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# MARKET ASSESSMENT OVERVIEW

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Market assessment was refined during FY 1980 with analysis disaggregated from a national level to the regional level and to specific market applications, resulting in more accurate and detailed market estimates.

The development of an integrated set of computer simulations, coupled with refined market data, has allowed tremendous progress in our ability to evaluate the worth of solar thermal parabolic dish systems. It is now possible to perform in-depth analyses of both electric and thermal market applications of these systems.

The following market assessment studies were undertaken in 1980:

- Regional analysis of the near term market for PD systems
- Potential early market estimate for electric applications
- Potential early market estimate for IPH/cogeneration applications
- Selection of thermal and electric application case studies for FY 1981

## Regional Analysis

A computer simulation program was used to evaluate the effect on the levelized busbar energy cost of increasing production levels of two types of solar thermal electric power plant systems in each of 13 U.S. regions. The first-generation solar thermal reference system was a parabolic dish with a Brayton engine, with a production level of up to 25,000 modules per year; the second generation case used an improved dish and a Stirling engine, with production levels from 25,000 to 100,000 units per year.

The input data for the two generations were held constant while the direct normal insolation resources of each region were changed to obtain the effect of regional insolation on the levelized busbar energy cost (BBEC). The levelized busbar energy costs for three conventional power generation systems were estimated region by region for the years 1985, 1995 and 2000. Then the BBEC for the three conventional power systems were compared to the PD electric option to determine potential early markets. The results were that PD could be competitive with oil-fired power plants before 1990 in Western and Southwestern regions. The second generation of technology, even with annual production of 100,000 modules/year will not be competitive with intermediate and large coal power plants before the year 2000 in many states.

| Regions | Breakeven with Small Oil Power Plants | | Breakeven with Small Coal Power Plants | | Breakeven with Large Coal Power Plants | |
|---|---|---|---|---|---|---|
| | Year | BBEC | Year | BBEC | Year | BBEC |
| New England | 1990 | 238 | -- | -- | -- | -- |
| West South Central I | 1990 | 236 | 1999 | 132 | -- | -- |
| Middle Atlantic | 1990 | 250 | -- | -- | -- | -- |
| South Atlantic | 1990 | 242 | 1996 | 160 | -- | -- |
| East North Central | 1989 | 285 | -- | -- | -- | -- |
| West North Central | 1990 | 186 | -- | -- | -- | -- |
| East South Central I | 1990 | 242 | -- | -- | -- | -- |
| East South Central II | 1991 | 188 | -- | -- | -- | -- |
| West South Central II | 1990 | 224 | 1993 | 140 | 1996 | 135 |
| Mountain I | 1986 | 250 | 1990 | 121 | 1991 | 95 |
| Mountain II | 1990 | 229 | 1995 | 128 | -- | -- |
| Mountain III | 1987 | 215 | 1990 | 105 | 1995 | 92 |
| Pacific | 1987 | 260 | 1992 | 132 | 1996 | 120 |

Regional Breakeven Cost
(1980 Dollars)

-- Breakeven level will not be attained before the year 2000.

## Electric Application

As the first step in estimating the electric application market size, it was determined that BTU's of oil and gas burned was a more relevant market size estimate than existing oil and gas capacity. Further, relying on the SAI case study results, the near-term (1985-1990) market for PD electrical applications will be limited to isolated utilities and utilities with favorable financing: municipals, rural electric cooperatives, and federal installations. An inventory was then compiled of oil and gas-fired generating plants used by electric utilities in high insolation states in the U.S. Based on this inventory and the above assumptions, the maximum near-term electrical application market size is 470 trillion BTU's or 890,000 dish modules.*

| | OIL & GAS CAPACITY DISPLACEMENT (MW) | OIL & GAS FUEL DISPLACEMENT ($10^{12}$ BTU) | # OF EQUIVALENT*2 DISH MODULES ($10^3$ MODULES) |
|---|---|---|---|
| MUNICIPALS | 11,880 | 280 | 520 |
| REC | 2,340 | 20 | 50 |
| FEDERAL | 1,800 | 30 | 60 |
| ISLAND | 4,360 | 140 | 260 |
| TOTAL | 20,380 | 470 | 890 |

*1 The marginal values of solar generation displacing oil and gas in these markets in 1985 are expected to range from 120 mills/kWh to 320 mills/kWh (1980 $).

*2 This column merely represents the number of solar modules required to generate the same amount of electric energy currently generated by the oil and gas units in these utilities.

* Note that this is the total replacement figure, not an annual market size. It is assumed that conventional systems have a heat rate of 12,000 Btu/kWh, and that the electrical output of a dish ranges from 32 to 52 thousand kWh/year, depending on the regional insolation.

Non-electric (IPH) Application

It was assumed that the industrial market would also be limited to areas of high insolation. Within these areas, industries with annual energy consumption of 5 trillion BTU's or more offer the highest potential market penetration. Representatives of industries identified in these areas were contacted to determine the constraints, if any, on the use of solar for specific IPH applications. Industry responses prompted the removal of applications in petroleum refining and iron and steel foundries from the market estimates: land constraints were prohibitive in both applications; the foundries needed direct heat rather than heat derived from steam. There were five industries which did not have any significant barriers against the use of solar thermal systems in the near future: industrial inorganic chemicals, agriculture chemicals, sugar refining, hydraulic cement, and enhanced oil recovery. The near-term maximum potential market in these industries is estimated to be 450 trillion BTU's, or an equivalent of 880 thousand dishes.

NEAR TERM POTENTIAL MARKET FOR PARABOLIC DISH NON-ELECTRIC APPLICATIONS

| INDUSTRIAL APPLICATIONS | | OPERATING | ENERGY CONSUMPTION* | EQUIVALENT |
|---|---|---|---|---|
| SIC CODE | INDUSTRY | TEMPERATURE | $10^{12}$ BTUs (1985) | NUMBER OF DISHES (000's) |
| 281 | INDUSTRIAL INORGANIC CHEMICALS | 1100° - 2500° | 100 | 200 |
| 287 | AGRICULTURAL CHEMICALS | 350° - 550° | 100 | 200 |
| 206 | SUGAR REFINING | 550° - 1100° | 30 | 60 |
| 324 | HYDRAULIC CEMENT | 1100° - 2500° | 50 | 90 |
| | ENHANCED OIL RECOVERY | | 170 | 330 |
| | TOTAL | | 450 | 880 |

*SOURCES: (1) "MARKET CHARACTERIZATION OF SOLAR INDUSTRIAL PROCESS HEAT APPLICATIONS," SERI/PR 353-212, DECEMBER 1979. STATES: CALIF. TEXAS, LOUISIANA: INDUSTRIES WITH ENERGY USE OF 5 x $10^{12}$ BTU'S OR MORE.

(2) DATA RESOURCES INC., ENERGY REVIEW, WINTER 1980, PP. 138 (INDUSTRIAL ENERGY CONSUMPTION; AVERAGE ANNUAL GROWTH RATE OF 1.5% DURING 1980-1990.

(3) HEAT RATE FOR CONVENTIONAL SYSTEM IS ASSUMED TO BE 3414 BTU/KWH AND T[illegible] OUTPUT OF THE DISH RANGES FROM 110,000 KWH TO 170,000 KWH.

Thus, the total potential new market for PD systems in electrical and non-electrical applications is about one quad, or equivalently, 1,770,000 PD modules.

These estimates, as noted previously, are the maximum potential market for solar systems. Two important issues consequently arise: first, how much penetration will be achieved by solar thermal technologies in general, and second, how much of this penetration may be achieved specifically by parabolic dish systems?

The latter issue involves defining the comparative advantages of PD systems over trough and central receiver systems. PD systems have some advantages over both troughs and central receivers in industrial applications. Dishes are more efficient than troughs, and are able to operate in higher temperature ranges (above 550° F). Close to 80% of the IPH market requires temperatures above 550° F. Although efficiency alone does not make a technology more attractive, solar thermal is a land intensive technology. High efficiency in this case implies smaller land requirements and thus mitigates one of the critical barriers to entry into this market.

Land constraints as well as thermal transport costs are also potential problems with central receiver systems. Because of their modularity, PD systems not only require less land for the same expected effective output, but the land need not be contiguous.

For electric applications, PD systems are again not only more efficient than troughs, but they also show more flexibility in dispatch options. The two-axis tracking allows optimal adjustment to seasonal demand and insolation variations, and thus different sun-following or load threshold dispatch strategies may be adopted at any time.

The major advantage of a PD system over the central receiver lies in the system's modularity; not because of land constraints, but because of the different patterns of capital costs. Central receivers require a much higher initial cash outlay, since the entire system must be installed before any power is generated. The capital costs of an equivalent PD system, on the other hand, may be spread out over many years as the system's capacity is increased.

Case Studies

Case studies performed with computer simulation models will be used to estimate market penetration in specific applications over time. Documentation, testing, and integration of the models were performed in FY 1980.

These studies were selected to represent a broad range of sizes, ownership, insolation, utility load characteristics, and utility generation mix. At present, case studies for Molokai, Hawaii, Osage City, Kansas, Burbank, California, the Salt River Project in Arizona, and the Southern California Edison Company in California are planned for FY 1981.