A Cloudy Forecast for Solar Cells

The U.S. photovoltaic industry, facing rising costs and growing Japanese competition, is looking to Washington for assistance

When the Reagan Administration took a hatchet to the federal government's solar energy programs in 1981, the infant photovoltaic industry was not unduly concerned. The United States dominated the world market for solar cells and, with the cost of the technology dropping while the price of oil was going through the roof, the prospects for photovoltaics seemed good. Three and a half years later, however, the industry is in trouble. "The photovoltaic industry's situation is critical," John Corsi, president of Solarex, warned recently in congressional testimony. Without government assistance, he said, "the U.S. stands to lose another emerging high technology industry to foreign competition, with the consequent loss of jobs and energy security. We cannot afford to let that happen."

Corsi's dire assessment is generally—though not universally—shared in an industry that is in the paradoxical position of meeting most of its technological goals and sales projections, yet is unlikely to be profitable for several years. In the past few months, several U.S. companies have decided to cut their losses and get out of the business, and even the biggest producers of solar cells have scaled back their plans. Meanwhile, U.S. dominance in the field is under challenge, primarily from Japan.

Although there is far from complete agreement on what should be done to ease the industry's plight, most of the proposed remedies run counter to the Reagan Administration's free-market policies for technological development. Indeed, some prescriptions for the industry, such as federally funded demonstration projects and direct government assistance in setting up production lines, are just the kinds of activities that the Administration has consistently weeded out of the budget. Photovoltaics thus provides an interesting battleground for opposing views on the appropriate federal role in assisting a potentially important high-technology industry.

The industry's problems lie in the fact that although costs have been dropping steadily, current state-of-the art solar cells are still very expensive. Over the past quarter century, the cost of producing and installing cells capable of generating 1 watt of power has fallen from about $1000 to between $8 and $12. In spite of that spectacular achievement, photovoltaic power is still too costly to compete with other forms of energy, except in relatively limited applications such as running machinery in remote areas where there is no electric grid. Every drop in price expands the potential market, but most analysts believe that costs will have to get below $2 per watt before the market really takes off.

To get to that point will require a change in technology. Today's power cells are mostly made from crystalline silicon that is formed into single-crystal rods, or cast into ingots, and then sliced into thin wafers. Although relatively straightforward, the process uses large amounts of material, much of which is wasted in the slicing stage. A less materials-intensive process, in which molten silicon is formed directly into ribbons of crystals, is under development by several companies, and others are using lenses to concentrate sunlight on the cells and boost their output. These technologies and refinements in manufacturing techniques may shave the price of solar cells still further, but in the long term, the future of the photovoltaic industry is not expected to lie in crystalline silicon.

The really low-cost cells are expected to use ultra-thin films of photovoltaic material deposited on a substrate such as glass or steel. Several candidates have emerged for this technology, but most investors are putting their money on amorphous silicon. Although amorphous silicon is less efficient than the crystalline form in converting sunlight into electricity, cells made from the material are expected to be so much cheaper to produce that the lower efficiency can be more than offset by increasing the area of the solar panel. More development and large-scale production is needed, however, before the full cost reductions are realized.

ARCO Solar, the world's largest producer of crystalline silicon cells has an aggressive R&D program on amorphous silicon, and "we have guessed that will be the way to go," says James Caldwell, Jr., the company's president. Solarex, the third largest U.S. photovoltaic company recently bought the rights to amorphous silicon technology developed by RCA. And several smaller firms—notably Energy Conversion Devices of Michigan and Chronar Corporation of Princeton, New Jersey—are concentrating exclusively on amorphous silicon. Zoltan Kiss, president of Chronar, recently predicted that his company will be producing amorphous silicon cells for less than 50 cents a watt by the end of this decade. This U.S. enthusiasm for the technology is more than matched by Japanese companies, which are banking on amorphous silicon for the future and are already producing substantial quantities of the cells for specialized markets.

Although just about everybody agrees that there is a bright commercial future around the corner for thin-film cells, the problem is how to get from here to there. The traditional business strategy would be to use profits from current operations to finance R&D and attract capital to establish production lines for the next generation of the technology. But nobody is making much of a profit on photovoltaics today and generating capital for future development is therefore tough. Kiss put it bluntly at recent hearings held by the House Committee on Science and Technology: "the U.S. photovoltaic industry has operated at a loss for the past years and its future is in jeopardy."

In addition, the industry has had to contend with high interest rates, which have made it extremely expensive to raise capital, and the soaring value of the U.S. dollar has made it difficult to compete with foreign suppliers in export markets. The global recession has also caused many would-be purchasers of solar cells to delay their investments, and oil prices have declined, making photovoltaics even less cost-competitive.

As a result, several companies including Exxon, Martin Marietta, and RCA have recently quit the business and those that are left are increasingly dominated by oil companies, which can afford to carry losses for a few years. For example, ARCO Solar is a wholly owned subsidiary of Atlantic Richfield, Solarex was recently bought out by Standard Oil of Indiana, and Energy Conversion Devices is largely being bankrolled by Standard Oil of Ohio.

Then there is increasing foreign com-

petition. In spite of the fact that profits are limited, worldwide sales of solar cells have expanded considerably in the past few years and non-U.S. firms have taken a growing share of the market. According to Paul Maycock, a private consultant who formerly headed the federal government's photovoltaic program, worldwide photovoltaic sales rose from just over 5 megawatts (MW) in 1981 to an estimated 25 MW this year. The U.S. share of the market has dropped from about 90 percent in the late 1970's to about 60 percent today.

Much of the competition is coming from Japan where, with government support from a program called Project Sunshine, companies have not only moved into the crystalline silicon market but have also begun aggressive development of amorphous silicon cells. Indeed, taking an approach that virtually every U.S. company ignored, Japanese firms are already producing amorphous silicon cells in substantial quantities.

The cells are being manufactured for consumer products, where the cost of the cell is a relatively small fraction of the total cost of the product and where photovoltaics is not in direct competition with alternative energy sources. The market for solar-powered calculators took off in the early 1980's and some 4 MW of amorphous silicon cells are now being produced in Japan for the consumer goods market. Solar-powered wristwatches and snap-together modules for charging batteries and powering portable radios and televisions are now entering the market. As a result, Japanese companies are developing important experience in production technologies for amorphous silicon cells. "There is no doubt that the Japanese got a big leg up on us from virtually zero," says ARCO Solar's Caldwell. The only U.S. company to enter the consumer goods market with amorphous silicon cells was Energy Conversion Devices, which formed a joint venture with the Sharp Corporation in Japan.

In addition to positioning themselves for the amorphous silicon market, Japanese companies are continuing to move down the cost curve in crystalline silicon. Two companies, Hoxan and Kyosera, recently caused a big stir by announcing plans to build state-of-the art production facilities for single-crystal cells which, if the claims are correct, could sell for $3 to $4 per watt. Maycock, who visited the two companies last month, says he is convinced that the claims are correct. If so, Japanese companies will be able to expand their market share over the next few years—particularly in the Third World, where many near-term applications are likely to open up—and will have their marketing operations firmly in place when prices tumble with the advent of thin-film cells for generating power.

Faced with the threat of foreign competition and the difficulties of raising capital for technological development, many in the U.S. photovoltaic industry are looking for assistance from the federal government. The industry's chief goal is to extend and expand tax credits for the purchase of solar cells. Under tax provisions enacted in 1978, individuals can deduct 40 percent of the purchase price of photovoltaic equipment from their income taxes and businesses can deduct 15 percent, a provision that effectively provides an indirect federal subsidy for the industry. But the tax credit is due to expire at the end of 1985 and dire consequences are being predicted if it is not extended.

Department of Energy

Solar-powered village

A federally funded demonstration project brought photovoltaic power to this Papago Indian village in Arizona. The industry would like more demonstration projects.

According to a recent study by Maycock,* if the credits expire, the United States will lose its dominant position in the market to Japan by 1990 and worldwide sales of solar cells will reach only 180 MW a year by that date. However, if the credits are extended, Maycock reckons that the market will climb to 500 MW by 1990 and U.S. manufacturers will continue to dominate.

Scott Sklar, director of the Solar Energy Industry Association, says getting the credits extended will be "absolutely the top priority" next year. The industry is lobbying for the tax credits to be extended to 1990, with individual credits remaining at 40 percent and business credits increased to 25 percent. Some are also calling for the credits to be made available to utility companies, which are currently excluded. The prospects are highly uncertain, however. Earlier this year, the Senate approved an extension and expansion along the lines the industry is pushing for, but the House refused to go along. Next year, with the political focus in Washington firmly on reducing the budget deficit, Congress is likely to be in even less of a mood for special-interest tax breaks.

Industry witnesses at recent congressional hearings also generally endorsed federal incentives for export sales, such as greater use of solar cells in projects funded by the Agency for International Development and subsidies for some types of export promotion. They also called on the federal government to step up purchases of solar cells for its own use.

Some in the industry have also called for substantial government investment in demonstration projects—perhaps financed by reprogramming funds from the synthetic fuels program—and even for low-cost federal loans to establish production facilities.

Such measures are the direct antithesis of the Reagan Administration's energy and economic policies, however. When it came to office, the Administration argued that the federal government should get out of the business of supporting the development of commercial technologies, and the Carter Administration's budget of $150 million for photovoltaics was slashed by two-thirds. Several demonstration programs were eliminated, and the focus was shifted to long-term basic research.

At the time, the industry was generally supportive, but it is now imploring the federal government not to leave it entirely to the buffetings of free-market forces.—**COLIN NORMAN**

* *Photovoltaic Technology, Performance, Cost and Market Forecast to 1995: A Strategic Technology and Market Analysis* (Phovoltaic Energy Systems, Inc., Alexandria, Va., September 1984; $695).