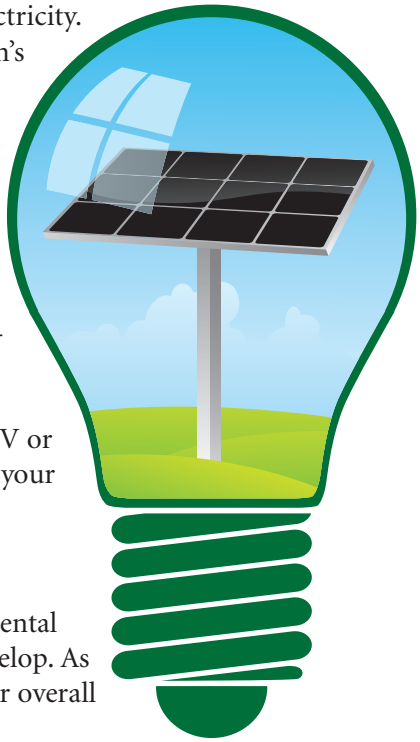
Your Solar Energy Options



Solar photovoltaics (PV) is the science of turning sunlight into electricity. Despite the relatively paltry contribution of solar PV to the nation's energy picture (thus far), it is not a new technology. NASA has been using the technology for decades to power satellites and other space-roving equipment.

As a well established technology, solar PV isn't a risky option for your building. New technologies are becoming less expensive and manufacturers are incorporating them into a range of building products, from metal roofing to siding shingles.

Thanks to legislation signed into law on Oct. 3, 2008, federal renewable energy tax credits have been extended at least through the end of 2013. These credits apply to solar thermal installations as well.

Bottom line: Even if you've never previously thought about solar (PV or thermal) as an option for your building, it's a good time to investigate your solar power options.

Progress on costs with more to come!

PV costs have dropped significantly in the past decade, as environmental concerns have boosted demand and enabled economies of scale to develop. As of 2009, solar power is poised to make a significant contribution to our overall energy portfolio.

While the U.S. lags behind both Germany and Spain in solar-based electricity generation (according to Solarbuzz, a research firm), the market here is nevertheless expanding rapidly. Photovoltaic generating capacity grew by 53% in 2007, the latest year for which figures are available.

Netherlands-based marketer SolarPlaza predicts growing competition among manufacturers could result in photovoltaic systems that produce electricity at the same cost as utility generators—a state called "grid parity"—by 2010.

How solar electricity is produced

Semiconducting wafers are the "stuff" from which a single photovoltaic cell is manufactured. This material is treated to create an electric field, so that one side of the wafer has a positive charge and the opposite side has a negative charge. Electrical conductors are attached to the wafers. The electrical circuit is powered by the electrons that are released when sunlight strikes the cells.

Single cells can be used to power small calculators, wrist watches, or simple lighting products. For much larger solar power systems, multiple cells are joined together into modules and then incorporated into a framed panel.

Panels can be mounted onto a rooftop, parking garage, or remote structure. A number of modules can be connected together in an array for greater electricity output.

Several other pieces of equipment are required to connect photovoltaic systems to a building's operations and the larger electrical grid. The most important of these is the inverter. This unit converts the direct current (DC) electricity solar panels produce into alternating current (AC), the type of electricity supplied by electric utilities and used by almost all electrical appliances and devices.

Circuit breakers also may be required on both the DC and AC sides of the connection, enabling the system to be disconnected safely when maintenance is needed.

Off-the-grid? Interested in disconnecting your facility from the utility grid? You'll need to include an energy storage system—typically commercial-scale batteries—in your plans. In this case, electricity produced by the solar panels in excess of the facility's immediate demand is used to charge the batteries, which in turn supply power once the sun goes down.

Putting solar PV to work

Determining whether a solar PV system will work for you begins with a common sense evaluation of your building's solar exposure.

For best results, an installation should have clear access to the sun's rays, preferably in a southern exposure and throughout the entire day. New thin-film products (see box, "*Newer Solar Technology*") may perform better in cloudy conditions, but shade is still a problem.

Determining the appropriate size of a photovoltaic system will likely require some help from a trained contractor. Several factors must be considered, including how much electricity your building typically uses and how much of your total electricity you would like the system to produce.

Additionally, there must be enough space at your location to fit a system sized to produce

Newer Solar Technology

Until recently, almost all photovoltaic cells were manufactured from crystalline silicon, the same material used to make the microchips found in computers and other electronic equipment. High demand for crystalline silicon across multiple industries has kept supplies low and prices high for several years.

Now a less expensive approach, using thin-film technology, offers promise for lowering solar cell costs and enabling new installation applications. Thin-film materials can be sprayed onto a substrate in a process similar to that used by dot-matrix printers, while crystalline silicon requires manufacturers to first grow silicon crystals that then are sliced into appropriately sized wafers, a much slower process.

Crystalline silicon is more efficient at converting sunlight into electricity, but it is also more rigid and brittle. Thin-film panels, on the other hand, are somewhat less efficient, but these units also are much less expensive to manufacture, so the cost per kilowatt of electricity can be lower.

What's more, thin-film products can be applied to more flexible substrates, which broadens the field of potential uses. Additionally, they perform better in diffuse light, like that found in cloudy areas.

Bottom line: While thin-film products may have a lower output when operating side-by-side with crystalline panels on a sunny day, they may be able to produce more kilowatt hours, overall, during a 24-hour period or during varied weather conditions.

There's more. The flexibility of thin-film materials is enabling the development of roofing, siding, and other building materials that incorporate photovoltaic properties as a side benefit. Called "building-integrated photovoltaics" (BIPV), these products are expanding options for building owners who wish to generate their own electricity.

Manufacturers also are working to perfect designs for windows and curtainwalls, so someday every building could end up serving as its own power plant.

the desired amount of electricity.

Your installation professional also may be able to help you understand your financing options. A photovoltaic system can require a significant investment; in effect, you are paying up front for decades of electricity the equipment will generate. A federal tax credit is available to help reduce the cost, and many states now are offering similar renewable energy tax breaks.

What's more, some electric utilities are beginning to explore leasing and power buyback arrangements that can reduce or eliminate your up-front costs.

While planning your installation's financing, be sure to consider ongoing maintenance issues. Photovoltaic panels are extremely durable (warranties can extend up to 20 years in some cases), but this equipment does require periodic attention.

Dust and dirt can build up on a panel, blocking sunlight and cutting electricity production, and accumulated snowfall can also block the sun's rays from reaching the panel's surface. As a result, your budgets should include occasional equipment cleaning to ensure the panels continue to operate at top efficiency.

MORE: Resources and Assistance

Who can help design and install a PV system of use to you and your building? Electrical contractors with experience in the field are your best first choice. These professionals are trained in the underlying principles required to ensure safe operation. See ***www.necaconnection.com***

For previous issues of the Electrical Design Library on this and related topics, see ***www.necanet.org/edl/.*** Some recent samples (all downloadable, FREE, as PDFs):

- Taking A Building Offline (September 2008)
- Greening Your Building (July 2008)
- Alternative Energy (August 2007)
- Sustainable Design (December 2004)

Also available

Emerging Green Markets, written by solar expert Dr. David Riley, associate professor of architectural engineering at Penn State, and published in 2007, talks about LEED and more. PDF download: $10.
www.necanet.org/store/products/ index.cfm/F2708

Emerging Photovoltaic Market Guide is a publication (scheduled for release in Summer 2009) from ELECTRI International—The Foundation for Electrical Construction. Author: Dr. Thomas Glavinich, D.E., P.E., of the University of Kansas.

Efficiency First, Then *PV*

Energy professionals like to say that the cheapest kilowatt is the one you never use, and this adage applies to solar energy systems just as it does to more conventional electricity supplies. Before planning any renewable energy installation, it pays to make sure your facility is already operating as efficiently as possible.

A more efficient building uses less electricity and thus requires a smaller photovoltaic system. If you can reduce your building's electricity usage first, you'll net significant up-front savings on a solar PV installation.

For an existing building: think about improvements that could make a difference without requiring a large investment. These could include replacing incandescent light bulbs with more efficient compact fluorescent or LED models, or replacing T12 fluorescent fixtures with T8 offerings. Retrofitting occupancy and daylight sensors into your lighting equipment also can help to reduce electricity demand.

Get Your Building Into Hot Water

Solar thermal differs significantly from PV. Essentially, heat from the sun's rays is concentrated to heat water to meet a building's hot water needs. According to the Department of Energy, solar thermal installations now in use range from those that heat the water in swimming pools to more advanced models, which create steam for power generation.

Obviously, from the table below, there's more commercial interest and more sales (and even exports) of solar thermal collectors these days. For more information, see:

Department of Energy solar thermal page: *http://snipurl.com/badez*
Wikipedia—solar thermal basics: *http://snipurl.com/badft*

Annual Shipments of Solar Thermal Collectors, 1998 - 2007

Year	Number of Companies	Collector Shipments (thousands of square feet)		
		Total[1]	Imports	Exports
1998	28	7,756	2,206	360
1999	29	8,583	2,352	537
2000	26	8,354	2,201	496
2001	26	11,189	3,502	840
2002	27	11,663	3,068	659
2003	26	11,444	2,986	518
2004	24	14,114	3,723	813
2005	25	16,041	4,546	1,361
2006	44	20,744	4,244	1,211
2007	60	15,153	3,891	1,376

[1]Includes shipments of solar thermal collectors to the government, including some military, but excluding space applications.

Note: Total shipments as reported by respondents include all domestic and export shipments and may include imported collectors that subsequently were shipped to domestic or foreign customers.

Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

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