SHARP'S SOLAR SOLUTIONS

BY DANIEL GLICK

The sun has always been the star of our solar system.

Guiding sailors to safety: Ogami Lighthouse, a solar-powered beacon

THROUGHOUT HUMAN HISTORY, scores of cultures, from ancient Egyptians and Greeks to sun-worshipping Aztecs, have revered it, worshipped it, even deified it. But the sun's powers have also been put to work—and not just recently, but for nearly three millennia. As early as the 7th century B.C., mankind was making fire by concentrating sunlight through glass. In the 1700s, humans made solar ovens to cook food. And a century or so later, French physicist A. E. Becquerel discovered the phenomenon behind making electricity from the sun, called photovoltaics.

Then in 1959 a Japanese businessman took a step toward turning that phenomenon into a working reality. Sharp founder Tokuji Hayakawa, whose company made radios, appliances and other electricity-dependent products, also dreamed of producing power to run them. He called the solar battery the "next big technological breakthrough after television" and launched his firm toward making electricity from the sun.

Today, in an era of climate change and dwindling fossil fuel supplies, the development of reliable, affordable, renewable energy is essential—and solar is a prime candidate. Scientists calculate that enough sunlight hits the Earth each hour to supply the world's electricity needs for an entire year. In the following pages, hear how Sharp's half-century of pioneering solar innovations and its vision for the future are helping us to realize humanity's ancient dream and modern hope: to harness the unfathomable power of the 15,000,000°C star we call our sun.

LIGHTING THE WAY

Making solar history: a sun-fueled buoy

SHARP'S LEADING-EDGE SOLAR ENERGY SYSTEMS are used in homes and businesses all over the planet today. But one of their earliest uses was off-shore, in an historic lighthouse and lighted buoys.

For sailors, a lighthouse can mean the difference between safe passage to a harbor and a wreck on a rocky shoal. In an island country like Japan, with more than 18,000 miles of coastline and an economy dependent on shipping, lighted navigational beacons are literally a lifeline.

That's why it has been so critical for the Japan Coast Guard to ensure the reliability of thousands of lighted buoys, channel markers and lighthouses. In the 19th century and well into the 20th, lighthouse keepers in Japan traditionally used oil and gas to keep their guiding flames lit—and if those flames went out for any reason, ships could be endangered. Even after the development of electricity-powered light bulbs that could show captains the way, floating buoys and lighthouses located on islands and remote promontories couldn't benefit from the new technology. Instead, many lighthouses had to be resupplied monthly with cumbersome acetylene gas canisters and heavy batteries; the buoys required constantly refreshed energy sources, too.

A BETTER WAY

Retired Coast Guard official Tetsuro Sakamoto dedicated much of his career to finding a better way. In the early 1960s, "we were looking for alternatives to oil and gas," he says, when Sharp approached the Coast Guard with an idea for using their new solar cells to light buoys. Japan's first solar-powered buoy was installed in 1963 in busy Yokohama Bay.

Sharp and the Japan Coast Guard then set their sights on a lighthouse located on Ogami Island off the coast of Nagasaki Prefecture in southern Japan. Ogami, a key navigational point on a shipping channel transporting goods back and forth between Japan, China and Southeast Asia, relied on battery power or gas to keep its lights blinking throughout the fog-shrouded nights. Shigehiro Nakanishi, a Sharp engineer who was just starting his career with the company in 1964, recalls having to scramble up a 100-foot hill every month to the lighthouse, to help carry a dozen 88-pound batteries. "That was a lot of work," he recalls. Sakamoto, the Coast Guard official, jokingly chides his former co-worker for being soft. "We had to carry gas canisters, which weighed 220 pounds each!" he says — and the lighthouse needed between 20 and 30 canisters every year.

All that changed in 1966, when Sharp installed photovoltaic (PV) panels on the lighthouse in what was then the largest solar energy system in the world: a 225 watt system that would eventually make Ogami sun-sufficient.

FIRST-GENERATION CHALLENGES

Those first-generation PV panels had some challenges to overcome: the extreme weather and huge temperature swings caused cracks, and the salt air corroded the wiring. Shigehiro Nakanishi, who joined the company's fledgling solar division in the 1960s, worked with the Coast Guard, tweaking the technology to make it better. If they could make the panels work in a harsh marine environment, he reasoned, almost anything else would seem easy—and Nakanishi, like his employer, was committed to solar's long-term, big-picture potential. "Powering the lighthouses was like powering the country," he says.

All their efforts paid off: eventually, PV worked so well, "we wanted to put solar panels everywhere," Tetsuro Sakamoto says. Today, most Japanese lighthouses are solar-powered: in fact, the last full-time lighthouse keepers left their lonely jobs a few years ago. All across Japan sunlight is supplying power to the beacons that keep ocean-going vessels and their crews safe.

That was just a first step in Sharp's solar revolution. "It's like a dream come true," says Sharp engineer Nakanishi. "Solar can power not just lighthouses but also the world."

And indeed, using solar to power communities all over the planet was a big part of Sharp's solar progress—read about it on the next page.

"WE WERE LOOKING FOR ALTERNATIVES TO OIL AND GAS."

—Retired Coast Guard official Tetsuro Sakamoto

Meeting the world's needs

Photo of Ogami Lighthouse courtesy of Japan Coast Guard

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Noyon, Mongolia

POWERING THE POWERLESS

FROM EARLY ON, SHARP HAS REACHED OUT to those who need power the most, creating solar systems that meet their specific needs.

When Sharp engineer Hirofumi Mitsuoka arrived in the remote Mongolian village of Noyon in 2002—after a grueling, 30-hour drive from the capital city of Ulan Bator, following caravan tracks and at times navigating by the stars—virtually the entire population of 500 turned out to greet the man who was about to light up their lives, literally. Noyon, set on the north edge of the Gobi Desert, had a sporadic system of electricity, powered by diesel generators that generally ran only a couple of hours each evening, due to the high cost of fuel. That meant that hospital procedures, even emergency surgery, could only happen at night. Children couldn't learn on computers during the school day. And a slew of tasks and activities—from washing laundry to watching TV—could only be done during a small window of time after nightfall. Mitsuoka was about to change all that, forever.

Mitsuoka visited every house, drinking endless glasses of tea and cups of fermented mare's milk, dining on goat meat—and learning about the villagers' lives. He asked each household the same question: How would they use the new solar electrical system that Sharp was engineering for them (in a joint project of the Mongolian government and the Japanese government's New Energy and Industrial Technology Development Organization)?

On the villagers' wish list were a host of things many of us take for granted. Daytime electricity to run the hospital was key, as was upgrading the telecommunications building. If the children could do their computer work during school hours, then families would have more time together in the evenings. Villagers also wanted to be able to do simple things, like making copies or washing clothes during the day, running their refrigerators continuously, watching TV for more than one hour a night and making their morning tea without having to build a fire from scarce wood or animal droppings. A group of five women even wondered if there would be enough power for them to start a bakery (the uncertainty of the power supply meant that village bread was not always fresh). "People were really in need," Mitsuoka said.

MEETING GLOBAL NEEDS

Globally, that need is huge. More than 1.6 billion people—almost one quarter of the world's population—have little or no electricity, according to a 2005 United Nations report. Increasingly, solar panel installations are a perfect solution, offering a chance to leapfrog traditional centralized grid systems fed by coal-fired power plants or other generating stations. Distributed-energy systems like these can take many forms, from rooftop solar installations to small-scale energy systems producing a few kilowatts each.

Sharp and its engineers have been a driving force in bringing such systems to remote, off-the-grid communities all over the globe. In central Thailand, for example, Sharp engineer Nobuyuki Morioka and his team helped to create a solar installation similar to the one in Noyon, working side by side with locals in

> "PEOPLE WERE REALLY IN NEED."
>
> *—Sharp engineer Hirofumi Mitsuoka*

the middle of a humid rainforest—and eating with them too, gamely sampling regional staples like snakes, frogs and lizards. ("The frog was okay, but I didn't like the snake," he recalls.) The result of all that toil: A 100 kilowatt (kW) system that served the village of Den Mai Sung, as well as providing power to two other nearby villages.

Sharp has also delivered solar-fed electricity to places where circumstances make it impossible to install traditional centralized grid power, such as Antarctica and Tibet. And it has reached out to communities that have had their power knocked out by natural disasters, as well. The company's SOLA in NOLA project—winner of a prestigious corporate-responsibility award—supplied 10 solar electrical systems to New Orleans's 9th Ward, hit hard by Hurricane Katrina, to help bridge the energy gap until the city's electricity infrastructure could be rebuilt.

MAKING A DIFFERENCE

In Mongolia, the first big step in creating a new power infrastructure was to set up a weather station to determine how many panels would be necessary. Next, after nearly a year of gathering weather data and assessing electricity needs, Hirofumi Mitsuoka, working with other Sharp engineers, designed five different solar panel energy systems for a 200 kW system: for the hospital, the telecommunications center, the town offices, the school and the power-generating center. If these were tied to the existing rudimentary grid that linked to most of the houses, he figured, most of the villagers' needs could be met.

Mitsuoka arranged for a shipment of solar panels and organized an 11-truck caravan to bring them to Noyon. From Ulan Bator it took a full week to drive the 700 kilometers to the village, with nomads offering directions along the way. One day at high noon, shortly after the system was set up, Mitsuoka joined the villagers to start it—and saw the glee on their faces when they could turn on their lights with a flip of a switch. When Sharp solar system engineer Momoki Watanabe, who also worked on the project, received a report from Mitsuoka about this remarkable moment in Noyon's history—and the culmination of all their hard work—he accurately observed that for the villagers, "it really was the difference between day and night." But the Noyon project, which was completed in 2004, will likely have an even bigger impact: because the system has to function in searing 35°C summer days and -30°C winter nights, its success means that other remote and challenging locations can also look to the sun for power.

GENERATING A NEW ECONOMY

In the years that followed, the ready availability of power generated new economic activity in the village and the region. Dr. Namjil Enebish, executive director of Mongolia's National Renewable Energy Center, says the installation brought about "revolutionary changes" in the lives of people in Noyon, and "it had a very impressive impact on this small, remote village." Several villagers began businesses: one man set up a building-supply center, milling lumber with an electric saw; another started a car-repair shop. A restaurant opened, providing a meeting place for villagers and people around the region. And the five women who wanted to open a bakery? Mitsuoka says they did just that. "The bread," he says with a satisfied grin, "was delicious."

In fact, as you'll read next, Sharp's advanced solar technologies have played a major role in radically—and profitably—transforming businesses all over the world.

Business's solar gains ▶


Dependable solar power means medical procedures can happen any time (top); household chores are easier, too (middle); teaching children computer skills (bottom)


Empowering a village: Noyon's solar energy system

SHARP

Sun farmer Frank Groneberg at Solarpark Rodenäs in Germany (left); Far Niente winery's Larry Maguire and his son, Michael (center); Clarum Home's John Suppes and one of Clarum's sun-powered abodes (right)

SOLAR-DRIVEN INNOVATION

THANKS TO SHARP'S HIGHLY ADAPTABLE ENERGY SYSTEMS, businesses and other organizations around the world are getting wise to the power of solar: it's not just good for the Earth, it's good for the bottom line, too.

Remember those first solar-powered calculators? In 1976, when Sharp introduced them, the idea of powering an electronic gizmo with the sun's rays seemed far-fetched. Today, ingenious and cost-effective energy systems are providing solar gains for individuals, businesses and cities all over the planet. And each has its own, distinctive solar story.

THE SUN FARMER

Frank Groneberg's path to solar farming began with some piglets that needed to be kept warm, some seed-eating geese and a German law that encouraged renewable energy. For decades, Groneberg grew wheat and raised pigs on the farm that his father and grandfather had worked, set two miles from the Danish border along the North Sea coast in northern Germany. Then one year he installed solar thermal panels (which heat water rather than producing electricity), using them to power a radiant-floor heating system that kept the piglets warm—and cut his fuel bill significantly.

In the meantime, geese were literally eating the profits from his wheat crop: every time he planted seeds, the geese feasted. It was time to think of something else. The German government was providing incentives to anybody who produced renewable energy, and Groneberg decided to take advantage of them. He built Solarpark Rodenäs, planting two fields with more than 700 Sharp photovoltaic panels. "Sharp was our first choice," says Groneberg. "They treated us like partners from the beginning, responding to our questions and ideas in a way that was always helpful and pleasant. Sharp's service has been exemplary. We're truly satisfied."

Discovering that the solar panels were most efficient when the sea breezes cooled them, Groneberg installed a tracking system that allowed him to get more than 12 hours of solar gain each day during the peak summer months. "I make one hundred times more money as a sun farmer than as a wheat farmer," he says.

His neighbors quickly followed his example. Today, virtually every nearby house and farm building has PV panels on its roof. In fact, four of the top six teams honored by Germany's Solarbundesliga—a kind of national solar energy championship league that scores individual towns owning the largest solar installations per capita—are from the area around Rodenäs. "Everybody can be an energy producer," Groneberg says.

THE SUSTAINABLE VINTNER

In California's Napa Valley, the plentiful sun and rich soil create one of the world's most famous winemaking regions. For Larry Maguire, president and CEO of Far Niente winery, the sun also created an opportunity for him and his partners to help preserve the planet for the next generation—and for Maguire to grow closer to his son.

A few years back, Maguire treated himself to a luxury sedan—one that got about 20 miles to the gallon. Far from being impressed, his teenage son, Michael, called his father out, saying, "You're worse than the ignorant. You know better, yet you've chosen inaction." He hit a nerve—Maguire *did* know better, at least when it came to his business: he'd long dreamed of running Far Niente, a historic winery founded in 1885, more sustainably. Michael's comment spurred him to action. Maguire and his staff started investigating photovoltaic systems and found they'd need at least a couple acres of panels to power the winery. Giving up that much land in Napa Valley—where an acre of vineyard growing Cabernet Sauvignon grapes can cost upwards of $200,000—was a tough call.

The innovative Floatovoltaic® system at Far Niente winery

But the winery had an irrigation pond that covered about an acre—and one of Maguire's partners wondered if there was a way to utilize it. Maguire was introduced to a company that had built a prototype system to float a PV panel, Thompson Technology Industries, along with its sister firm, SPG Solar, that could install it. The result? Floatovoltaics®—994 Sharp panels that sit on floating pontoons, looking more like a floating sculpture garden than a solar power plant. On an adjacent acre of less productive land, Far Niente installed another 1,302 panels. Today, just one year later, 100 percent of the winery's electricity needs are met by solar, with power to spare.

> "SOLAR IS GOING TO BE THE FUTURE."
>
> —John Suppes, president, Clarum Homes

Far Niente picked Sharp for a host of reasons. "This is an important investment that needs to last at least 25 years," says Maguire. "The Sharp 208 panel we chose is tried and true, proven to be robust, and manufactured by a company with a great reputation that is sure to be around for a long time."

Far Niente didn't receive the same government support that Germany provided to Frank Groneberg, but it did earn rebates, tax credits and attractive financing. And it earned Maguire the respect of his son. Showing him the installation "was one of the most wonderful moments," he says. "In some small way, we had done something that was helping to save the world."

THE SOLAR BUILDER

A mother-son connection forged yet another solar innovator. Green builder John Suppes recalls learning about solar building when he was just five years old. His mother, a Harvard-trained architect, used to drive young John around in the 1960s, telling him how silly it was that architects missed out on opportunities to use the sun's power—to create passive solar heat, for instance, by building homes with plenty of south-facing windows.

Today, as president of Clarum Homes, Suppes has moved his company into the vanguard of energy-efficient building. "Forty percent of energy use in the U.S. is from heating and cooling buildings," he says. Since installing his first solar PV system in 1998, Suppes has put PV panels on hundreds of houses—including those in the new Hansen Lane Estates subdivision in Danville, California. In this leafy suburb near San Francisco, Suppes has built 10 homes equipped with Sharp photovoltaic panels. "Sharp's on the cutting-edge—they're the leader," says Suppes. "And their panels are very reliable. I've tried other companies in the past—and Sharp's the most consistent and dependable for the money." The panels, along with other green features—including solar thermal for hot water, as well as high-efficiency appliances—have earned the development the coveted Gold Certification from the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Green Building Rating System.

For Suppes, installing PV systems on new homes makes perfect economic and environmental sense. If the price of the installation is built into a standard mortgage, the electricity savings more than compensate for the additional cost. "It's a no-brainer," says Suppes, who recalls one homebuyer showing off his $9 electricity bill with great pride. "Solar is going to be the future."

A NEW ENERGY ECONOMY

In many cases, the future has already been installed. The city of Denver in Colorado christened a seven-and-a-half-acre PV system last summer at the Denver International Airport (DIA)—one dramatic step toward building a new energy economy. The system, which uses Sharp panels, is expected to generate more than three million kW hours of electricity every year and power the United States' fifth-busiest airport for decades to come.

The DIA energy system is one of the most visible PV installations in the world—far more massive than Frank Groneberg's solar farm, Larry Maguire's Floatovoltaic®-fed winery and John Suppes's sun-fueled housing development. But all of them share one thing: a powerful spirit of innovation, along with a drive to fully realize solar's promise.

In 2010 Sharp will help to make that promise a reality with a sun-fueled power plant in Japan—a quantum leap into the future, detailed in the following pages.

Solar's next giant step

Photos clockwise from top left: Bert Bostelmann/Getty Images. All others Don Feria/Getty Images

SHARP

Photos left to right: Solar in space holds great promise; at the CIS Tower in Manchester, England, over 7,200 Sharp solar modules generate 183,000 kW a year; in Mainz, Germany, the Bruchwegstadion is powered by solar; artist's rendering of the municipal hall in Suzuka City, Japan, on a sunny day, with thin-film solar panels on the roof; exterior view of Suzuka City's municipal hall; in Austria, solar power is part of Salzburg Airport's emphasis on environmental management (the airport has been awarded an ISO 14001 certificate)

FUTURE VISION SAKAI & SOLAR'S GLOBAL PROMISE

WHAT'S NEXT FOR SOLAR TECHNOLOGY, AND FOR SHARP? A new, sprawling industrial complex on the oceanfront of Sakai in Japan's Osaka Prefecture holds the answer.

The state-of-the-art solar and LCD panel plant in Sakai City promises to manufacture the future. A bright one. The plant, scheduled to begin solar production in 2010, embodies 50 years of solar research and development by Sharp. When it opens the huge manufacturing complex will mass-produce revolutionary thin-film solar cells, as well as LCD panels. The facility's roof will also be a solar-generating system, producing a maximum of 18 megawatts of electricity to help fuel manufacturing.

The Sakai plant's launch won't come a moment too soon. Governments are recognizing that the need for renewable energy has become acute. Not only are the climate-change impacts of traditional coal-fired power plants—which produce the lion's share of energy consumed in many nations—becoming more obvious, but their health impacts are looming ever larger: according to the Earth Policy Institute, they contribute to tens of thousands of asthma attacks, heart attacks and deaths each year in the U.S. alone. A host of countries—Japan, China, Germany, Spain, the U.K., the Netherlands, the U.S. and many others—have created various incentives for companies or individuals to install sun-powered systems. And new solar technologies are coming on line just in time to provide an essential alternative to fossil fuels.

CREATING A SUSTAINABLE SOCIETY

"We all feel an urgent need to develop an effective alternative energy source," says Tatsuo Saga, Sharp's solar systems development group executive technical research fellow. With atmospheric carbon dioxide levels rising, along with global awareness of the impacts of climate change, cost-effective, renewable power solutions have become the energy sector's holy grail. "One of the great challenges for humankind is how to reduce carbon dioxide emissions," says Saga. "We must construct a more sustainable society for the future."

That's why Sharp has been developing solar since 1959, mass-producing the first solar cells in 1963 and following them up with ever-larger, thinner, more efficient and less expensive PV energy systems, as well as with more innovative ways to use them. Sixteen miles west of Sakai at Sharp's manufacturing plant in Katsuragi City—which has a production capacity of 550 megawatts of crystalline PV cells each year, as well as 160 megawatts of thin-film cells—a solar-powered fountain and an intriguing installation of experimental photovoltaic panels greet visitors. On a nearby rooftop, an electricity-producing solar laboratory includes different kinds of PV energy systems, with sensors tracking the efficiency of various orientations throughout the day.

Sharp founder Tokuji Hayakawa (right) testing a crystal radio set (1925)

A GIANT STEP FOR SOLAR

The Sakai plant represents a critical next step toward energy sustainability, in terms of both energy yield and cost. Projections indicate the plant will produce up to a gigawatt of thin-film solar panels annually. Thin-film panels use a fraction of the amount of silicone that crystalline panels do, so they can be made less expensively. In addition, thin-film technology is at the heart of many new solar applications, like building-integrated PV panels (BIPV), which promise architectural sleekness along with extraordinary functionality at a reduced cost, compared to standard crystalline panels. Thin-film technologies are seen as the next wave, and a powerful one.

However, crystalline panels remain the technology of choice for a large number of applications—depending on the latitude of the installation, how much room is available for panels and the system's energy production requirements. In our drive to tap the sun's power and reduce our reliance on fossil fuels, crystalline panels continue to play a major role—and will do so for years to come.

Photo of satellite (top left): original photo by JAXA

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The Sharp plant in Sakai, Japan, will have the capacity to produce up to a gigawatt of thin-film solar panels each year

> **"ONE DAY WE WANT TO BE ABLE TO PRODUCE THE ELECTRICITY CONSUMED BY OUR PRODUCTS."**
>
> *—Sharp founder Tokuji Hayakawa*

Beyond that, there are many new frontiers for solar to explore, including the vast reaches of our solar system: Tetsuo Saga believes that space-based solar stations will one day be capable of generating massive amounts of energy and beaming it down to Earth.

GLOBAL & LOCAL VALUE

At Sakai Sharp has focused on every part of the manufacturing process, creating a vertical integration of the facility that will likely become a case study for companies around the world. The emphasis on ensuring energy efficiency and creating manufacturing facilities for all stages of production will help keep costs down. Katsuhiko Nomoto, Sharp's solar systems group division general manager, believes that increases in efficiency will soon mean that solar power will be as inexpensive as electricity powered by fossil fuels.

Sakai represents another piece of Sharp's Total Value Chain, whose goal is to provide solar services around the world, from manufacturing to installation training and service. In addition, Sakai is one of several new Sharp manufacturing facilities coming on line or under construction all over the globe—part of the company's effort to provide what Nomoto calls "local production for local consumption." Sharp global manufacturing facilities for crystalline modules now include those in Memphis, Tennessee, in the U.S. and Wrexham, Wales, in the U.K.; another facility will come on line in Italy in 2012.

A FOUNDER'S VISION

That will coincide with Sharp's 100th anniversary, marking a century since a young Tokyo metalworker apprentice named Tokuji Hayakawa founded the company that would become one of the largest and most enduring electric-appliance manufacturers in the world. Hayakawa challenged his employees to "make products that other companies want to imitate." His firm has done just that when it comes to solar technology.

The fireball that is our planet's star sends an almost unfathomable amount of energy to Earth, even from 91 million miles away. Harnessing that power has not been as easy as burning coal, but the world stands poised to enter a new era where solar power is cheaper, more environmentally sustainable and more effective than any fossil fuel could ever be. With the Sakai plant, Sharp continues to ensure that founder Hayakawa's vision—that "one day we want to be able to produce the electricity consumed by our products"—will become a reality.

Stay tuned at SHARP-SOLAR.COM

Daniel Glick writes about energy, the environment and a host of other topics for numerous publications. He's the co-founder of The Story Group, which taps new and traditional media to cover climate change, the environment, international development, the global economy and many other issues. Glick is also the author of two books, the most recent of which is *Monkey Dancing: A Father, Two Kids, and a Journey to the Ends of the Earth.*

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