Solar energy's cloudy past
Advocates say 50-year-old industry is finally in a position to heat up

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Fifty years ago, scientists at Bell Laboratories unveiled the first modern solar cell, using a silicon semiconductor to convert light into electricity.

Their demonstration inspired a 1954 New York Times article to predict that solar cells would eventually lead "to the realization of one of mankind's most cherished dreams -- the harnessing of the almost limitless energy of the sun."

Half a century later, solar power generates less than 1 percent of the electricity in the United States, according to Robert Margolis, a senior analyst with the U.S. Department of Energy.

"Solar energy has been just around the corner for about 30 years," said Joel Makower, a partner in Clean Edge, a Bay Area energy consulting firm, adding the industry's inside joke: "And it's still just around the corner."

At the same time, solar advocates say steady advances in manufacturing technology and installation techniques have finally positioned the industry for serious and sustained growth.

"Solar energy power generation is growing 20 percent to 30 percent a year, and that's not shabby," said Roberta Gamble, an energy analyst at Frost & Sullivan, the Palo Alto market research firm that recently completed a report on the industry.

Daniel Shugar, president of PowerLight, a Berkeley firm that installs solar systems, said the fastest-growing niche in the industry is putting rooftop arrays in business settings, where they can recoup their installation costs in four to eight years.

"Today we're doing systems for half the cost of the systems we did seven years ago," said Shugar, who is among those who believe solar will eventually live up to its great expectations. "I don't see this as taking another 50 years."

Why has it taken solar so long to grow up, and what evidence bolsters advocates' current claims?

The answer to the first question is relatively simple: In an era of cheap fossil fuels, solar cells were at first only economical in remote applications like space satellites, said Bill Yerkes, a 40-year solar industry veteran.

"Twenty years went by out of my (work) history with only one real customer, the space program," said Yerkes, who started working with solar cells in 1964 with Boeing Space Division.

As early as 1962, when Bell solar cells powered Telstar, the world's first communications satellite, photovoltaic arrays have been fixtures in space. But the space market was small and never created enough demand for solar cells to drive down costs. That's why solar cells remained pricey, while computer chips, their cousins in the semiconductor world, became affordable so fast.

"The space solar business was like making jewelry," said Yerkes, now chief technology officer at Solaicx, a Los Gatos startup working to reduce

solar cell costs by improving the process for making silicon.

It took the 1973 Arab oil embargo to give solar its first push into the mainstream.

Prompted by the ensuing energy crisis, President Jimmy Carter pushed incentives during the late '70s to promote solar and renewable energy. Environmentalist Denis Hayes, who organized the first Earth Day event and ran the National Renewable Energy Laboratory in the Carter administration, said he tried to get federal agencies to buy solar cells to create demand.

Hayes, now president of the environmental Bullitt Foundation in Seattle, said it was such government purchases that helped drive down the cost of computer chips. But neither Carter nor his support for solar lasted.

Hayes is convinced that if Carter had won re-election and pushed a federal procurement program, solar energy would have reached its current cost by the end of his second term.

Even though federal support for solar diminished after Carter, the industry stayed alive by selling into niche markets like offshore oil rigs and mountain-top relay stations, where even pricey solar cells were the best way to generate electricity, said Yerkes, who in 1979 helped build the solar cell manufacturing plant in Camarillo (Ventura County), now owned by Shell Solar.

Over the last 20 years, improvements in manufacturing techniques gradually lowered the costs of solar cells. That has widened their use, which in turn has led to further expansions in the market and further economies of scale.

"Basically every three years, the overall industry volume doubles, and for every doubling of volume you reduce costs 18 percent, " said Tim Woodward,

a venture capitalist at Nth Power, a San Francisco firm that invests in energy technologies.

"Right now, this is a real industry that's growing 30 percent a year," said Woodward, whose firm has a stake in Evergreen Solar Inc., a Massachusetts company that is developing a new solar cell manufacturing technology.

Manufacturing advances are not the only factor driving solar adoption. In recent years, Japan, Germany and the world's sixth-largest economy, California, have fashioned a variety of incentives and policy changes that have made them the centers of the budding solar industry.

In California, two programs have spurred solar adoption: a rebate that helps defray the cost of installing small-to-mid-sized solar arrays and a policy that allows solar users to sell electricity to the utilities.

Called net metering, the latter program has spurred a revolution in solar affordability, said Shugar, the PowerLight president. To understand why, realize that today, the typical solar array is connected to the energy grid, rather than charging batteries, as was the case in the old days, when solar was mainly installed far from power lines, or off-grid.

So, during the hottest, brightest part of the day, solar arrays can pump electricity back into the grid, spin the electric meter backward and lower electricity bills, Shugar said.

While some California homeowners have taken advantage of these incentives to install solar arrays, Shugar said, the program appeals mainly to businesses. They can afford the installation costs and have the patience to wait for the payback -- free or cheaper energy once the initial investment is recouped.

According to Frost & Sullivan, these incentives

have reinforced California's role as the U.S. leader in solar energy installation.

At the international level, though, the United States is lagging Japan and Germany, which offer more aggressive incentives to install solar. Various estimates say Japan has 40 percent of the world's installed solar cells, followed by Germany with 20 percent and the United States with 12 percent.

Hayes, the environmentalist, says Japanese and German government support gives manufacturers an edge in what could become one of the growth industries of the future.

"Someone is going to do for photovoltaics what Henry Ford did for automobiles, and it pains me deeply that, at this moment, it seems extremely unlikely that someone is going to be an American," Hayes said.

But T.J. Rodgers, chief executive of Cypress Semiconductor and a survivor of the 1980s chip wars with Japan, said his firm is helping create what will be one of the world's largest solar cell manufacturing plants.

Rodgers, whose firm makes special-purpose electronic chips, explained how Cypress detoured into solar.

In 2001, when it was building a new headquarters in San Jose, he decided to install a rooftop solar array capable of generating about half of the building's expected power. He figured that after seven years, the array would recoup its installation cost and thereafter deliver most of the building's power for free.

Not long after, Rodgers ran into an old Stanford pal, Richard Swanson, who had founded SunPower Corp. in Sunnyvale. Swanson told Rodgers that SunPower was making solar cells that were 20 percent efficient, meaning they converted 20

percent of light into electricity -- making them superior to the 14 percent efficient cells on Cypress' roof.

Swanson also said that SunPower was running out of money and on the verge of laying off half its staff. "It was right around Christmas," said Rodgers, who was so intrigued he met with Swanson over the holidays, reviewed SunPower's business plan and made a personal investment to tide the firm over until he could convene Cypress' investment committee.

The upshot was that Cypress bought 57 percent of SunPower in 2002 and is buying the rest and making it a wholly owned subsidiary. With Cypress' backing, SunPower is building a solar cell assembly plant in Manila. The ribbon- cutting will be held in March, and the factory is supposed to start shipping arrays by the end of the year.

"By the time we get everything done, we will have bet $100 million," said Rodgers.

Such investments by hard-nosed industrialists encourage long-time solar advocates like the Rocky Mountain Institute's Amory Lovins, whose 1979 book "Soft Energy Paths" urged the adoption of decentralized energy systems like solar arrays.

"In 15 years, it should be routine for new commercial buildings to make most or all of their power," said Lovins. "Today, a few merchant home builders provide solar power as an option. But they're starting to introduce it as standard equipment."

Meanwhile, for those sick of promises and wondering what solar cells have done for them lately, David Bishop, research vice president for Bell Labs, said one need look no further than the fiber-optic Internet.

Working in conjunction with another Bell

invention, the laser, "The solar cell is the heart of all optical communication," he said.

Conceptually, it's simple. Electronic data from computers are routed to a laser, which converts the information to photons and pumps them through glass filaments. At the receiving end, a charge-coupled device -- an invention that operates on the same principle as the solar cell -- converts those photons back into electrons and electronic data.

So if the solar cell hasn't lived up to its energy-producing promise, it has played a vital role in creating the fiber-optic network "that can let any human being talk to any human being anywhere," Bishop said.

Here comes the sun

-- 1954: On April 25, Bell Labs unveils a solar battery that converts light into electricity.

-- 1962: 3,600 solar batteries power the world's first communications satellite, Telstar.

-- 1969: Bell scientists adapt solar principles to translate electronic data into light energy, leading to the charge-coupled device, or CCD, now used in digital cameras and the Internet.

-- 1973: Arab oil embargo shocks the U.S. economy and awakens interest in solar energy.

-- 1976: Solar power estimated to cost $55 per peak watt. Incoming President Jimmy Carter pushes short-lived subsidies to kick-start industry.

-- 1984: Solar power estimated to cost $12.26 per peak watt.

-- 1992: The United States leads the world in total power derived from solar cells, generating 43,500 kWp (kilowatts at peak), followed by Japan with

19,000 kWp and Germany with 5,619 kWp.

-- 1997: Japan takes the lead with 91,300 kWp of installed solar power, passing the United States with 88,200 kWp and Germany with 41,890 kWp.

-- 2001: Japan expands its lead with 636,842 kWp of installed solar power, while Germany's 260,600 kWp passes the United States' 167,800 kWp. Demand pushes solar power's estimated cost down to $3.50 per peak watt.

(Peak watt prices in 2001 dollars.)

Sources: Bell Laboratories, Energy Policy journal (1976 and 2001 solar power prices, in 2001 dollars), Worldwatch Institute (1984 solar power price, in 2001 dollars), International Energy Agency (total solar power by nation).

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