LETTER FROM TOKYO (5)

A PROJECT CALLED SUNSHINE

The solar energy part of the program may have been oversold as a solution to Japan's energy problems, but underestimated as a source of new Japanese exports

BY JOHN H. DOUGLAS

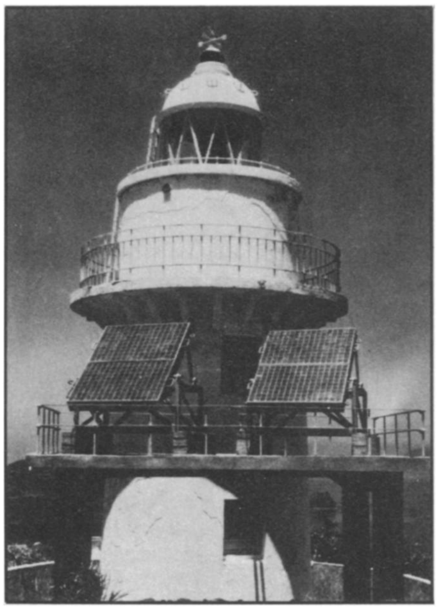
An ancient tradition has helped gain for solar energy a degree of public acceptance in Japan that still eludes energy planners in many other nations. The Japanese custom of the communal bath, *ofuro,* with one large tub of hot water shared by all members of a family, presented a perfect opportunity for the early application of solar energy on a commercial scale. Solar water heaters have been available in Japan for more than 30 years. Some 2.6 million units have so far been manufactured, of which about half are still in use.

Although the heaters pay for themselves (through reduced fuel bills in about five years) their popularity fell off during the period of rising affluence and cheap oil in the late 1960s. It was not until the oil crisis of 1973 that the Japanese government launched a national program of research and development to introduce alternative energy technologies in an organized way. Thus, in 1974, the so-called Sunshine Project was born.

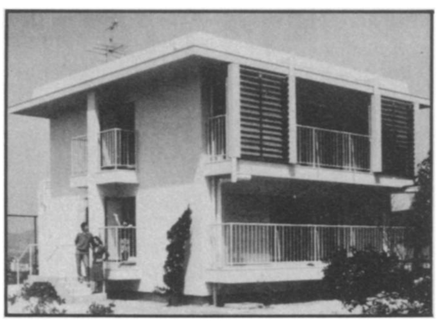
The stated goals of the program were exceptionally ambitious: "To alleviate the energy crisis" by developing commercially feasible technologies in solar and geothermal energy, coal liquifaction and gasification, and hydrogen gas production. Explicit targets were set. Solar technology, for example, was to be developed to the extent that heating and cooling units for houses could become competitive by 1985, the cost of photovoltaic cells reduced to one percent of present levels by 1990, and commercial solar power generating plants built by 2000.

Coordination of the program was undertaken by the powerful Ministry of International Trade and Industry (MITI), with government laboratories performing basic research and private companies handling development and commercialization. Despite the effectiveness of the overall program being called into question, Japanese solar energy R&D has scored some impressive individual achievements:

- The National Industrial Research Institute and Mitsubishi Electric Corp. recently announced development of what was billed as "the world's first dependable automatic sun-tracking type of solar furnace intended for industrial application."



An unmanned lighthouse on the Nagasaki coast is powered by solar cells.



Collectors on terrace of solar house.

Photos: Foreign Press Center — Japan

A minicomputer is used to keep a 1.5-meter diameter parabolic mirror pointed at the sun, including making adjustment for seasonal change. Temperatures of 3,000° C to 3,500° C have been reported. The unit is intended for such applications as high-temperature alloy testing.

- Plans have been completed to begin construction next October on what the Japanese say will be the world's largest solar power generating station. The installation will consist of two types of plants, each capable of generating one megawatt of electricity. In one plant, 807 heliostats (4-meter-square flat mirrors to track the sun) will focus light on a steam generator atop a 65.5-meter tower. In the other plant, 2,500 smaller heliostats will reflect light on a curved mirror, which in turn focuses onto a generator. Electricity for about 2,000 houses in Nio, Kagawa Prefecture, will be generated at the station, beginning in 1981.
- Experiments using solar energy to increase plankton concentration in small areas of deep ocean water are being conducted in hopes of increasing fish populations in traditional fishing grounds. In one recent experiment, about 10 watts of light energy were conducted into the water by means of 1,000 optical fibers. (Japanese fisherman have been seriously affected by the 200-mile territorial claims recently enacted by many nations.)
- A family living in a solar home built by the Science and Technology Agency found that they saved 57 percent of their expected fuel costs over a two-year period. The Agency announced that the solar heating and cooling system could thus pay for itself after about 11 years (it cost 83 percent more than a conventional unit initially). Closer examination of this estimate, however, reveals that a 12 percent annual increase in fuel costs is assumed, compared with expected 6 percent increases forecast in other government publications.

Perhaps the most important aspect of the Sunshine Project's solar component is the work being sponsored on photovoltaic cells. Japanese companies already possess some of the world's best facilities for precision work on the semiconductor materials involved. Success seems likely to depend more on technological breakthroughs than on overcoming the more difficult social and economic barriers that face other forms of solar energy. Finally, a whole new range of consumer applications is likely to result — a natural attraction for companies whose strength lies in the inexpensive manufacture and export of high-technology equipment, and whose traditional markets (for example, television sets) are drying up.

As in their attempts to make the Japanese computer industry competitive on the world market (SN: 1/28/78, p. 60), the planners at MITI have parcelled out the various approaches to the problem of reducing solar cell costs to individual private companies and have underwritten their efforts with modest amounts of government money. MITI's own Electrotechnical Laboratory conducts the basic research on photovoltaics and makes results available to the private companies, which then compete to bring new products to market.

Most solar cells are made of silicon, which has an electronic structure ideally suited for absorbing the most prevalent wavelengths of sunlight. Silicon is also very abundant. The problem of cost arises when one must produce very pure silicon by growing large artifical crystals, then turn around and waste more than two-thirds of the precious material by sawing

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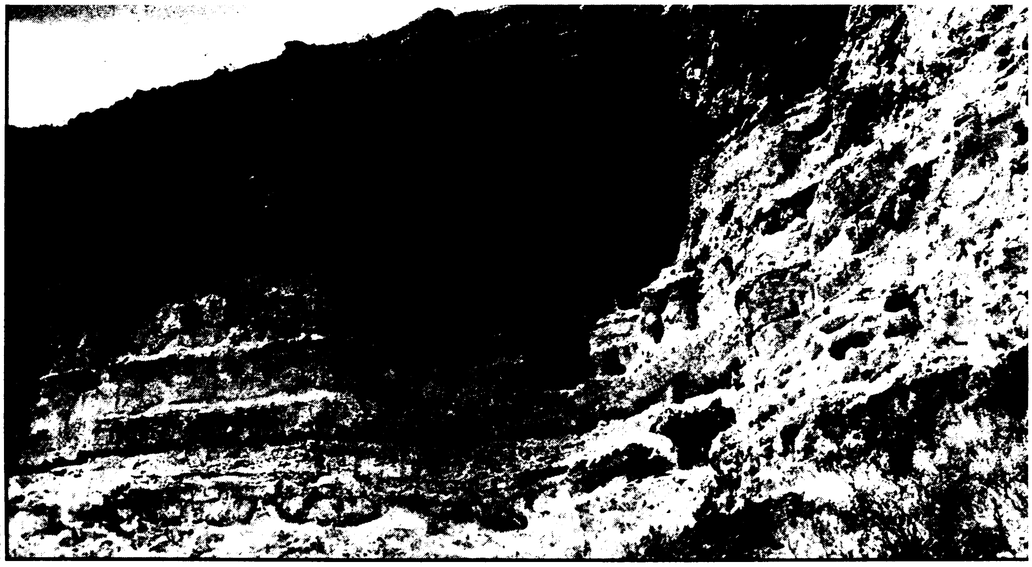
is humidified and returned to the room. Running the cycle backward will heat air. This system, which has been undergoing tests for several years, has heating efficiencies comparable to those of gas furnaces, IGT says.

... AND PASSIVE

Finally, no roundup of solar research is complete without a word on passive systems. Passive collectors are simple. In their pure form they contain no moving parts — a building is its own solar collector. Buildings can be designed to use every possible means of storing solar heat in walls, floors and ceiling. Although passive solar architecture is at least as old as the Pueblo Indians' adobe structures, architects and engineers are still learning why and to what extent certain materials store — and later reradiate — heat.



Robert Bennett

Montezuma's Castle: Precolumbian example of "passive" solar energy architecture.

The newest of MIT's five experimental solar buildings is entirely passive and relies on materials developed at MIT, none of which are commercially available yet. Its polymer ceiling tiles, two feet square and one inch thick, contain a core of Glauber's salt (SN: 1/7/78, p. 8), fumed silica and other chemicals that can store a day's heat and then release it as needed. The core serves as a built-in thermostat to maintain a near constant 73 degrees. It operates on the principle of heat-of-fusion phase changes. As it radiates heat, it freezes into a solid; the next day as it takes in heat again, it melts back to a liquid. It was developed at MIT and produced by the Cab-O-Sil Division of the Cabot Corp. in Billerica, Mass. Even the venetian blinds are special. The extremely narrow louvers are mirrored in their upper surface to reflect incident solar energy onto the thermal-storage ceiling tiles. Solar energy is expected to provide 85 percent of the heat used by this building.

As with all passive buildings, designing for energy conservation is as important as designing for solar collection. A special transparent plastic sheet is inserted between the panes of double-glazed window to reflect heat that might otherwise be lost back into the room. "The window system provides better insulation than the usual wood and stud wall," and loses only 25 percent of the energy that a conventional double-glazed window would, according to MIT's Timothy Johnson.

Montezuma's Castle is the product of an early solar age — when trees (biomass) and masonry (passive solar collectors) — were among the only ways man could warm his world. Twelve centuries later, dwindling fuel supplies and environmental pollution are motivating Americans to work out how they might return to a solar age. □

... Project Sunshine

and polishing it into thin cross-sections. Three general solutions to this problem are being attempted in Japan, as elsewhere: Grow long thin crystal "ribbons," make thin films of silicon containing many smaller crystals, or use other materials that are easier to fabricate (such as amorphous semiconductors, see p. 249).

The ribbon crystal approach is being pursued by Toshiba Electric Co. and Toyo Silicon Co. The former uses a flat capillary tube to draw molten silicon out of a pool, forming a ribbon that solidifies as it is pulled vertically into the air. Toyo Silicon draws a ribbon horizontally off the surface of a pool of molten silicon, a method not yet as well developed, but one that promises faster crystal growth rates.

Hitachi Ltd. and Nippon Electric Co. (NEC) are experimenting with thin film fabrication. The former is trying to create thin layers of silicon on the surface of cheaper materials by chemical vapor deposition, vacuum evaporation and sputtering. NEC is concentrating on a method that uses a sustained plasma to aid deposition. Although thin films are much cheaper to make than silicon ribbons, their efficiency in converting sunlight to electricity is only about half as great.

Work on nonsilicon solar cells, particularly those made from compounds similar to cadmium sulfide, is being pursued by Matsushita Electric Industries. The cost of fabricating these cells is low and efficiency is higher than that obtained by silicon thin films, but the cells tend to degenerate. The cause of this degradation has now tentatively been identified and the company is trying to make a stable compound cell.

Finally, the Sharp Corp. is experimenting with ways of improving photovoltaic efficiency by improving cell design, fabrication methods and concentration of light. The company has already succeeded in making sample cells that operate with sunlight intensity increased as much as 20-fold by various focusing methods.

The upshot of this government-funded division of labor is that Japanese electronics companies have been thrust to the leading edge of research in a field that is likely to spawn a new generation of exportable products. Housetop water heaters and huge "power tower" generating systems can be made competitive only through brute-force trial and error and mass production of components. But photovoltaics will be improved by delicate experimentation, precision manufacturing and careful automation — the very areas where Japanese companies excel.

Despite the ballyhoo surrounding the launch of the Sunshine Project, relatively little money is being spent on actually trying to get Japan to switch to alternative energy sources. For fiscal 1977 only about $18 million was spent on the whole Sunshine program (of which solar energy is only one component). This compares with about $438 million spent on Japanese nuclear research. Indeed, the International Energy Agency has censured Japan for its reluctance to cooperate with other nations in non-nuclear energy development.

Perhaps the strongest indictment of the whole Japanese non-nuclear R&D effort was made by Justin Bloom, Science Counsellor at the U.S. Embassy in Tokyo, who has represented the United States in energy negotiations with Japan. He told a group of newspaper editors last year:

"On sober reflection I come to the conclusion that the Japanese people, who had heard so much about the Sunshine Project, did not truly comprehend its small scale, and were under the impression that Japan was pulling its weight in the development of solar energy, geothermal energy, coal liquifaction and gasification, etc. Today this misapprehension is fading."

If the funding for solar energy is modest, it is nevertheless strategically placed, for a half-dozen of Japan's leading high-technology companies have been launched into what is likely to become a lucrative new export market. But to see where both Japanese government and industry are placing their bets for future energy, one must look at Japan's nuclear program. That topic will be covered in a subsequent article. □