 22A

A study on the effects of solar radiation pressure on the SPS orbit is documented. It was shown that the eccentricity of the orbit can increase from initially being zero. The SPS configuration is primarily considered but the results are applicable to any geosynchronous satellite that resembles a flat surface continually facing the sun. The orbital evolution of the SPS was investigated over its expected 30 year lifetime and the satellite was assumed to be in free flight. The satellite's motion was described with analytical formulae which could be used to develop an orbit control theory in order to minimize station keeping costs. Author

N78-15213# Colorado State Univ., Fort Collins. Dept. of Mathematics.
ADAPTIVE CURVE FITTING FOR CHEMICAL PROCESSES Interim Report
M. Andrews, J. A. Hull, and G. D. Taylor Jul. 1977 17 p refs
(Grant AF-AFOSR-2878-76)
(AD-A046456; AFOSR-77-1262TR) Avail: NTIS HC A02/MF A01 CSCL 07/4

In this paper application of some recent adaptive curve fitting algorithms is made to the problem of modelling chemical processes. Specifically, the problem of the mathematical modelling of the kinetics of oil shale pyrolysis using the Hubbard-Robinson data set is treated. Author (GRA)

N78-15229*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FRICTION AND WEAR OF SEVERAL COMPRESSOR GAS-PATH SEAL MOVEMENTS
Robert C. Bill and Donald W. Wisander Jan. 1978 42 p refs
(NASA-TP-1128; E-9276) Avail: NTIS HC A03/MF A01 CSCL 11A

Rub interaction experiments were conducted on a series of sintered and plasma sprayed compressor gas path seal materials in contact with Ti-6Al-4V blade tip and knife edge rotors. The most rub tolerant materials investigated were sintered Nichrome and plasma sprayed nickel 25 percent graphite. The effectiveness of providing a compliant substrate for dense seal material coatings was also demonstrated. In general, it was observed that rotor wear and high frictional energy generation rates accompanied smearing of surface densification of the materials investigated. The onset of smearing was sensitive to rub interaction parameters and seal geometry. Two complementary models were proposed to account for the smearing trends. One is based on thermal effects, the other on particulate escape effects. They were shown to be consistent with the experimental evidence at hand, and together they predict that smearing, with the onset of high energy rub conditions, is favored when incursion rates (radial motion) are low, incursion depths are high, the seal geometry is of a knife-edge character, and the seal particle size is small. Author

N78-15295# Utah Univ., Salt Lake City.
THEORETICAL AND EXPERIMENTAL INVESTIGATION OF REACTION MECHANISMS OF EXPLOSIVES, CORROSION, AND BATTERY AND FUEL TECHNOLOGY Final Report, 1 Sep. 1974 - 31 Aug. 1977
Henry Eyring and Robert Kelley 19 Oct. 1977 31 p refs
(Grant DAHC04-75-G-0019)
(AD-A046641; ARO-12367.1-C) Avail: NTIS HC A03/MF A01 CSCL 19/4

Research efforts on the formation and analysis of polymer carbon electrodes to serve as oxygen electrodes and on the synthesis of porphyrins and porphyrazines for study as oxygen reduction catalysts in conjunction with polymer carbon electrodes are described. The report also presents a very simple but highly accurate model of detonation which ignores viscosity, diffusion, and heat conduction. The salient features of the model are unimolecular reaction, kinetics with starvation, balance laws, and a covolume equation of state. Author (GRA)

N78-15487 Georgia Inst. of Tech., Atlanta.
EXPERIMENTAL AND ANALYTICAL COMPARISONS OF THE PERFORMANCE AND COMBUSTION CHARACTERISTICS OF GASOLINE, METHANE, AND METHANOL IN A WANKEL ENGINE Ph.D. Thesis
Pravin Kamalakar Raut 1977 168 p
Avail: Univ. Microfilms Order No. 77-20597

Experiments were performed on a Wankel engine to obtain engine performance and emission data as well as chamber pressure time diagrams for gasoline, natural gas, and methanol fuels. A thermodynamic model of a Wankel engine was developed which accounts for Apex-seal leakage, heat transfer and wall quenching. The mass fraction burned as a function of crank angle was calculated from a measured pressure-time diagram. The predictions of heat loss to cooling water gave good agreement with the measurements for the three fuels. The predictions of oxides of nitrogen also gave good agreement with measurements for lean mixtures of gasoline and natural gas fuels. For methanol, the predictions of oxides of nitrogen were about 50% lower than measurements and results show it burns at lower temperatures than gasoline or natural gas. Dissert. Abstr.

N78-15497# Payne, Inc., Annapolis, Md.
WATER PULSEJET RESEARCH Final Report
Aug. 1977 149 p refs
(Contract N00014-75-C-0926)
(AD-A046533; Working-Paper-125-32) Avail: NTIS HC A07/MF A01 CSCL 21/5

The aim of this research was to obtain a quantitative understanding of the McHugh steam water pulsejet cycle, which in its simplest embodiment, is a thrust-producing engine with no moving parts. The cycle is also adaptable to water pumping, a study of which is currently being funded by ERDA; or, indeed, to the pumping of any vaporizable fluid. It has also been used as an agitator, and may find applications as such where a fluid or slurry is too corrosive for conventional mechanically-driven pumps or agitators. The basic theory may also be peripherally helpful in such diverse fields as the 'chugging' of atomic reactors during emergency shut-down and the catastrophic explosions which can result from the dynamic mixing of water with lava or molten metal. Although by no means complete, it's believed that the theory presented herein adequately explains the McHugh cycle, and points the way for further performance improvements. Steam water pulsejets are not yet as efficient as conventional steam engines, but there may be applications where the rather extreme mechanical simplicity makes them cost effective. In terms of 'specific fuel consumption,' the best engine tested corresponded to about 0.56 lb of fuel per hour per pound of thrust, assuming an 80% boiler efficiency. This is comparable to a turbojet, but, of course, the pulsejet has a natural advantage in the denser medium. Fuel consumption is about five times that expected of a diesel engine driving a water propeller. GRA

N78-15552# Watkins and Associates, Lexington, Ky.
ONSITE CONTROL OF SEDIMENTATION UTILIZING THE MODIFIED BLOCK-CUT METHOD OF SURFACE MINING Feasibility Study, Dec. 1974 - Apr. 1976
Jul. 1977 103 p refs Prepared in cooperation with Ky. Dept. of Natural Resources and Environ. Protection, Frankfort
(Grant EPA-S-802681)
(PB-272244/5; EPA-600/7-77-068) Avail: NTIS HC A06/MF A01 CSCL 08I

The feasibility of a demonstration project for onsite control of sedimentation was determined using the modified block-cut method of surface mining. A project site on Lower Lick Fork in Perry and Letcher Counties in Kentucky was selected. Based on certain assumptions, a comparison of costs involved in the modified block-cut method of mining and in a method using the minimum acceptable requirements as set forth in the present regulations was prepared. GRA

N78-15557# Joint Publications Research Service, Arlington, Va.
TRANSLATIONS ON USSR RESOURCES, NO. 768
23 Jan 1978 114 p refs Transl. into ENGLISH from Russian journals
(JPRS-70524) Avail: NTIS HC A06/MF A01

The report contains information on energy, fuels, and related equipment; manpower; metallurgy and mineral fields; fishing industry and marine resources; and water resources. Author

N78-15558 West Virginia Univ., Morgantown.
AVAILABLE WORK ENERGY AND COAL CONVERSION PROCESSES Ph.D. Thesis
Chun Yen Lin 1977 144 p
Avail: Univ. Microfilms Order No. 77-22741

The available work energy for coal conversion processes as derived from the second law of thermodynamics was examined to provide the relationship between operating conditions and useful energy recovery. The concept of total energy recovery and the available work energy loss was applied to each of the process units in various coal conversion processes. The coal conversion processes which were studied include those which produce synthetic crude oil, pipeline gas, methanol and/or electricity. The preliminary conceptual design of the coal conversion processes was investigated in order to estimate the unit production cost of the various products. It was found that process analysis based on considerations derived from the second law of thermodynamics can be used to achieve an understanding of the process variables, process units, and process schemes which provide more desirable characteristics. Dissert. Abstr.

N78-15560* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SOLAR HEATING SYSTEM Patent
Ronald N. Jensen, inventor (to NASA) Issued 24 Aug. 1976 7 p Filed 24 aug. 1976 Supersedes N76-32649 (14 - 23, p 3024)
(NASA-Case-LAR-12009-1; US-Patent-4,062,347; US-Patent-Appl-SN-717320; US-Patent-Class-126-270; US-Patent-Class-126-400; US-Patent-Class-237-1A) Avail: US Patent Office CSCL 10A

A system is disclosed for using solar energy to heat the interior of a structure. The system utilizes a low cost solar collector to heat a recirculating air mass which then flows through a series of interconnected ducts and passageways without the use of exterior fans or blowers. Heat is transferred from the air mass to the structure's interior and the air mass is then reheated. Official Gazette of the U.S. Patent Office

N78-15561*# National Aeronautics and Space Administration, Washington, D. C.
A HOME CENTRAL ELECTRIC SYSTEM
Renaud DelaTaille Jan. 1978 11 p Transl. into ENGLISH from Une Centrale Elec. Chez Sol (France), Jan. 1976 p 42-45 Transl. by SCITRAN, Santa Barbara, Calif.
(Contract NASw-2791)
(NASA-TM-75084) Avail: NTIS HC A02/MF A01 CSCL 10B

A description is given of a device which can be used as a generator, and extracts energy from metals. The experiments are discussed, and it is concluded that the device may be a source of inexhaustible energy. Author

N78-15562*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
BLACK CHROME ON COMMERCIALLY ELECTROPLATED TIN AS A SOLAR SELECTING COATING
G. E. McDonald Sep. 1977 10 p refs Presented at Concentrating Collector Conf., Atlanta, 26-28 Sep. 1977
(Contract EX-76-29-1060)
(NASA-TM-73799; ERDA/NASA-1060/77/1; E-9375) Avail: NTIS HC A02/MF A01 CSCL 10A

The reflectance properties of black chrome electroplated on commercially electroplated tin were measured for various black chrome plating times for both the solar and infrared spectrum. The values of absorptance and emittance were calculated from the measured reflectance values. The results indicate that the optimum combination of the highest absorptance in the solar region and the lowest emittance in the infrared of the black chrome plated on commercially electroplated tin is obtained for a black chrome plating time of between one and two minutes. Author

N78-15563*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ERDA/NASA 100 KILOWATT MOD-O WIND TURBINE OPERATIONS AND PERFORMANCE
R. L. Thomas and T. R. Richards Sep. 1977 18 p refs Presented at Conf. on Wind Energy Conversion Systems, Wash., D. C., 19-21 Sep. 1977
(Contract E(49-26)-1028)
(NASA-TM-73825; ERDA/NASA-1028/77/9) Avail: NTIS HC A02/MF A01 CSCL 10B

The ERDA/NASA 100 kW Mod-0 wind turbine is operating at the NASA Plum Brook Station near Sandusky, Ohio. The operation of the wind turbine has been fully demonstrated and includes start-up, synchronization to the utility network, blade pitch control for control of power and speed, and shut-down. Also, fully automatic operation has been demonstrated by use of a remote control panel, 50 miles from the site, similar to what a utility dispatcher might use. The operation systems and experience with the wind turbine loads, electrical power and aerodynamic performance obtained from testing are described. Author

N78-15564*# Union Carbide Corp., Tonawanda, N.Y. Linde Div.
STUDY OF THE POTENTIAL FOR IMPROVING THE ECONOMICS OF HYDROGEN LIQUEFACTION THROUGH THE USE OF CENTRIFUGAL COMPRESSORS AND THE ADDITION OF A HEAVY WATER PLANT

C. R. Baker Dec. 1977 146 p refs
(Contract NAS1-14698)
(NASA-CR-145282) Avail: NTIS HC A07/MF A01 CSCL 21D

An approach to the liquefaction of hydrogen was developed which permits the application of standard centrifugal compressors in place of reciprocating machines. A second fluid, such as propane, is added to the hydrogen prior to compression to form a mixture having a molecular weight much greater than that of hydrogen alone, so that a standard centrifugal compressor can be used. After compression, the mixture is cooled to cryogenic temperature levels where the propane condenses out of the mixture and is separated as a liquid. Since a small amount of deuterium is produced during hydrogen liquefaction, the potential of recovering deuterium and selling it as a co-product was investigated. Deuterium, in the form of heavy water, can be used in certain nuclear reactors as a neutron moderator to reduce the neutron velocity and enhance the probability of neutron collision with uranium nucleii. Author

N78-15565# Massachusetts Inst. of Tech., Cambridge.
NONLINEAR DYNAMIC RESPONSE OF WIND TURBINE ROTORS Ph.D. Thesis
Inderjit Chopra Feb. 1977 230 p refs
(Grant NSF AER-75-00826)
Avail: NTIS HC A11/MF A01

The nonlinear equations of motion for a rigid rotor restrained by three flexible springs representing the flapping, lagging and feathering motions are derived using Lagrange's equations for arbitrary angular rotations. These are reduced to a consistent set of nonlinear equations using nonlinear terms up to third order. Author

N78-15566*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SOLAR CELL RADIATION HANDBOOK
H. Y. Tada (TRW Systems Group, Redondo Beach, Calif.) and J. R. Carter, Jr. (TRW Systems Group, Redondo Beach, Calif.) 1 Nov. 1977 400 p refs
(Contract NAS7-100)
(NASA-CR-155554; JPL-Pub-77-56) Avail: NTIS HC A17/MF A01 CSCL 10A

Solar cell theory cells are manufactured, and how they are modeled mathematically is reviewed. The interaction of energetic charged particle radiation with solar cells is discussed in detail and the concept of 1 MeV equivalent electron fluence is introduced. The space radiation environment is described and methods of calculating equivalent fluences for the space environment are developed. A computer program was written to perform the equivalent fluence calculations and a FORTRAN listing of the program is included. Finally, an extensive body of data detailing the degradation of solar cell electrical parameters as a function of 1 MeV electron fluence is presented. Author

N78-15567*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
A FIXED TILT SOLAR COLLECTOR EMPLOYING REVERSIBLE VEE-TROUGH REFLECTORS AND VACUUM TUBE RECEIVERS FOR SOLAR HEATING AND COOLING SYSTEMS Final Report
M. Kudret Selcuk Dec. 1977 149 p refs
(Contract NAS7-100)
(NASA-CR-155426; JPL-Pub-77-78) Avail: NTIS HC A07/MF A01 CSCL 10A

The usefulness of vee-trough concentrators in improving the efficiency and reducing the cost of collectors assembled from evacuated tube receivers was studied in the vee-trough/vacuum tube collector (VTVTC) project. The VTVTC was analyzed rigorously and various mathematical models were developed to calculate the optical performance of the vee-trough concentrator and the thermal performance of the evacuated tube receiver. A test bed was constructed to verify the mathematical analyses and compare reflectors made out of glass, Alzak and aluminized FEP Teflon. Tests were run at temperatures ranging from 95 to 180 C. Vee-trough collector efficiencies of 35 to 40% were observed at an operating temperature of about 175 C. Test results compared well with the calculated values. Predicted daily useful heat collection and efficiency values are presented for a year's duration of operation temperatures ranging from 65 to 230 C. Estimated collector costs and resulting thermal energy costs are presented. Analytical and experimental results are discussed along with a complete economic evaluation. Author

N78-15568*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PROJECTION OF DISTRIBUTED-COLLECTOR SOLAR-THERMAL ELECTRIC POWER PLANT ECONOMICS TO YEARS 1990-2000
T. Fujita, N. ElGabalawi, G. Herrera, and R. H. Turner Dec. 1977 90 p refs
(Contract NAS7-100)
(NASA-CR-155427; JPL-Pub-77-79) Avail: NTIS HC A05/MF A01 CSCL 10B

A preliminary comparative evaluation of distributed-collector solar thermal power plants was undertaken by projecting power plant economics of selected systems to the 1990 to 2000 time frame. The selected systems include: (1) fixed orientation collectors with concentrating reflectors and vacuum tube absorbers, (2) one axis tracking linear concentrator including parabolic trough and variable slat designs, and (3) two axis tracking parabolic dish systems including concepts with small heat engine-electric generator assemblies at each focal point as well as approaches having steam generators at the focal point with pipeline collection to a central power conversion unit. Comparisons are presented primarily in terms of energy cost and capital cost over a wide range of operating load factors. Sensitivity of energy costs for a range of efficiency and cost of major subsystems/components is presented to delineate critical technological development needs. Author

N78-15570# Chicago Univ., Ill.
NON-IMAGING CONCENTRATORS FOR WIDE ANGLE COLLECTION OF SOLAR ENERGY, 2 Progress Report, 1 Jul. 1976 - 30 Apr. 1977
R. Winston Apr. 1977 21 p refs
(Contract EY-76-S-02-2446)
(COO-2446-8) Avail: NTIS HC A02/MF A01

The principles of nonimaging concentration and their applications for solar energy collection were studied in an effort to optimize the design of CPC solar thermal collectors for electric power generation. The optics of a Fresnel lens mirror concentrator, the thermal performance of nonevacuated and evacuated receivers, and the optics of a liquid filled internally reflecting CPC are discussed along with a demonstration project using the CPC solar thermal collectors. Results show that the collectors using nonimaging concentrators coupled to evacuated tubular receivers are capable of delivering high thermal efficiencies with a nontracking distributed array of relatively inexpensive collectors. J.M.S.

N78-15571# Colorado School of Mines, Golden. Dept. of Chemical and Petroleum Refining Engineering.
CLEAN SOLID AND LIQUID FUELS FROM COAL Quarterly Progress Report, Jul. - Sep. 1976
J. H. Gary, J. O. Golden, R. M. Baldwin, R. L. Bain, and D. W. Dickerhoof Oct. 1976 25 p
(Contract EX-76-C-01-2047)
(FE-2047-2) Avail: NTIS HC A02/MF A01

Research being done with the goal of producing an environmentally acceptable fuel from coal is disclosed. This fuel may be either solid or liquid, depending upon processing conditions and operational mode chosen. An ash-containing low sulfur, low nitrogen fuel that may be burned in new and existing power generating facilities is the primary objective, while the production of a suitable refinery feedstock is secondary. The work scope covers sulfur removal using nacent hydrogen in a bench scale pilot plant, catalytic hydrodenitrogenation of coal-derived liquids, improved solid-liquid separation characteristics for coal liquids and improved analysis techniques for sulfur, nitrogen and characteristic compounds found in coal liquids. The process under development uses conventional chemical engineering equipment and does not entail the consumption of pure hydrogen in the initial liquefaction/desulfurization step. This process will ultimately allow greater utilization of our fossil fuels without deteriorating the environment by the emission of pollutants. Author

N78-15573# Sandia Labs., Albuquerque, N. Mex.
STRUCTURAL EFFECTS IN CHEMICALLY SPRAYED CdS/Cu/SUB X/S PHOTOVOLTAIC CELLS
R. S. Berg and R. D. Nasby May 1977 40 p refs
(SAND-76-0737) Avail: NTIS HC A03/MF A01

A chemical spray technique was explored, as used in the fabrication of cadmium sulfide/copper sulfide photovoltaic devices. The technique can be integrated into a float glass substrate plant and utilizes pyrolysis of the chemical solutions by spraying onto hot substrates. The structures and morphologies of the various layers are described and growth characteristics discussed. Effects of the resulting structures on device properties are also considered. Author

N78-15575# Parsons (Ralph M.) Co., Pasadena, Calif.
OIL/GAS COMPLEX CONCEPTUAL DESIGN/ECONOMIC ANALYSIS: OIL AND SNG PRODUCTION
J. B. OHara, G. H. Hervey, S. M. Fass, N. E. Jentz, H. W. Klumpe, B. I. Loran, E. A. Mills, and R. V. Teeple Mar. 1977 320 p refs
(Contract EX-76-C-01-1775)
(FE-1775-8; IR-4; R-and-D-Rept-114) Avail: NTIS HC A14/MF A01

A commercial complex is designed to mine high-sulfur coal and produce substitute natural gas, fuel oil, naphtha, and liquefied petroleum gases using hydroliquefaction technology for the coal conversion portion of the complex. The design uses the solvent refined coal hydroliquefaction and entrained slagging gasification programs, with adaptation to the specific oil/gas objectives. Pseudo catalytic SRC hydroliquefaction techniques are used in which a portion of the hydroliquefier effluent is recycled to the hydroliquefier reactor to provide a higher content of ash constituents, longer reaction time, and greater hydrogen consumption to produce products that are primarily gases and liquids at ambient conditions. The design basis was developed in cooperation with ERDA. Process flowsheets and heat and material balances are presented. ERA

N78-15576# Northern Arizona Univ., Flagstaff.
GENERALIZED NUMERICAL MODEL FOR PREDICTING ENERGY TRANSFERS AND PERFORMANCE OF LARGE SOLAR PONDS
B. W. Davis, J. A. Day, and A. Iantuono 12 May 1977 28 p refs Prepared jointly with California Univ., Livermore, Lawrence Livermore Lab.
(Contract W-7405-eng-48)
(UCRL-13722) Avail: NTIS HC A03/MF A01

The code is used to optimize the design and operation of a large solar pond at a uranium milling facility in New Mexico. The code predicts that two inches of glass foam insulation will reduce the energy losses by more than 20% over the no-insulation condition. The code also provides information about the energy delivered in response to a myriad of variation in the fill/empty cycle. Other information available from the code are the temperature response of the earth underneath the ponds at discrete points to a depth of 40 ft., the average instantaneous temperature response of the water during any day of the year, the individual loss components by radiation, convection and conduction given instantaneously throughout any day of the year, the instantaneous values of loss coefficients during the day, and instantaneous values of efficiency during any day of the year. A brief discussion of extensions of the code is also presented. ERA

N78-15578# Lincoln Lab., Mass. Inst. of Tech., Lexington.
PHOTOVOLTAIC APPLICATIONS IN THE SOUTHWEST FOR THE NATIONAL PARK SERVICE
C. R. Peatfield and P. O. Jarvinen 28 Apr. 1977 38 p ref
(Contract EY-76-C-02-4094)
(COO-4094-3) Avail: NTIS HC A03/MF A01

Nearly three megawatts of electrical power are produced annually by diesel/electric generator sets at National Park Service sites. To prove the economic viability of photovoltaic power generation systems to meet NPS electric power needs as well as to stimulate public acceptance and reliance on solar-generated electricity, NPS and MIT/LL are cooperating in a field tests and applications project sponsored by the U.S. Energy Research and Development Administration. The power level for the applications will be in the range from 10 to 100 kW. The most promising NPS sites were visted and evaluated. Based on ten criteria, Natural Bridges National Monument in Utah was selected as the optimum first pick. The FT and A Project and evaluation details for ten sites are described. ERA

N78-15579# California Univ., Berkeley. Lawrence Berkeley Lab.
PERFORMANCE OF AN EXPERIMENTAL SOLAR-DRIVEN ABSORPTION AIR CONDITIONER Annual Report, Jul. 1975 - Sep. 1976
K. Dao, Melvin Simmons, Richard Wolgast, and Michael Wahlig Jan. 1977 67 p
(Contract W-7405-eng-48)
(LBL-5911) Avail: NTIS HC A04/MF A01

The development of a heat-actuated air conditioner that can operate with the temperatures available from flat plate solar collectors and use air cooling for disposal of the waste heat was explored using the ammonia water absorption cycle. Results of initial tests of an experimental system that fabricated to provide basic engineering data on the operation of the ammonia-water absorption cycle under such conditions are presented. ERA

N78-15581# Sandia Labs., Albuquerque, N. Mex.
ENVIRONMENTAL ISSUES ASSOCIATED WITH SOLAR HEATING AND COOLING OF RESIDENTIAL DWELLINGS
P. J. Brannon, H. W. Church, R. E. Luna, and W. A. Thomas Apr. 1977 47 p refs
(Contract EY-76-C-04-0789)
(SAND-77-0172) Avail: NTIS HC A03/MF A01

The negative issues associated with solar heating and cooling of residual dwellings were surveyed. Effects which were addressed as possibly significant include: (1) heat transfer fluids and storage media hazards, (2) material resources usage, (3) architectural and aesthetic changes, (4) air pollution due to outgassing or evaporation losses, (5) reflected light hazards, and (6) legal questions arising from reflected light nuisances and solar rights. The magnitudes of these environmental effects were compared to similar effects from common sources whenever possible. ERA

N78-15582# Sandia Labs., Albuquerque, N. Mex.
SOLAR IRRIGATION PROGRAM Status Report, Oct. 1976 - Jan. 1977
R. L. Alvis Apr. 1977 64 p refs
(Contract EY-76-C-04-0789)
(SAND-77-0380) Avail: NTIS HC A04/MF A01

The solar irrigation program initially consisted of a shallow well experiment now under construction in New Mexico. It has recently been expanded to include a deep well experiment in Arizona and a follow-on, as yet undefined, demonstration system. Technical discussions of the shallow well experiment design are presented and analyses are given which support the design choices selected. ERA

N78-15583# Martin Marietta Corp., Denver, Colo.
CENTRAL RECEIVER SOLAR THERMAL POWER SYSTEM, PHASE 1 Final Annual Progress Report, 30 Sep. 1976
Feb. 1977 209 p
(Contract EY-76-S-03-1110)
(SAN/1110-76/3; MCR-76-526) Avail: NTIS HC A10/MF A01

Primary efforts were the preparation of the pilot plant preliminary design baseline, and the conceptual design of the three subsystem research experiments. The preliminary design baseline for the pilot plant was developed from the commercial plant conceptual design defined prior to the start of this program. For each of the solar peculiar subsystems, the collector subsystem, the receiver subsystem and the thermal storage subsystem, the receiver subsystem and the thermal storage subsystem, a subsystem research experiment was prepared and reviewed in order to obtain authorization for the design, build and test of these experiments. ERA

N78-15584# Polyset, Inc., Manchester, Mass.
DEVELOPMENT OF A FREEZE-TOLERANT SOLAR WATER HEATER USING CROSSLINKED POLYETHYLENE AS A MATERIAL OF CONSTRUCTION Progress Report, 5 Jan. - 15 Mar. 1977
J. M. Bradley 1977 6 p
(Contract EY-76-C-02-2956)
(COO-2956-5) Avail: NTIS HC A02/MF A01

A total of 15 10 ft coils of crosslinked tubing were subjected to repeated freezing and thawing. The composition of the crosslinked polyethylene and the stress in the wall of the tubing are parameters which are being studied to find a crosslinked polyethylene composition which will be strong and resilient enough to withstand repeated freezing and thawing without necessitating excessively thick walls. The results are presented. The two formulations used in the coils appear sufficiently promising to be used in the construction of the collectors which will be performance tested at Los Alamos. ERA

N78-15585# Virginia Polytechnic Inst. and State Univ., Blacksburg.
EVALUATION AND TARGETING OF GEOTHERMAL ENERGY RESOURCES IN THE SOUTHEASTERN UNITED STATES Progress Report, 1 Nov. 1976 - 31 Mar. 1977
J. K. Costain, L. Glover, III, and A. K. Sinha 1977 155 p refs
(Contract EY-76-S-05-5103)
(VPI-SU-5103-3) Avail: NTIS HC A08/MF A01

Targeting procedures for the evaluation of low temperature radiogenically derived geothermal resources in the eastern United States were developed and applied utilizing geological, geochemical, and geophysical data. Detailed study of the Liberty Hill and Winnsboro plutons, South Carolina, is continuing in order to provide insight into the behavior of uranium and thorium in unmetamorphosed granitic plutons during periods of crystallization, deuteric alteration and weathering. Accessory uraninite found in the Liberty Hill pluton, and molybdenite mineralization occurs in both the Liberty Hill and Winnsboro plutons. The molybdenum mineralization is present in a number of 300 m.y. granitic plutons in the southeastern U.S. A steep metamorphic gradient across the Roxboro, North Carolina, Metagranite should provide a good opportunity to study the effect of prograde metamorphism on the distribution of uranium and thorium. ERA

N78-15586# Boeing Co., Seattle, Wash. Engineering and Construction Div.
TECHNICAL AND ECONOMIC ASSESSMENT OF PHASE CHANGE AND THERMOCHEMICAL ADVANCED THERMAL ENERGY STORAGE (TES) SYSTEMS. VOLUME 2: PHASE CHANGE TES SIZING COMPUTER PROGRAM Final Report
Dec. 1976 92 p refs
(EPRI Proj. 788-1)
(EPRI-EM-256-Vol-2) Avail: NTIS HC A05/MF A01

The computer program used in conceptual studies of phase change thermal energy storage systems is described. The model assumes the phase change media contained in a tube-bath configuration. The program was used in conjunction with, but is not necessarily limited to, a high temperature, gas-cooled solar power plant. The program represents a computer implementation of the engineering equations used to estimate the size and cost of a given phase change storage system design concept. A description of the model is presented as well as a description of the inputs and outputs of the program. ERA

N78-15587# Boeing Co., Seattle, Wash. Engineering and Construction Div.
TECHNICAL AND ECONOMIC ASSESSMENT OF PHASE CHANGE AND THERMOCHEMICAL ADVANCED THERMAL ENERGY STORAGE (TES) SYSTEMS. VOLUME 3: THERMOCHEMICAL TES SIZING COMPUTER PROGRAM Final Report
Dec. 1976 96 p refs
(EPRI Proj. 788-1)
(EPRI-EM-256-Vol-3) Avail: NTIS HC A05/MF A01

The computer program used to size and evaluate the SO_2/SO_3 thermochemical energy storage device for application with the high temperature gas cooled solar power plant is described. A description of the program and how it is used including inputs, outputs and operating instructions is also included. ERA

N78-15588# Lockheed Missiles and Space Co., Huntsville, Ala. Huntsville Research and Engineering Center.
DEVELOPMENT STATUS AND ENVIRONMENTAL HAZARDS OF SEVERAL CANDIDATE ADVANCED ENERGY SYSTEMS Final Report, Dec. 1975 - Feb. 1976
Morris Penny and Sidney V. Bourgeois Jun. 1977 111 p refs
(Contract EPA-02-1331)
(PB-272759/2; EPA-600/7-77-062) Avail: NTIS HC A06/MF A01 CSCL 10B

The development status of several advanced energy concepts is reviewed and the primary environmental hazards of each system are discussed. Systems include potential new sources of energy and improved energy conversion. Each system was evaluated with respect to its development status, and estimates were made as to when each will begin to contribute significantly to U.S. energy needs. Appraisals were made of the environmental impact of each system including assessment of the adequacy of pollution control technology and potential gross ecological impact. GRA

N78-15589# Lockheed Missiles and Space Co., Huntsville, Ala. Huntsville Research and Engineering Center.
ASSESSMENT OF LARGE-SCALE PHOTOVOLTAIC MATERIALS PRODUCTION Final Report
Martin G. Gandel, Paul A. Dillard, D. Richard Sears, S. M. Ko, and S. V. Bourgeois Aug. 1977 128 p refs
(Contract EPA-68-02-1331)
(PB-272604/0; LMSC-HREC-TR-D497252; EPA-600/7-77-087) Avail: NTIS HC A07/MF A01 CSCL 10B

Solar cell production at rates needed to supply continuously 1% of projected U.S. power requirements in the year 2000 is examined. Si and CdS are followed from raw material extraction to finished cell; GaAs is reviewed less thoroughly. Numerical data are developed for air, water, and solid wastes, and compared with corresponding effects of equivalent coal-electric power. GRA

N78-15590# Oak Ridge National Lab., Tenn.
ENERGY CONSERVATION AND THE ENVIRONMENT Progress Report, 1 Jan. - 30 Jun. 1974
R. S. Carlsmith Sep. 1974 72 p refs
(Contract W-7405-eng-26; Grant NSF AG-398)
(PB-272428/4; ORNL/NSF-EP-77; NSF/RA/N-74-100) Avail: NTIS HC A04/MF A01 CSCL 10A

The research emphasizes energy conservation in the residential sector. Experimental investigations attempt to determine optional insulation standards for mobile homes. The program started with a comparison of energy intensiveness for the various transportation modes. Subsequent research was devoted to detailed analysis of automobiles, airplanes, and bicycles. Policy options were reviewed to determine potential impact in reducing overall energy consumption, reducing the energy intensiveness of a mode, and in promoting shifts toward the less energy intensive modes in the statistical analysis of electricity demand growth, earlier projections are compared to actual recent experience. The comparison shows a clear advantage in using the econometric models over the traditional approach of extrapolating previous trends. The first phase of research on coal supply costs was completed and findings demonstrate a sharp rise in costs for surface mining on steep slopes. Brief summaries are given of results; each section lists references to topical reports and technical papers. GRA

N78-15605# Radian Corp., Austin, Tex.
HYDROCARBON POLLUTANTS FROM STATIONARY SOURCES Final Report, Dec. 1975 - Jun. 1976
E. C. Cavanaugh, M. L. Owen, T. P. Nelson, J. R. Carroll, and J. D. Colley Sep. 1977 333 p refs
(Contract EPA-68-02-1319)
(PB-272784/0; EPA-600/7-77-110) Avail: NTIS HC A15/MF A01 CSCL 13B

Readily available information was assembled on stationary sources of hydrocarbon emissions and effluents. Information was also obtained on process descriptions, operating parameters, current controls, and control problems. As the data base was assembled, the data were divided into major categories for subsequent evaluation. Pollutants from process streams were evaluated along with fugitive emissions associated with equipment leaks. Emissions were also included from open sources and from natural sources. Information in each category was divided into logical classes and grouped for further assessment of emissions and effluents from processes and operations. A list of the emission and effluent rates from the processes and operations studied was compiled. Major emission and effluent sources in each category were identified and assessed as to source controllability. GRA

N78-15606# Research Triangle Inst., Research Triangle Park, N. C.
LITERATURE SURVEY OF EMISSIONS ASSOCIATED WITH EMERGING ENERGY TECHNOLOGIES
J. E. Sickles, II, W. C. Eaton, L. A. Ripperton, and R. S. Wright Sep. 1977 77 p refs
(Contract EPA-68-02-2258)
(PB-272550/5; EPA-600/7-77-104) Avail: NTIS HC A05/MF A01 CSCL 21D

A literature survey was conducted to address fuel contaminants and atmospheric emissions from the following energy-related operations: coal gasification, coal liquefaction, shale oil production, and petroleum refining. Sulfur and nitrogen found in coal, coal liquid product, shale oil, and petroleum crude are, for the most part, organically bound. Only coal was found to have substantial amounts of inorganic contaminants, and this was as pyrite (FeS_2). Quantitative estimates of criteria air pollutant emissions from energy-related operations are tabulated. A broad spectrum of sulfur-containing compounds, nitrogen-containing compounds, and hydrocarbons has been identified from analyses of intermediate process streams and final products from fuel conversion processes. The surveyed literature provides a basis for identifying the major emissions. The same or similar species are expected to be emitted from each fuel conversion facility. GRA

N78-15607# Institute of Gas Technology, Chicago, Ill. Applied Combustion Research.
BURNER DESIGN CRITERIA FOR NOx CONTROL FROM LOW-Btu GAS COMBUSTION. VOLUME 1: AMBIENT FUEL TEMPERATURE Final Report
Donald R. Shoffstall Aug. 1977 120 p refs
(Contract EPA-68-02-1360)
(PB-272614/9; EPA-600/7-77-094a) Avail: NTIS HC A06/MF A01 CSCL 21D

Results are given of a research program initiated to characterize problems associated with retrofitting existing utility boilers with low- and medium-Btu gases produced using commercially available coal conversion processes. All experimental results were gathered from a pilot-scale furnace fired with a movable-vane boiler burner at a heat input of 0.66 MW (2.25 million Btu/h). The synthetic gases tested, ranging in heating value from 3.7 to 11.2 MJ/cu m (100 to 300 Btu/SCF), were produced using a natural gas reformer system. Data were collected to permit a comparison between natural gas and the synthetic gases in the areas of flame stability, flame length, flame emissivity, furnace efficiency, and NOx emissions. Flame stability was found to be very sensitive to fuel jet velocity. An injection velocity of 30.5 m/s (100 ft/s) was found to be optimum. Flame length decreased with increasing movable-vane angle (swirl of the combustion air); flames of the synthetic gases tested generally were shorter than those of natural gas. Good agreement was obtained between measured and calculated flame emissivities. Some boiler modifications would be necessary to maintain rating when burning gases of less than 7.5 MJ/cu m (200 Btu/SCF) heating value. NO emissions were ordered by adiabatic flame temperature. The NO emissions data yielded an activation energy of 153 kcal/mole compared to kinetic model predictions of 135 kcal/mole. GRA

N78-15657# Sandia Labs., Albuquerque, N. Mex. Environmental Research Div.
NEW DETAILS ON WIND POWER CLIMATOLOGY
J. W. Reed 1977 26 p refs Presented at the Am. Wind Energy Assoc. Meeting, Boulder, Colorado, 13 May 1977
(SAND-77-0696C; Conf-770539-1) Avail: NTIS HC A03/MF A01

The national isodyn map of average available wind power was used to help select fifteen stations, representative of interesting wind power climatic regimes, for detailed analyses of ten-year records of hourly wind speed observations. These long time series have been corrected for observer bias, homogenized to constant anemometer exposures, and extrapolated to select heights 10m, 20m, and 50m above flat terrain. Various analyses have shown that correction generally gave results in excellent agreement with the national isodyn contours, turbine cut-in and cut-off speed selections were not critical to power recovery efficiency, turbine rate speed needs to be tailored to the regional wind climate, stand-alone systems require huge storage filters to smooth annual and inter-annual variations in supply, and modest storage will effectively filter periodicities of a few days in both supply and demand. ERA

N78-15956# Midwest Research Inst., Kansas City, Mo.
ENVIRONMENTAL ASSESSMENT OF WASTE-TO-ENERGY PROCESSES: SOURCE ASSESSMENT DOCUMENT
K. P. Ananth, L. J. Shannon, and M. P. Schrag Aug. 1977 81 p refs
(Contract EPA-68-02-2166)
(PB-272646/1; EPA-600/7-77-091) Avail: NTIS HC A05/MF A01 CSCL 13B

Environmental impacts are identified which result from waste-to-energy conversion processes. These processes are: (1) waterwall incinerators; (2) combined firing systems; (3) pyrolysis processes; (4) hog-fuel boilers; (5) biochemical systems; and (6) advanced combustion systems. Constituents in solid wastes illustrating the diverse nature of the feedstock used in such systems. An environmental impact analysis is presented based on the contribution of each waste-to-energy conversion system to criteria and other major pollutants. GRA

N78-15957# EG and G Washington Analytical Services Center, Inc., Rockville, Md.
SAMPLING OF WATER AND WASTEWATER Final Report
Philip E. Shelley Aug. 1977 322 p refs Revised
(Contract EPA-6-99-3131)
(PB-272664/4; EPA-600/4-77-039) Avail: NTIS HC A14/MF A01 CSCL 13B

The general characteristics of the source flows are described, and the mechanics of polydisperse systems as they affect sample gathering are discussed. The various types of samples are defined and compared and their use indicated. Each of the elements of an automatic sampler is discussed from the viewpoint of design considerations in order to help the readar assess the ability of a particular unit to meet his needs. Commercially available samplers and some custom designed equipment are reviewed. GRA

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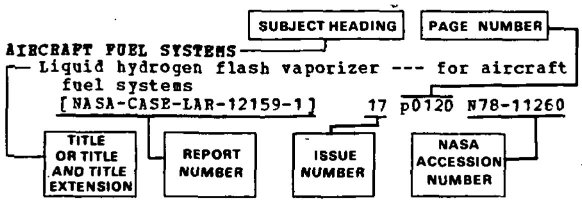

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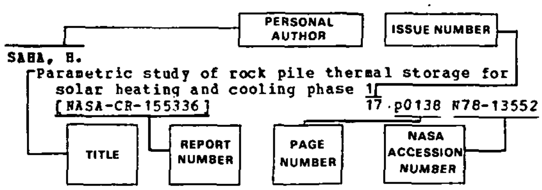

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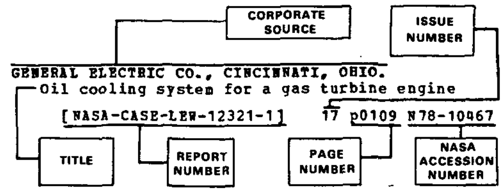

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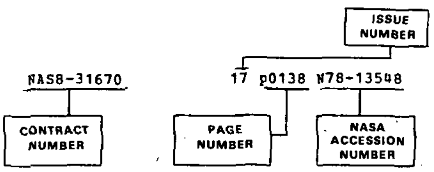

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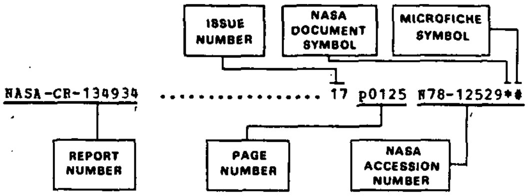

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