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### Can U.S. factories take on China?

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First of three parts

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Cars once jammed the parking lots at Evergreen Solar Inc.'s 23-acre manufacturing complex in the former Fort Devens.

Having barely finished constructing a 300,000-square-foot plant in April 2008, the Marlboro-based manufacturer of photovoltaic panels announced it was expanding to 450,000 square feet. Jobs grew from 350 to 760. Workers' cars quickly flooded an auxiliary parking lot leased next door.

Machines inside worked at the blink of an eye, stacking up batches of new photovoltaic cell. Eight-foot-tall robots could be seen swinging their arms like dinosaurs, shifting panel laminates and framed panels.

Back then, photovoltaic panels -- or

photovoltaic "modules" -- were selling for an average \$4 per watt. Still spending \$4.35 per watt to make the panels, Evergreen knew mass production held the key to lowering costs. The race was on: Make more. Sell more.

Science was on Evergreen's side. With the exclusive rights to its trademarked String Ribbon technology developed at Massachusetts Institute of Technology in the early 1980s, the company could make wafers -- the component in solar panels that produce electricity -- with half the silicon used by competitors.

String Ribbon wafers are made when hot, liquid silicon is spread between two parallel strings the way soapy water expands inside a bubble wand. It cools off and hardens into a

thin strip of silicon wafer.

The conventional method of making wafers is slicing them from big silicon blocks, which loses half of the expensive material to sawdust.

The cutting-edge technology made Evergreen a rising star. On Nov. 2, 2000, six years after three former employees of Mobile Solar Energy Corp. of Billerica founded

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Evergreen in a 2,500-square-foot lab in Waltham, the company debuted on Nasdaq. Its initial public offering shot up from \$14 a share to \$19 the first day.

After partnering with German and Japanese companies, Evergreen was ready to expand manufacturing in the U.S. in 2007.

Massachusetts wooed Evergreen to build its plant in Devens with a \$21 million cash grant plus \$15.1 million tax incentives and a \$1 annual lease for the land.

The production strategy worked. Production cost dropped to \$2 per panel by the end of 2009. Shipments rose 84 percent to 104 megawatts. By then, the company was supposed to be turning healthy profits, says spokesman Chris Lawson.

Instead, the company announced last month it would shut down the Devens plant by the end of March and lay off 800 workers.

Rumors that the jobs were moving to China were inaccurate, Lawson said: Evergreen will no longer manufacture solar panels, only silicon wafers. As Chinese photovoltaic companies moved into the market, panel sale prices plummeted to record lows in two short years.

Chinese companies manufacture panels for

\$1.20 per watt and sell them for \$1.60 to \$1.70. Evergreen spends \$1.90 per watt to make them.

China continues to build factories, and supply nearly 40 percent of global demand. Average panel prices dropped by 10 percent just this past December,

"Who would have predicted that?" Lawson asks. "We certainly didn't."

The story sounds familiar to Usha Haley, professor of international business at Massey University in Auckland, New Zealand. The American scholar who has done extensive research on manufacturing and subsidies in China, says the Chinese government's enormous investments into manufacturing businesses is changing the landscapes for virtually every industry around the world.

Steel, glass, auto parts: In each of the industries, China has turned itself from a major importer to the largest producer of the world in a matter of a few years, Haley says.

Solar is no exception.

The majority of American companies that produce silicon-based photovoltaic panels

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struggle to survive the fierce price competition led by China, experts say. It has already forced Evergreen Solar -- the symbol of the Bay State's economic future, as Gov. Deval Patrick has put it -- out of the module-making business.

Spectrawatt, an Intel spin-off that manufactures silicon photovoltaic cells, announced in December it is closing its Hopewell Junction, N.Y., plant and laying off 117. It opened only in May last year.

The company has cited the declining demand from Europe as utility incentives have been cut back, according to media reports. Some experts speculate the Chinese advancement into the market might have played a role, too.

What other companies will follow their fate?

The amount of research and development ongoing in the U.S. gives American industries some hope, says Travis Bradford, founder and president of Prometheus Institute in Chicago. Silicon-based solar panels -- the focus of Chinese solar production -- are based on 40-year-old technologies.

"MIT engineers are a lot more competitive than you might think," Bradford says.

Evergreen, for one, is trying to capitalize on the String Ribbon technology that drastically reduces the amount of silicon to make wafers. The downside is the width limit.

String Ribbon wafers cannot be made wider than 3.5 inches -- too skinny for conventional panels that require 6-inch-wide wafers. Evergreen is on a mission to expand the width so it can sell wafers to panel manufacturers around the world for the most competitive price. The company has already bought 10 prototype furnaces, for \$150,000 a piece, to experiment.

Bradford says any company that uses a unique and new technology gets a competitive edge.

"But, it doesn't mean they will hold on to it," Haley says of new technologies.

American manufacturers have been moving jobs to China to take advantage of the subsidies. Chinese subsidies always come with strings, Haley says, and conditions usually include transfer of technologies.

Evergreen Solar denies Haley's claim that the company has already shared the String Ribbon technology with its Chinese business partner, Jiawei Solar, in Wuhan, China, to get a grant for construction of its new wafer

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plant there.

The condition for the subsidy was creating jobs, says Michael McCarthy, director of investor relations and government affairs for Evergreen. Giving out the proprietary information wouldn't make sense for the company that is trying to become the leading wafer manufacturer, McCarthy says. In fact, Evergreen is making wafers in its own plant on Jiawei's campus to protect the technology, according to McCarthy.

But, companies feel pressure to give into Chinese demands, Haley says. After investing in new technologies financially and emotionally, entrepreneurs want to see a return. Chinese government rewards that.

Fierce price competition encourages them to do what makes financial sense.

And even if they successfully keep their special technologies to themselves, there is no guarantee that the Chinese won't figure out how to make similar products and sell them cheaply.

Copycatting of American technologies is rampant. Companies around the world have done it. But, "Chinese is unique in stealing in technologies" in terms of the scale and speed at which they are doing so, Haley says.

Companies can assume they will lose new technologies in which they invested in two to three years after commercialization, Haley says. Unless the U.S. government starts pumping in more capital into the industries, the future of manufacturing jobs belongs to China.

And, for American manufacturers wanting to access Chinese capital, Haley has a piece of advice: Be careful what you wish for.

"Go in with your eyes wide open," Haley says.

See Wednesday's paper for the second installment.

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