The Space Congress® Proceedings

1974 (11th) Vol.2 Technology Today for Tomorrow

Apr 1st, 8:00 AM

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INTERNATIONAL ENERGY PROBLEMS AND ENVIRONMENTAL POLICY

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I. INTRODUCTION

Energy -- the ability to work -- is essential to our economic welfare, productivity and our living standards. Before the recent oil embargo, it was said that a gallon of oil (or its equivalent in other forms of energy) provides power for the economic activity associated with two dollars of gross national product. However, the raw material cost of that oil at the point of production was only 7 percent of this gross national product value.

In the aftermath of the embargo, there is grave concern that the United States will become overly dependent on imports of oil, and will not be able to meet its energy requirements without which the nation will see its national income drop sharply. Unfortunately we share this energy predicament with most industrialized countries. Primary sources such as hydro power, petroleum, natural gas, solid coal, and uranium are insufficient to meet future demands of the World economy, unless other primary nonfossil fuel can be developed.

The uses of energy also have some adverse environmental impacts associated with generation of energy (oil drilling, coal mining, water storage), delivery (oil spills, transmission lines, exhaust fumes), and misapplications (glare, noise, debris). In large part, the adverse side effects are a sign of inefficiency. Environmental enhancement will gain as efficiencies improve, as technology develops new sources, such as hydrogen or solar sources, and as customers accept the higher costs of cleaner fuels, such as synthetic gas.

II. THE UNFOLDING WORLD-WIDE ENERGY SHORTAGE

1. A decade of inept policies (by government, industry and academe) gave preference to short-term experiency over long-term planning, and condoned profligate use of energy with much waste.

A paper to the Eleventh Space Congress, Cocoa Beach (Fla.) April 18, 1974

2. The Organization of Arab Petroleum Exporting Countries began leaning on the international companies long before October 6, 1973: A number of unprecedented demands (e.g. increased taxes and royalties, participation agreements and, in some cases, nationalization - in others, even veiled threats of expropriation) resulted in sharp escalation of oil prices to the consuming nations. In September 1973 oil prices had already reached a level 3 to 4 times higher than 5 years ago and experts were predicting that crude oil prices might reach $8-10 per barrel by 1980. By New Year's Eve, 1974 they had reached 720% of 1970, or $10.3 $/barrel CIF, Philadelphia for Lybian crude and $10/barrel for U.S. domestic "free" oil. While European monetary experts were still debating how the Arab riches would be invested, and the degree to which the weakened and floating dollar was a sign of U.S. vulnerability, they obviously did not expect the embargo to hit them, nor that all consuming countries would become a target for redistribution of wealth on a world-wide scale threatening in the process the foundations of the international monetary system. Chart 1 illustrates this trend.

3. The benign neglect of energy matters in the last two Administrations is illustrated by the following errors in the energy forecasts: The Cabinet Task Force on the Relationship of Oil Imports to National Security, which labored from March 1969 through February 1970, predicted that oil demand in 1980 would be 19 million bpd, (barrels per day) of which domestic production would provide 13.5 million; the remaining 4.5 million bpd would be imported, but only 1.5 million (or less than 10% of our needs) would come from the Eastern Hemisphere (which also includes some "moderate" countries in the Middle East, with no position in the Arab-Israeli conflict, and African producers). (The Western Hemisphere was considered safer.) In 1973 our demand already reached 18.8 million bpd; domestic production has dropped to 11.0 million, and we needed to import over

7 million barrels, of which 4.5 million - or 25% - of our demand was expected to come from the Eastern Hemisphere. Still, in February 1973, the then head of the Domestic Council was telling the Detroit Economic Club that there could be no energy crisis and the mistakes of the past were being remedied.

4. While we are much less dependent on oil imports than other developed countries, our present vulnerability to the skyrocketing price rises is due to the estimate that we will need to import, in 1980, 14 million bpd, or 58% of our total demand, of which 50% is expected to come in greater part from the Eastern Hemisphere, and some other OPEC countries. Only Saudi Arabia and Iraq have oil reserves that are large enough to increase exports sufficiently to avoid an energy shortage of severely damaging proportion in the U.S. (Our suppliers from the Western Hemisphere, i.e., Canada and Venezuela, either are not in a political mood for joint energy policy with the U.S., or have committed elsewhere their exportable production.)

While there may be hope that we will increase domestic discoveries, or increase production of coal or nuclear power, the deficit is of such magnitude that conservation measures - however necessary - can not give us sufficient relief, without going to the brink of lasting economic dislocation and unemployment.

5. By their production cuts, selective export bans and unprecedented price increases, the Arab States are waging economic warfare on a number of the world's main consuming countries, which must, without delay, reappraise their energy policies.

Western Europe, which is normally dependent on the Arab States for over 70 per cent of its crude oil supplies, is being severely affected by the OAPEC production costs. (e.g. The Netherlands imported 86% of its 1972 oil requirement from the Arab countries; the French 63%; the U.S. only 9.6%, but it is rising rapidly - probably will reach 25% in 1980.) Our total oil imports from all sources are 32.4% of our total petroleum demand.

6. The overall effect on domestic unemployment is the one to watch first: It has been estimated by experts that a drawdown of 500,000 KW of power may bring 300,000 out of work, and that a shortage 275,000 barrels of oil per day could cost 600,000 jobs. Thus, a year-long shortage of 3 million bpd could cost 6.5 million jobs. We have been short, during the embargo, of 1.6 million barrels, and our unemployment has risen from 4.6% to 5.2%. (These figures are purely illustrative, for effects vary in time and place.)

7. The oil embargo also brings with it a drain on the balance of payments, due to higher prices for imported oil. The monetary impact has hit Europe worse than the U.S., and this is one of the reasons why it is clearly disrupting further the Atlantic Alliance: Our NATO Allies are resentful that our stand in the Middle East and the escalating demands of OPEC may bring about a permanent debasement of European currencies.

The fact of the matter is that the Atlantic Alliance is already in disarray: It has been beclouded by a number of misunderstandings and anxieties, with suspicions rampant on both sides for quite some time. The U.S. were alone in the days of Vietnam (after shouldering alone, for over a decade the cost of Aid to the Free World and most of the costs of defending Western Europe, and seeing some of our European allies deny us access to World markets while talking down the U.S. dollar). On their side, European statesmen fear - with much basis in experience - that we may well plunge the world into a conflict - or detente - without consulting our NATO allies, which resent the magnitude of our investments in Europe and suspicion of our monetary policy.

III. WORLD ENERGY DEMAND AND WORLD ECONOMY

1. The most recent year for which the UN has population, GNP, total energy per capita, electricity per capita, and power generation per dollar of GNP has been computed for some forty-nine countries, is the year 1968. Much has changed since then: A plot of GNP per capita in 1968 U.S. dollars against the 1968 total per capita consumption of energy will not take into account the outstanding industrial progress since 1968 in certain countries, and the uneven inflationary trends in others. Thus when we plot total GNP against the total energy per capita, the correlation is somewhat more scattered. A closer look at the parameters of World energy demand, and some computer simulation reveals a few interesting correlations: When we plot the fraction of total energy demand which is electrical, against the electric energy per dollar of GNP with GNP per capita, we find that countries which consume a large portion of their energy in form of electric power are more dependent on reliability of that service than on petroleum supplies. A plot of the gross national product per capita against the apparent load factor for 1969 reveals that four countries have a better apparent load factor than the U.S.: Canada, Taiwan, Japan, and Israel. Charts

2-6 forecast the increase in world-wide energy demand for the balance of the century.

2. The gross national product of the entire world is 2.9 times that of the U.S. In other words, the U.S. generates 35% of all the goods, wealth and services per annum generated in the world. The rest of the world generates only 1.9 times that of the U.S. GNP. The portent of this is that if one reviews the gross national product per capita and sees that all of the many essential needs of the world, primarily those of food, shelter, health, education, transportation, employment, social welfare, etc., are all competitors for that part of the less than 3 trillion dollars of GNP available in the world, by no means all of which is disposable income.

This is particularly important in attacking the various energy problems relating to the environment: If we neglect to follow objectively cost-effective and efficient methods in selecting control strategies and trade-offs, then urgent capital-intensive energy facilities will not be able to find the necessary investment support.

3. The computer simulation of our US energy model (to be published elsewhere) reveals that while the energy problems of the U.S. appear to be bewildering, and of the highest priority, the comparable problems in the rest of the world are much more severe from almost any standpoint. Therefore, the U.S. should not only apply without delay its most creative capabilities to the alleviation of the world wide energy and concomitant environmental problems, but also share with the rest of the world the advanced research, the applied technology and the design of urgently needed equipment to avoid a very serious energy and capital bind.

IV. OUTLINE OF AN INTERNATIONAL ENERGY DEVELOPMENT PROGRAM

1. An energy shortage of severely disruptive and damaging proportion is a distinct possibility in the immediate future, in most consuming countries. In some, major economic stresses will come as a consequence of quantitative energy deficits between now and 1980. In others - particularly the poorer countries of the World, higher prices and uncertainty as to sources of supply will be the severest symptoms. In any event, it is necessary to act now to avoid shortages in the future, because to develop and operate new technology for energy materials, or better conversion methods will take not less than a decade.

Energy, environmental and other materials policies are interrelated and must be integrated to assure both continuing economic progress and cleaner air and water. When energy is in short supply, conflicts arising from demands for energy and for a quality environment may need to be resolved. Policy and regulation should be based on an analysis of all the costs and benefits. Events of the past few years have shown the need for flexibility in our regulations. (See X below.)

2. The need to expedite additional power facilities is pressing in all industrial countries. Slippage in expansion schedules will limit the energy supply seriously in the US, Europe and Japan, and since it is the same equipment capability that will be called to design large and modern installations for increased production and treatment of coal; for large refineries, for synthetic fuels, nuclear plants and other energy facilities, it would be quite useful to have international coordination in keeping under constant review and ranking some of these projects - and their equipment needs - in order of priority and vulnerability, to determine if they can be strengthened by fuel allocations, environmental variances, or other emergency measures.

3. To protect essential activities, during periods of emergency brought about by fuel shortage it is important to increase the inventories of fuels held in large centers of trans-shipment, in large consuming centers and in the hands of basic energy suppliers. Inventories should include as much environmentally acceptable low sulfur oil and low sulfur coal as possible. Tax incentives to utilities that will install standby facilities to use alternate fuels should be studied. Where tax incentives are not sufficient, the Governments should consider participating in the expense of stockpiling, at strategically selected power centers, preferably in the vicinity of or on power plant sites, a sufficient amount of low sulfur coal and other high quality fuels for prompt and emergency allocation to fossil fuel power plants. This emergency inventory would be used only when demands peak acutely, when emergencies interrupt supplies of fuel, or when weather conditions coincide with threats of a power blackout.

4. Nuclear energy is still expected to be a major source of energy in the long term but it is lagging now. If further slippage occurs in the nuclear

power schedule, the World will be even more dependent on fossil fuels. Individual projects of high urgency that may be plagued by procedural, scheduling, or engineering difficulties should be vigorously expedited. Public opposition -- here and abroad -- will continue to delay a number of nuclear projects. A candid educational campaign, to tell the public story "as it is" (e.g., that accidents can and do occur, but that standards are reviewed to seek complete safety), might restore confidence in the program. Correlation of the likelihood of radiation hazards with perils we accept daily in our lives may help the public to see the issues in perspective. International co-operation in the preparation of objective data and conclusions would be more reassuring -- and more objective than local litigations and debate over specific installations -- sometimes already too acrimonious for prompt public conclusion.

5. Among other measures to increase supply we would also mention accelerated exploration of the sea-beds for oil and gas, and a thorough review of the feasibility of modernizing and reopening some of the World's coal resources. Both areas cover large international assets that may reduce the oil deficit. In the case of the U.S., we have successfully advocated:

- a high priority for development of low-sulfur coals; and construction of transportation facilities to move this coal to the Middle West, or to where it will be needed in case of an emergency, with Government assistance, under plans formulated by the National Resources Council.

- financial incentives if necessary to equip, open and modernize certain low-sulfur mines to serve plants which must continue to use high cost/low-sulfur fuels.

- review of the desirability and magnitude of further commitments to export low-sulfur coals from the United States. Ongoing Congressional study of health and safety in the coal mines to determine how changes in procedures or cost allocation can relate the two objectives of protecting the miner and raising productivity through feasible health regulations which entail an acceptable, reduced, but practical risk.

- more attention to the technology of controlling stack emissions of power generating installations for which present technologies may be inadequate in some countries and more advanced in others. Since standards for stack emissions are likely to be tightened as we have to use less desirable qualities of coal.

Nevertheless, in the present period of energy gap, many countries are likely to allow temporary relaxation of emission standards to avoid a serious loss of capacity. The whole topic lends itself quite usefully to international technical consultation.

Since much of the additional low-sulfur coals output will be strip-mined, environmental concern will require surface reclamation procedures adapted to the physical conditions of the area.

- We believe that planning by industry, the States, and the Federal Government for esthetic reclamation of stripped sites can be coordinated with the roadbuilding, new cities, reforestation, landfill, and housing programs, to mesh remedial actions with the progress of mining. This concern is shared by engineers and conservationists in several European countries, and it is hoped that international engineering and energy experts will promptly look into the problem and compare results.

V. WORLD ENERGY CONSUMPTION TRENDS: 1960-1970

The combined energy requirements of the World rose to 4,920 Mtoe in 1970, expanding at an annual average rate of 4.9 per cent during the past decade (with an average consumption per capita in 1970 of nearly 1.5 t of oil equivalent).

Among the various forms of primary fuels, oil increased its share from 33 per cent in 1960 to 44 per cent in 1970. Whereas at the start of the decade, coal was the major world fuel, oil overtook coal towards the middle of the decade and now holds this premier position. Far behind oil in overall world significance, but yet showing the highest growth rate over the period is natural gas, which raised its contribution to overall requirements from 14 per cent in 1960 to 19 per cent in 1970.

VI. WORLD CONSUMPTION TRENDS: 1970-1980

During the decade of the 70's it is expected to increase from 4,920 Mtoe in 1970 to some 8,480 Mtoe in 1980, i.e., at an average annual rate of 5.6 per cent with demand for energy rising particularly in the Socialist countries and the "Third World."

Of the total energy demand projected for 1980, oil could claim some 48 per cent (exceeding 4 billion tons), coal some 25 per cent, gas 20 per cent, with the remainder made up of hydro and nuclear power. The latter is expected to be the fastest growing element (16 per cent per annum), largely in Western Europe and the U.S.A.

Oil and natural gas together dominate the world energy market and may provide in 1980 two-thirds of total requirements. The World energy problem, in a nutshell, is that world energy supplies are not in the area where major petroleum supplies are located, and the demand for energy is growing at different speed in various areas of the World. In addition, the present level of consumption between countries varies greatly, as seen below:

TABULATION I

ENERGY CONSUMPTION PER CAPITA PER ANNUM[1]

	In tons of oil equivalent 1960	1970	1980	1985
North America	5.7	7.8	11.2	12.7
Japan	0.9	2.6	5.5	7.8
Europe	1.8	2.8	4.4	5.5
Rest of world	0.5	0.6	0.9	1.3
Total World	1.0	1.35	1.9	2.5

[1]Source of population data: "Enquiry into Demographic Trends in Member countries," OECD Working Document, 1971; UN Demographic Yearbook; UN Monthly Bulletin of Statistics, November 1971.

VII. ENERGY AND ENVIRONMENTAL PROTECTION

1. In most industrial areas, environmental considerations are expected to gain in importance over the coming decade. Recent work in Energy suggests that one difference between the North American and European or Japanese situation is that assuming no additional abatement measures over and above those already planned, coal, rather than oil combustion, would in 1980 be responsible for the bulk of sulphur emissions. This reflects the high sulphur content of suitably located North American coal reserves.

2. The statistical material below (Chart 1 and Tabulation 4) show the correlations of energy demand with Gross National Product, which was considered to be a generally reliable guide of forecasting, until the U.S. provided an exception to this rule during the late 60's. As long as economic development remains a universal aspiration the demand for energy will increase with the World's GNP. However, any trend towards increasing efficiency or economy in the use of energy (substitution of more efficient for less efficient fuels or appliances, the secular increase in the average efficiency of power stations, new process methods in industry lowering the input of energy per unit of output) will lower the ratio. Conversely, a trend towards more energy-intensive, as opposed to less energy-intensive, industries, substitution of energy for other factors of production (perhaps associated with a higher level of technology), growth in labour productivity generally, will have a contrary effect; as will the general rise in the standard of living leading to higher heating standards and the purchase of more energy-intensive appliances.

3. Another disrupting factor in World energy demand is the trend in energy prices. The assumption of any shift in relative prices of substitutable energy forms will usually imply some substitution in the medium term. A rise in oil prices, for instance, not matched by equal increments for nuclear power would necessarily make the latter more attractive and hasten its development. Similarly, a rise or fall in the absolute price of energy in relation to prices of goods and services in general, would normally be expected to influence the use of energy as a whole. A relative hardening of energy prices would encourage development of less energy-intensive processes in industry, as well as the more rational use of energy in domestic and commercial sectors. (See Chart

The magnitude of the figures above shows the imperative need to review demand in the light of supply possibilities. Indeed, supply limitations are upon us -- quantitatively and in terms of security of supply as is mostly the case with European coal production and Middle East oil reserves.

4. Finally, measures to be undertaken which hopefully will lead to pollution abatement and to preservation of the environmental in themselves will require the expenditure of additional energy. A gallon of unleaded gasoline will not be able to do the work of a gallon of leaded

gasoline; thus, all things being equal, an automobile will consume more fuel per kilometre travelled in the future when the lead content of gasoline is either reduced or eliminated entirely. The continued surge in demand for "clean" electric power for industrial and household use will have an accelerating effect on primary energy consumption, e.g. coal, fuel-oil and natural gas burned to generate this electric power. In the generation process, some two-thirds of the heating value of the primary fuel is lost, implying that a shift to conventional electric power is not the environmentally safe approach to our energy needs as may be thought. Cleaning up the lakes and rivers and the disposal of large accumulations of solid wastes are not only going to be expensive in monetary terms, but will also involve a certain increase in energy consumption of the pollution abatement installations.

VIII. NEW SOURCES OF ENERGY

We live in a world economy and a high energy civilization that require the development of more adequate and cleaner sources of energy and impose the need to practice frugality in conversion and use of primary energy.

1. Since the demand for natural gas and crude oil is increasing faster than available supplies, it is now clear that nuclear energy will have to be used increasingly to reduce the dependence of the World Energy Program on exhaustible petroleum resources.

Unfortunately there is some delay in the international energy program: Although the safety record of nuclear power plants is good, their efficiency rating is not as high as expected, and there is much disagreement first on the radiation hazards and other environmental problems, and second on the relative merit of various types of nuclear reactors. To the public, the extent of the disagreement among the experts on nuclear safety is disturbing. As a result, the lack of public acceptance is seriously delaying nuclear power. Other debated points have to do with the size of the proposed World Nuclear Program: If the 2,000 nuclear plants that are projected were built by the end of the century, all available low-cost uranium supplies would be used up. That is why so much hope is vested in the Liquid Metal Fast Breeder Reactor, which makes (or breeds) more nuclear fuel than it uses.

The drawback of the fast breeder reactor is that it uses meterials - including plutonium - that are far more hazardous than uranium. Plutonium is the world's most toxic material: It could cause cancer in some organisms, including man; amounts the size of a grain of pollen. And in the breeder program, hundreds of tons of this material will be used. The breeder must, therefore, face far more difficult safety problems than the current generation of fission reactors. Although the first (small) experimental breeders have been operating without serious accidents, in the present public mood of apprehension it is not easy to predict whether the environmental problems will be more serious than with the present generation of reactors. We will know in 10 years or so.

2. At the other end of the spectrum - and probably 50 years into the future, is the fusion of the atom - the most hoped for alternative, since it is obviously the cleanest and safest form of nuclear energy: Fission, the process now used in our nuclear plants, splits the atom creating radioactivity. Fusion is the process of joining two atoms. Both create heat but fusion creates little dangerous activity.

The research on fusion will grow this year about 22 to 23 million dollars, which is about a 33% increase in funding. Different scientific approaches to fusion are being explored, but the development problems are still forbidding: We are trying to duplicate the reaction that takes place in the sun, and the sun has a temperature of millions of degrees. To contain that reaction so that we can operate in a controlled manner is probably the most challenging problem facing the next generation of scientists and engineers.

3. We are eagerly seeking ways to gasify coal, produce synthetic pipeline gas which has been an important component of our energy development. We are also looking for ways to liquify coal or produce synthetic crude oil, and trying to find new ways to burn coal so that we can remove the sulphur as we burn it, rather than to have to put large chemical plants on the end of generating stations so that we can remove the sulphur from the stack gas before it is discharged to the atmosphere.

Coal R&D is now in the order of 120 million dollars (25% up from a year ago). Fusion, solar energy, geothermal, these are other important, longer range energy sources and all of these programs are growing.

4. We have plenty of oil shale, which is another source of petroleum. And I think that in the next ten years we will begin to see oil from oil shale emerging from our western states, particularly if "in situ" methods prove to be feasible.

5. We are beginning to look for ways that permit us to use solar energy immediately so that we don't have to wait for the process to occur that converts our plants and decaying material into oil, coal, and gas.

Solar energy is very diffuse. We have to concentrate it, we have to raise the temperature of a fluid such as steam in generating plants so that we can actually convert it to electrical energy. But today we have 12 million dollars, and that is up by a factor of 3 from what it was a year ago and that was up a factor of 3 from the year before that. This is a rapidly growing program and we hope that it will yield results in the near future, particularly if we concentrate on heating and cooling, in geographical areas which are receptive to this form of energy.

6. Geothermal sources have been studied and advocated by United Nations experts for a number of years. It is essentially the energy that comes from the high temperature readings in the ground. In some places, nice hot dry steam (which is a perfect fluid) can be simply tapped, run up directly to the turbines, as done in the Geysers region of California, with cheap clean power as the end result.

7. I might add that magnetohydrodynamics, otherwise known as MHD, as one of the future options that some consider to be the solution to all our energy problems. MHD is not a new source, but only a new way of converting thermal energy we would get from coal or from a nuclear reaction to the electrical energy that goes into our transmission lines. The attractive thing about MHD is that it is far more efficient than the forty percent which is the best we now get in converting energy into electricity. (MHD efficiency is 60%.)

We started rather late to develop these alternative sources of energy, but in the federal energy budget, they have doubled in the last four years, to 770 million dollars in 1973. This may not be enough.

Industry analyses indicate that the per barrel price necessary to provide the economic incentives to bring forth:

Far offshore production (1,000 to 1,500 feet) is $7 ±

Coal Liquifaction (start now, production 1978) is $9 to $10

Tar sands (start now, production 1978) is $8 to $9

Tertiary recovery techniques by 1980 is $8 to $10

Shale oil (production by 1978) is $8 to $9

However without a realistic expectation that these prices will be available for a sufficiently long period to amortize such heavily capital-intensive programs, investors will be extremely reluctant to provide the billions in capital that will be necessary to encourage domestic self-sufficiency.

IX. INCENTIVES AND CONSTRAINTS IN ENERGY

1. The tax policies affecting energy and fuel producers, distributors and consumers in the U.S. as well as in other industrialized countries - were designed for fuel abundance and continuously decreasing energy prices. They served the world economy well, particularly in the decades of economic expansion where leveraged enterpreneurship was well rewarded.

2. Now that exploration for oil and gas is insufficient to meet the world petroleum demand, and that we are now in a cycle of economic and monetary uncertainty, of sharp escalation of energy prices, and the threat of liquidity crisis - the general use of taxes and subsidies to encourage exploration and development of primary energy resources will have to be considered (be it to stimulate exploration for much needed fuels, or to expedite plants or projects, or to modify wasteful energy consumption patterns).

3. In a free economy, such devices should be considered only in time of shortages, and in the U.S. tax incentives have been in force, for a number of years, to spur exploration and development of certain domestic natural resources, and every exploration and development abroad. There is a danger in removing these suddenly just as it becomes apparent that the magnitude of capital requirements may be the real constrictant in our energy problem.

Additional incentives may now be necessary to close the energy gap, but they should be fair, visible and sufficiently tangible and swift to be helpful in our predicament: We do not need a drilling boom comparable to that enjoyed in the 1947-1958 period.

Power conservation, R&D, and the substitution of one fuel for another are likely to be encouraged also by tax incentives.

4. Taxes and subsidies affect both resource allocation and income distribution.

- If a tax is levied on consumption of a particular energy source, the market price of that resource will increase. The extent of the increase depends on supply and demand elasticities. Higher prices reduce consumption of the energy item taxed. The greater the elasticity of demand, the greater will be the reduction in the amount demanded for any specific tax increase.

- Income from one source such as oil and gas production may be subject to relatively low tax rates, as provided for by percentage depletion allowances. Certain farm products receive a direct cash subsidy.

In all such instances, the pattern of resource allocation is modified, and at least the initial pattern of after-tax income distribution is affected. After a new equilibrium is established, rates of return on investments in the favored industries will return to normal, but the total of income to this sector of the economy will be increased.

5. Regulatory and Other Constraints that may cause delays to completion of much needed energy facilities are likely to bring about changes in the regulatory process. Such changes should be in the direction of streamlining, flexibility, and reducing the number of regulatory "stops."

A "crisis" already exists in the field of natural gas prices, and existing F.P.C. controls over the field price of natural gas enables existing consumers to obtain natural gas at low prices and use it lavishly, while many new consumers are unable to obtain gas supplies at any price. Some economists believe that field price controls of new gas supplies have outlived their usefulness, and that decontrol would bring forth larger supplies to help alleviate shortages. As the nation is entering into long-range commitments to import liquid natural gas and manufacture synthetic natural gas at a cost greatly in excess of the present regulated field price of natural gas, it is likely that de-regulation of the field price of natural gas in part or totally would be in the national interest. The costs and benefits of alternative systems - such as methane - should also be explored.

X. ENVIRONMENTAL POLICY AND ENERGY SUPPLY

1. It would be a serious error to assume that environmental protection and priority needs for energy are mutually exclusive. In the real world we have to face the lasting concern of public opinion for degradation of our air and water media, and while the control standards result in higher cost for energy, new energy facilities will now be designed to meet feasible pollution control strategies. The urgency and increased capital intensiveness of these facilities (and of new sources of energy) will make the cost of pollution abatement devices more acceptable than previously. For example:

- The cost of SO_2 removal from stacks of fossil-fueled power plants has been estimated at $30/KW. In 1970, the capital costs/KW installed were estimated at $200. Now that the cost has reached, by the end of 1973, $500/KW, the $30 figure is tolerable.

- Treatment of high sulfur coal or oil (to bring the S content down to reasonable or environmentally acceptable limits) was estimated to be between $3 and $5/Ton. When coal prices were about $8/Ton this environmental cost looked very high. Now that the low sulfur coal is priced as high as $30/Ton the cost of abatement may be acceptable.

2. There is a trade-off between energy and ecology. Once the parameters are defined, national policy will dictate a choice. A thorough feasibility and cost-effectiveness analysis is particularly important in this area, and would no doubt develop better solutions, since the environmental movement has been more problem-oriented than solution-oriented. Legislation may have progressed faster than data analysis necessary for policy formulation or trade-off. For example:

- There are those who feel that it is wrong to concentrate so heavily on control of sulphur emissions, since there is now a body of medical evidence that small size "hard" particulate particles are the most harmful emissions since they absorb sulphur and deposit it in the lungs. If we get rid of particulates the danger from sulphur emission would thus be greatly reduced.

- The air pollution control strategists reply that particulates are anyhow in the atmosphere, and if we relax abatement of sulphur emissions, it is likely that the SO_2 will go up and meet the particulates, and thus lead to sulphuric or nitric acid concentrations may become most nocive. However, this has not been proven, ad the biological question still remains to be resolved.

3. The cost of pollution abatement in the next decade has been estimated by the Council on Environmental Quality to be 2.5% of our GNP in the next 10 years, 2/3 of the cost to be borne by private sector. (Only 55% of total expenditure will be due to Federal initiatives.) But the cost estimating could usefully be refined to include various technological options, the effects of inflation, and the ability of industry -- and the consumer -- to bear the costs of pollution abatement that is passed on to them. The Ambient Air Quality Standards are not the same in various countries as shown by the chart below, nor do they affect various industries (at different locations) to the same extent.

4. On the international scene, the interface between environment and energy is of practical importance mainly in the industrialized countries (Japan, U.S., Western Europe), who also happen to be manufacturers of nuclear and fossil fueled power plants.

(a) --nocive effects of SO_2 and NOx (automobile exhaust fumes would be favorably affected by the switch to small specially designed passenger automobiles and to newly equipped mass transportation)

(b) --shift from oil and gas energy to larger utilization of coal will be handled by using the industry parameters of $5/ton of coal to comply with environmental strategies*

*With coal at $8/ton this was prohibitive. With low-sulfur coal now at $30 CIF, this may be tolerable.

- for fossil fueled power plants, $30/KW (with the KW at $150 installed) this was prohibitive. With present day costs of new power plants ($500/KW) this is tolerable

- chart 3 below entitled "Heavy Fuel Oil Desulfurization Costs," shows that to reduce the sulfur content of heavy crude from 2.6% to .6% the costs per barrel increase by 1.56-. 55= $1.00/barrel. Even if we add 25% for the increase in the index of chemical construction costs, the cost of making the fossil fuel environmentally acceptable will be $1.25 or 10-15% of the now prevailing heavy fuel oil cost.(See Charts 7&8)

XI. IN CONCLUSION

The realities of World Energy look as follows:

- rapidly increasing energy consumption is expected to nearly double by 1980, even with conservation measures. The demand for petroleum may increase four-fold by 2000, unless substitute energy sources can fill the gap.

- producing countries are in a strong position, and the trend to nationalization of producing properties is unlikely to increase supply.

- production may be restricted for political reasons, bringing about tight and precarious supply situations, in spite of sharply increasing prices.

- danger of recurring embargo if our dependence on imports of energy materials continues to increase, unless renewed exploration and a crash R&D effort help to bridge the gap until new fuels are available.

- the impact of the environmental movement will remain throughout the 70's and harmonious cooperation between industry and Government will be essential to mesh environmental protection, urban and transportation planning and land use with the priority need for energy.

- concern over finite reserves will challenge the geologist, but government rigidities and shortage of capital may remain service constraints.

- energy conservation is a new and challenging topic of R&D, and probably one of the most rewarding fields for scientific and engineering talent both in the chemical processing, civil and industrial engineering fields.

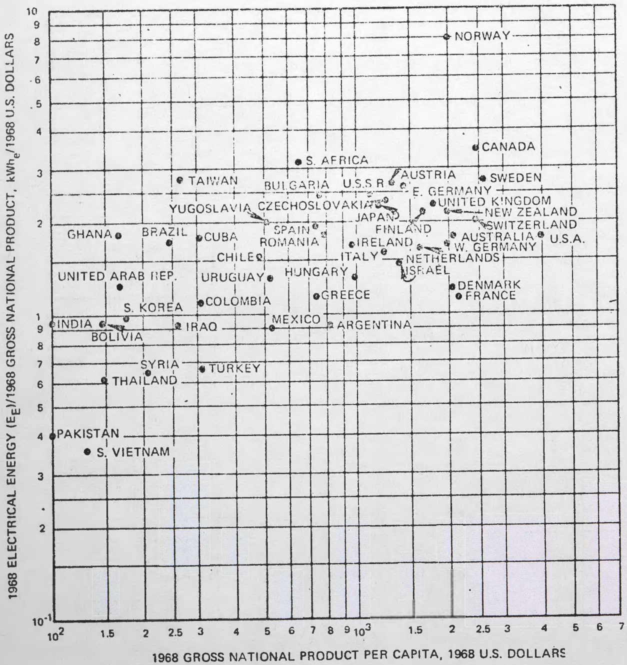
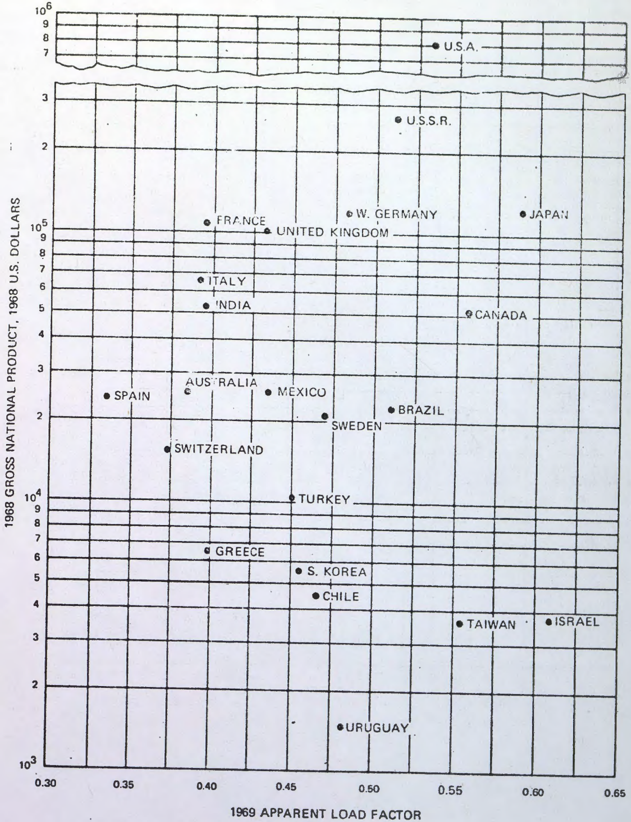


CHART I

ELECTRICAL ENERGY (E_E) PER UNIT GROSS NATIONAL PRODUCT vs. GROSS NATIONAL PRODUCT PER CAPITA, 1968

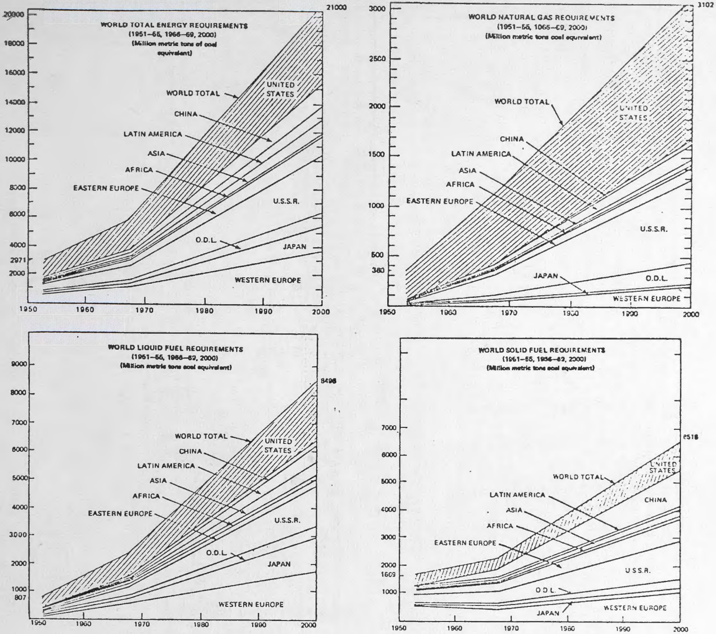


C H A R T I A.

GROSS NATIONAL PRODUCT vs. 1969 APPARENT LOAD FACTOR

CHART 2

U.S. AND WORLD REQUIREMENTS FOR ENERGY AND FUELS, TO 2000



7-12

CHART 4

WORLD: Primary Energy Requirements

Million metric tons oil equivalent

	W Europe	N America	Japan	Rest of World	World
Solid Fuels 1970	306	352	62	978	1 698
1980	240	502	105	1 299	2 146
Annual Change (%)	*−2.3*	*+3.6*	*+5.5*	*+2.9*	*+2.4*
Liquid Fuels 1970	620	763	190	587	2 160
1980	1 113	1 209	466	1 261	4 049
Annual Change (%)	*+6.0*	*+4.7*	*+9.4*	*+7.9*	*+6.5*
Gaseous Fuels 1970	70	598	4	251	923
1980	231	870	14	582	1 697
Annual Change (%)	*+11.9*	*+3.8*	*+14.5*	*+8.8*	*+6.2*
Primary Electricity 1970	45	50	10	30	135
1980	173	288	50	76	587
Annual Change (%)	+13.9	*+19.4*	*+17.7*	*+9.9*	*+15.8*
Total 1970	1 041	1 763	266	1 846	4 916
1980	1 757	2 869	635	3 218	8 479
Annual Change (%)	*+5.4*	*+5.0*	*+9.1*	*+5.7*	*+5.6*

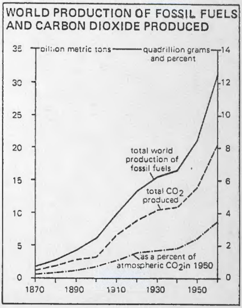
Source OECD Oil Committee

CHART 5

Impact of Energy Crisis on U.S. and Western Europe

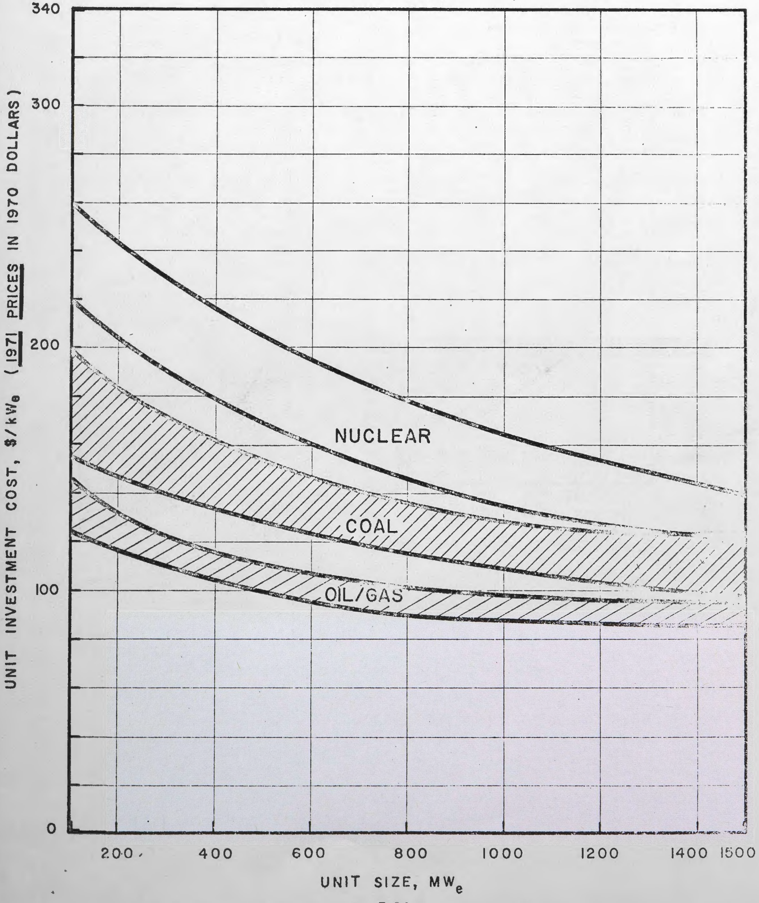
	United States	Austria	Belgium	Britain	France	Italy	Netherlands	Switzerland	W. Germany
Dependence on Arab Oil	15%	59	65	50.8	80	74	63	80	75
Speed Limits Cut	●	●	●	●	●	●	●	●	●
Weekend "Gas" Sales Curbed	●	●				●			●
Sunday Driving Banned			●			●	●	●	●
"Gas" Prices Up	●	●	●		●	●	●	●	
"Gas" Rationing Scheduled							●		
Heating Oil Prices Up	●	●	●		●	●		●	●
Heating Oil Allocated	●	●				●		●	
Air Services Cut	●			●		●	●	●	●
Display Lighting Cut	●	●	●	●	●	●			

CHART 6

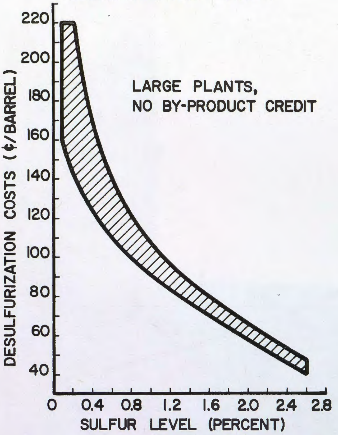


INVESTMENT COSTS FOR POWER PLANTS USING DIFFERENT FUELS

CHART 7.

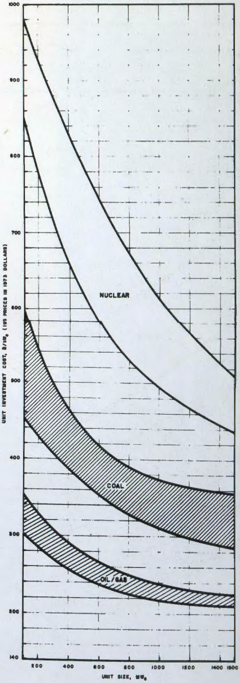


HEAVY FUEL OIL
DESULFURIZATION COSTS



Source: OEP/EPA Soctap Report, 1973

INVESTMENT COSTS FOR POWER PLANTS
USING DIFFERENT FUELS



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TOTAL EXPENDITURE FOR OIL BY AREA

(1960 to 1980)