

# ROOFTOPS AND PHOTOVOLTAICS

## – THE PERFECT MATCH

BY BRIAN WHELAN AND JON SLANGERUP

The need for renewable energy has never been more evident. The effects of recent hurricanes hitting the Gulf Coast are just starting to be realized from an economic standpoint. The petrochemical industry, a major driver in our overall economy, has been disrupted, resulting in record-breaking gasoline and

natural gas costs. One could argue that the current war with Iraq – which is causing casualties and adding to our deficit every day – is all about oil. There is no argument that California's rolling blackouts in 2001 and 2002 and the Great Blackout that occurred in the Northeast and Canada in 2003 are clear examples of how vulnerable we are today. Alternative sources of energy will be required. Our leaders in industry

and government are slowly "getting it." As a country, we must become more self-sufficient with respect to energy. We are talking about our national security, as well as the comfort of our daily lives. Effective use of renewable energy will revolutionize society. It will improve the environment and potentially reduce wars and terrorism, but most of all, it will improve the health and quality of life for all of us.

Today, renewable energy is only a small part of the \$220 billion per year electric power business. Renewable energy is defined as power generated from wind, solar, or biomass (plant matter such as trees and grasses or agricultural crops that can be used as a solid fuel or converted into liquid or gas for production of electrical power or heat). Geothermal energy entails harvesting hot water from the earth that is used for heating and process applications.

One could debate the advantages and opportunities that each

*Flexible PV panels being installed.*



type of renewable energy brings. In this article, we will concentrate on solar energy. One of the clear advantages of solar power is that it delivers most of its power during peak hours of energy use. The rooftop is a natural platform for harnessing power generated from the sun.

Industrial flat roofs represent billions of square feet of untapped real estate where building integrated photovoltaic (BIPV) roofing systems can be easily and cost-effectively installed. Typically, industrial rooftops represent nothing more than a financial liability to a building owner or tenant with no return on investment (ROI). BIPV systems have the ability to turn roof liabilities into energy-producing assets, producing clean and secure energy for direct use by the building's operations and at an attractive ROI. When we consider the nearly unlimited availability of industrial flat rooftops across the world, combined with the exciting renewable energy opportunity of BIPV roofing systems, the potential to substantially reduce dependency on energy produced from fossil fuels is staggering.

Solar photovoltaic (PV) market installations worldwide totaled 927 megawatts (MW) in 2004, representing a 62% growth over 2003 installations. Once again, Germany led the pack with a startling 152% growth. Germany has taken over market leadership from Japan in terms of annual installation rate (the latter still remains the leader in cumulative PV installed).

The two largest markets, Germany and Japan, accounted for 69% of the total world market installations in 2004.

The U.S. market showed 27% growth in 2004, compared to 17% the previous year. In 2004, 277 MW of PV was installed in Japan, an increase of 27% but a fall from 36% growth in 2003.

However, the star performer among the

top three country markets was Germany, which secured 366 megawatts of new installations, following on a strong 2003, when that country's market gained 76%.

### PV Systems

There are presently two types of PV systems in use – rigid crystalline panels and thin film panels.

Most of us are familiar with crystalline PV modules encased in glass and metal frames on rack mounts. Besides being aes-

square foot, making thin film PV an ideal application for solar roofing systems.

Crystalline PV panels are generally about twice as efficient as current, commercial, thin-film PV panels in their ability to convert sunlight into electricity. However, thin-film PV panels have three significant advantages over crystalline PV panels:

First, amorphous, silicon-thin-film PV has excellent low-light sensitivity,

**Flexible PV panels over PVC roof system.**



thetically obtrusive, the extra weight of five to eight pounds per square foot that crystalline systems add to the roof typically results in additional structural considerations. The other drawback of these systems is that, in order to mount them, the racks typically require penetrations to be made through the roof to properly secure the solar system. Making holes in a roof is not a good thing, and coupled with the added weight, it is no wonder why so few roofs serve as hosts for crystalline PV systems.

The second type of solar system utilizes flexible, thin film PV based on amorphous silicon solar cells. These cells are made in a roll-to-roll deposition process on stainless steel. The result is a unique, flexible, lightweight solar cell, and when combined with state-of-the-art single-ply roofing membranes, weighs only about 12 ounces per

which means that the thin-film PV panels begin generating electricity from the break of dawn through sundown, thereby generating electricity for the entire period of daylight hours. These remarkable systems even produce lesser amounts of electricity during cloudy or rainy days. Crystalline PV, on the other hand, while more efficient, requires direct sunlight to produce electricity over a much shorter period of the day. So, in fact, amorphous, silicon PV panels produce as much or more electricity during the day, which is the true measure of success.

Second, amorphous, silicon PV panels generate electricity lying flat on their back, regardless of where the sun is in the sky, while crystalline PV panels generally need to be installed at an angle and orientation to optimize exposure to direct sunlight in order to maximize output. This further lim-

its the application of crystalline PV as a rooftop solar application.

Finally, the weight and durability of crystalline PV panels, which are mounted in metal frames and covered by glass, is at a significant disadvantage to thin-film PV panels, which are encapsulated in a Teflon-based material that withstands weather, debris, dirt, and other hazards often encountered on rooftops. Having glass solar panels on a roof increases the risk of damage to the roof from glass breakage.

Solar Integrated Technologies (SIT) of Los Angeles, California, has introduced a patented "building-integrated photovoltaic" (BIPV) roofing system. The Solar Integrated (SI) BIPV system is comprised of thin-film,

amorphous PV modules factory laminated onto a time-proven, 60-mil Sarnafil PVC single-ply roofing membrane that turns a roof into an energy-generating asset. PVC roofing membrane was selected as the support material to ensure long-term weather-proofing, reflectivity, and superior fire resistance. The SIT-integrated roof system is available with a 20-year watertight and power-generating performance warranty.

Specifically, SIT laminates 12 thin-film, flexible PV modules to form a 10' x 40' flexible solar roof panel. During the roof installation, the panels are hot-air welded onto the PVC roof system. The electrical wiring is connected to inverters that convert the DC power generated by the solar panels into AC



## PHOTOVOLTAICS – HISTORY IN THE MAKING

- 1876 William Grylls Adams and student, Richard Evans Day, discovers a solid material – selenium – produced electricity when exposed to light.
- 1953 While researching silicon for its possible applications in electronics, Gerald Pearson, a physicist at Bell Laboratories, inadvertently makes a solar cell that was far more efficient than solar cells made of selenium.
- 1956 Silicon solar cells are used to power radios and toys.
- 1960s Silicon solar cells are selected by the Navy for powering earth-orbiting satellites.
- 1970s Solar cells power navigation warning lights and horns on most off-shore gas and oil rigs.
- 1970s Dr. Elliot Berman, with financial help from Exxon Corporation, designs a significantly less costly solar cell, bringing the price down from \$100/watt to \$20/watt.
- 1970s Solar cells power the lights of almost every lighthouse run by the U.S. Coast Guard.
- 1974 Solar cells used to power railroad crossing in Rex, Georgia.
- 1980s Since 1983, half of the households in the outlying islands of Tahiti rely on solar energy.

At least one hundred thousand families in Mexico, Central America, and the West Indies run their lights, television sets, and radios with solar electricity.

Solar electric panels cover the rooftop of an apartment complex in Bremen, Germany.

- 1990s Better, cheaper cells are developed.

power. Each panel generates approximately 1,500 watts. SIT's manufacturing plant in Los Angeles has the capacity to produce up to 60 megawatts of BIPV panels a year, facilitating the growing number of SI installations currently in place in the U.S. and Europe, with more than 10 megawatts of orders currently on backlog.

### Turning a Roofing Liability into an Energy-producing Asset

Frito-Lay has been committed to protecting the environment and conserving national resources and for years has reaped the financial benefits of those actions. For example, every Frito-Lay employee is encouraged to act as an environmental steward. Each manufacturing location has its own Green Team, a group of individuals dedicated to finding ways to help the company save money by saving energy and other resources.



**Completed  
Frito-Lay project,  
Los Angeles, CA.**

So when Frito-Lay's Los Angeles Distribution Warehouse needed a new roof, it was no surprise that management looked for a way to not only replace the existing built-up roof with a durable, long-lasting alternative, but also to find a way for the roof to make their facility more energy efficient.

Frito-Lay found the solution in a BIPV roofing system. The environmental benefits, combined with the local utility's solar rebate, made the SIT solar roofing solution a clear choice.

#### **Tracking the Results**

Now that the system is fully operational, Frito-Lay can see exactly how much electricity the roof is generating using SIT's web-enabled energy management software. "The system works so well that during some periods of the day, we are producing more power than we need," said Chris McKenna,

electricity manager at Frito-Lay. "When that happens, the extra power gets fed back into the utility grid."

In addition, the energy management software allows Frito-Lay to analyze data, which will help them catch billing errors and manage electrical consumption more efficiently. Customized alarms and status indicators also allow for off-site power management.

#### **Generating Energy and Good Will**

"We are very happy with the results," said Matthew Ollivier, Frito-Lay's area planning manager. "We have an environmentally friendly roof that will last for years, help us keep our cooling costs down, and gener-




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800-828-1902  
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ate electricity, all at the same time.”

Since the first installation of the solar integrated roof system, Frito-Lay has installed another system on its Sylmar, California, distribution center roof, its Rochester, New York, distribution center and has additional installations underway and planned for the future.

“The performance of the system has exceeded our expectations in terms of efficiency and power produced,” adds McKenna. “We anticipate significant cost savings from reduced use of electricity with the new photovoltaic roof systems in place.”

The early success of Frito-Lay’s solar roofing initiatives led to Solar Integrated being named the Frito-Lay North America 2004 Capital Supplier of the Year, lending further evidence to the synergy between economic value and environmental stewardship. Through the leadership of major corporations like Frito-Lay, the renewable energy revolution is getting a secure foothold in the climb to energy security and environmental recovery – leading to improved health and quality of life for generations to follow. 

### Brian Whelan

Brian Whelan has been employed by Sarnafil, Inc. for 25 years and is currently its president and CEO. He jointly owns three patents on hot air welding of thermoplastic membranes and profiles. Prior to joining Sarnafil, Inc., Brian was a project manager for Simpson, Gumpertz & Heger. He is a graduate of Harvard University’s Business School PMD Program and has a degree in architectural technology. Brian was one of the original members of SPRI (Single Ply Roofing Institute), later becoming a member of its board of directors and chairman of its thermoplastic subcommittee. He is a member of the RICOWI board of directors and of RCI and CSI and has participated on ASTM committees on roofing and waterproofing. Brian has written many published articles, technical pieces, and literature on roofing and waterproofing.



### Jon W. Slangerup

Jon W. Slangerup - In February of 2005, Jon W. Slangerup joined Solar Integrated as its chief executive officer. Prior to that, he was president and CEO of Stuart Energy until the company’s acquisition by Hydrogenics in January 2005. During his tenure at Stuart, Mr. Slangerup transformed the company into a global leader in providing hydrogen infrastructure products for transportation, power generation, and industrial applications. Previously, Slangerup was chairman and CEO of Electron Economy, a supply chain management software company; and president of FedEx Canada for seven years. Slangerup holds bachelors and masters degrees.

