Power Where You Need It
The Promise of Photovoltaics

Connie Brooks
Sandia National Laboratories
Photovoltaics Systems Assistance Center
A DEDICATION TO THE PV INDUSTRY

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Acknowledgements

Special thanks goes to Jim Rannels, Director of the Department of Energy’s Office of Solar Energy Technologies, for conceiving the idea for this book. He believes that DOE and its contractors, such as Sandia National Laboratories, and the entire U.S. photovoltaics industry can benefit from a book that captures the myriad uses for photovoltaics under one cover. Thanks also to Chris Cameron, manager of the Photovoltaic System Applications Department at Sandia, for his guidance during the preparation of this book, and for his vision that it should be a book about ideas, about promise, about opening up our minds to photovoltaics applications not yet conceived. Several staff members within Sandia’s Photovoltaic Systems Assistance Center, notably Hal Paut and John Stevens, gave generously of their time; their decades of experience with PV were invaluable in helping structure, critique, and guide the preparation of this book. Finally, without the U.S. photovoltaics industry itself, this book would never have been possible. They created the successful systems illustrated here. They work daily to further the acceptability, quality, and reliability of PV. They were a huge part of the preparation of this volume. From CEOs to secretaries; from marketers to web managers, thank you for sharing your photographs and for sharing your enthusiasm.

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Power Where You Need It:
The Promise of Photovoltaics

For more than twenty years Sandia National Laboratories has been involved in helping establish successful programs and partnerships with members of the photovoltaics community in the United States. In large part, Sandia’s efforts have fallen within the realm of engaging expertise and systems excellence. Because those efforts have been documented in numerous technical publications disseminated by the tens of thousands to industry, government agencies, educational institutions, and interested individuals, the installations with which Sandia has assisted are well known. Power Where You Need It is unique in that it also features dozens of installations with which Sandia has had little or no connection, except that those installations came about, in the end, because U.S. Department of Energy funding through its National Photovoltaics Program helped foster their existence. Sandia’s technical expertise in systems engineering created the overarching technical framework under which many of these PV installations were made possible. Sandia, along with the National Renewable Energy Laboratory, is a partner in the National Center for Photovoltaics, which is the Department of Energy’s focus organization for carrying out its National Program. Some of the installations featured in this book were made possible through various programs at the Department of Energy, but many were not. Many were simply the result of an enthusiastic end user making a vital business connection with one of the thousands of spirited members of the U.S. Photovoltaics Community. This book is dedicated to all of them. May something depicted here spur your imagination to make PV a part of the world around you.
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**Of This Book**

This book is loosely organized into categories that represent how PV is used, where it is used, and by whom. This necessarily means that a reader will find lighting applications, for example, on several different pages. We mean to stimulate thinking, not structure thinking. The PV pictured here was installed for many different reasons, not all of which have to do with their ‘green’ image and allows users to choose renewables; and it can provide uninterruptible building power.

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**Photovoltaics**—often called “solar electricity,” is the direct conversion of sunlight to electricity. When sunlight strikes a PV cell, electrical current and voltage are created—silently and cleanly. Because of this, PV is one of the most attractive alternative energy forms. The modern PV cell was developed in the mid-1950s. Shortly thereafter, it powered our first space satellites, and after several decades many of these PV-powered systems are still operating—a great witness for the reliability of this power source.

Terrestrial use began to be encouraged by the U.S. government in the early 1980s. These early projects sought to prove PV’s reliability and competitiveness in practical field applications. Some of those early applications, such as the Coast Guard’s aids to navigation, were embraced immediately. Today PV is the prime power source for all of the U.S. Coast Guard’s navigational aids. Likewise, other military and governmental applications have proven irreplaceable, remote meteorological monitoring for example.

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**Enormous growth in terrestrial photovoltaics has occurred.** The 21st century opens with the United States dominating the world market in PV manufacturing and technology. A presidential initiative has suggested we can have solar systems on a million U.S. roofs by 2010. The world’s first PV-powered neighborhood in Gardner, Massachusetts spawned neighborhods throughout the country, Sacramento, California being a prime example. Utility deregulation has made it possible for homeowners to install PV and sell back to their utility that portion of power generation beyond their daily needs. PV as a power source in remote areas not served by a utility was attractive from the outset and continues to create hungry markets for photovoltaics.

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**Lofty Beginnings**

Photovoltaics is a universal power source. Though still a young technology, its strength is that it can be used anywhere. This book strives to highlight the myriad ways in which photovoltaics is already being used—then expand the ways we use photovoltaics (PV). PV is an enabling technology—and it can enable us to do things never dreamed of before.

---

**Down to Earth**

There are few limits to PV as a power technology. Anything that requires electricity can be powered with PV. It has become the power of choice for a vast number of telecommunications challenges worldwide. In a fragile environment, it is often the only appropriate technology. Increasingly, it is the power of choice for utilities, commercial entities, and informed individuals.

So expand your thinking. Imagine what PV can do for you, your company, your power challenge. **Power Where You Need It** highlights many ways in which PV is being used—right now—but its future is limitless. PV is truly a clean, competitive and reliable power source for the 21st Century.

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**About the Organization**

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Lofty Beginnings

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COMMERCIAL APPLICATIONS

There are excellent reasons why American businesses and industry might be interested in using photovoltaics as part of their total energy package. The installations shown here represent some of these reasons. Also depicted here is PV on schools. There is a major push to incorporate PV on schools to educate the next generation of power consumers.

Perhaps the most important economic reason for businesses to consider PV is reduction of peak demand. Electric bills for most consumers represent kilowatt hours used; but large energy consumers are also billed for their peak power consumption during a demand period. If a company’s peak demand coincides with a time when the sun is shining, then installing a PV system can reduce their demand, thereby possibly saving them money.

PV can also be an economic boon to a business that needs to power a sign where the grid is inaccessible or it is too expensive to remove asphalt or concrete.

Commercial entities also realize that incorporating some form of renewable energy can be a huge public relations gesture—as well as a way to help with a healthy environment. BP Solar’s public awareness campaign with PV visible on their gas stations and educational kiosks at their front doors is a good example of this.

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COMMERCIAL APPLICATIONS

The City of Tucson Southeast Service Center (Ward 4) hosts a grid-tied 5kW PV system. With estimated peak daytime electrical loads at about 7kW, the system provides a significant portion of the facility’s energy requirements. A solar acquisition system designed and installed by the Southwest Technology Development Institute, New Mexico State University, allows remote monitoring of system performance.

[Photo courtesy Southwest Technology Development Institute]

Siemens modules electrify this facility on Fox Island, just on the Virginia side of the Virginia/Maryland line, Chesapeake Bay. The system powers 20-watt fluorescent lights, a marine radio, refrigeration, and a wastewater treatment system. Atlantic Solar, Baltimore, Maryland, provided the system for the Chesapeake Bay Foundation.

[Photo courtesy Atlantic Solar]

This 41.4kW rooftop array on Fetzer Vineyards’ administration building in Hopland, California, features AstroPower’s AP-106 single-crystal cells, 36 per panel, 90 panels per module, 4 modules. Real Goods Trading, Jackson, California, and Sonoma State University, Rohnert Park, California, were the developer/distributor and PowerLight the system integrator. Fetzer plans to run all its operations from electricity generated by renewable energy by purchasing 5 million kWh per year under a long-term contract with Pacific Gas & Electric.

[Photo courtesy AstroPower, Inc.]

The engineering lab at the University of California, Irvine, uses Uni-Solar structural standing seam roofing panels. The project was performed by Uni-Solar, Inc., of Culver City, California. The installation provides up to 46kW of grid-connected solar electricity to the building, with surplus power fed back into the electric grid. The installation will include a convenient to Southern California Edison. [Photo courtesy Uni-Solar Systems Corp.]

Bluffsview Elementary School, Columbus, Ohio, a 2kW conventional power system by BP Solar, Inc. [Photo courtesy BP Solar, Inc.]

An ancient order of Benedictine monks thrive in the modern world. The Monastery of Christ in the Desert is able to pursue a high-tech livelihood—designing web pages, broadcasting, and producing power from its own modules. The system, run entirely by solar power, has been designed for high performance, including the monasteries’ work site. Connections to the nation’s electric grid from a remote corner on the New Mexico border have been cost only $1 million. The solar power array mounted on the monastery’s roof trees the sun throughout the day. [Photo courtesy Siemens Solar Industries]

PVI Photovoltaics International’s SunFocus Power System™ installation at the Sacramento Municipal Utility District. This 20-panel system, consisting of 240 individual modules, has an output of 31kW of power. Each module tracks the sun as it moves across the sky. The system provides peak load shaving to SMUD and its customers seeking green power. [Photo courtesy of PVI Photovoltaics International]

PVI Photovoltaics International’s SunFocus Power System™ installation at the Sacramento Municipal Utility District. This 20-panel system, consisting of 240 individual modules, has an output of 31kW of power. Each module tracks the sun as it moves across the sky. The system provides peak load shaving to SMUD and its customers seeking green power. [Photo courtesy of PVI Photovoltaics International]
COMMERCIAL APPLICATIONS

- By creating the 2.6-kW peak array on top of the roof of the Hopland Administration Building of Fetzer Vineyards, the University of California, located in Hopland, California, a 41.4-kW rooftop array was installed. The system includes 12 panels of single-crystal cells, 36 panels per module, and 12 modules. The system was installed by Fortum Solar Power, and the developer/distributor is PowerLight. The system was installed by real goods trading, and the project was performed by the National Renewable Energy Laboratory.

- In partnership with Southern California Edison and the San Diego Gas & Electric, the 5-kW solar array at the new DaimlerChrysler headquarters was installed. The system includes 10 panels of single-crystal cells, 36 panels per module, and 10 modules. The system was installed by Fortum Solar Power, and the developer/distributor is PowerLight. The system was installed by real goods trading, and the project was performed by the National Renewable Energy Laboratory.

- The engineering lab at the University of California, Irvine, uses Uni-Solar structural standing seam roofing panels. The project was performed by the National Renewable Energy Laboratory.

- By covering the 2,400 square foot lunch eating area at Tofte Elementary School in Imperial Beach, California, with PVI Photovoltaics International's SunFocus Power System™ installation, a 20-panel system consisting of 240 individual modules, has an output of 31kW of ac power. Each module tracks the sun as it rises and sets, and the system provides peak load shaving to SMUD and its customers seeking green power.

- Siemens modules are installed at the University of California, Davis, on the solar array on the roof of the PowerPlant building. The system includes 12 panels of single-crystal cells, 36 panels per module, and 12 modules. The system was installed by Fortum Solar Power, and the developer/distributor is PowerLight. The system was installed by real goods trading, and the project was performed by the National Renewable Energy Laboratory.

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- This 43.8-kW rooftop array on the new Children's Hospital building in Eugene, Oregon, consists of 120 single-crystal cells. The project was performed by the National Renewable Energy Laboratory.

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The deregulation of the electric utility industry has heralded an increase in grid-tied PV systems on homes, due in part to the fact that consumers now find it easier to own a system that is readily accepted by the utility, and then sell the excess power they create back to the utility. Selling excess electricity generated is the premise of net metering, which several states now allow.

Programs that educate utilities with respect to PV and its successful interface with electric power lines have been increasingly visible. That, too, has promoted the acceptance of PV by utilities, which have often meant incentives offered to consumers, which translates to more utility-tied photovoltaic systems.

It is estimated that there are now at least 20 megawatts of power being generated by grid-tied PV in the United States.

The Million Solar Roofs Initiative has given PV a boost among state energy programs and the general citizenry. Initiatives such as the Sacramento Municipal Utility District’s Pioneer program allow residents to purchase SMUD’s rooftop systems, which are all net metered, and programs in Florida and Arizona are part of a large thrust to make PV a viable grid-tied option for homeowners.

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Some homeowners choose to have their photovoltaic system installed as an awning or patio cover, thereby alleviating the need for a roof-mounted system, while providing a desirable shaded area.

The Florida Solar Energy Center and a Lakeland, Florida homebuilder partnered to build and monitor this home, which demonstrates how energy-efficient strategies significantly decrease a building’s energy load and increase the value of a building’s PV system. Photovoltaics, when installed in homes that have already been modified to take advantage of these energy-efficient options, can offer a large portion of a homeowner’s electrical load. The 4kW PV system matches with day time solar energy, avoiding the early evening peak utility use.

Although 20 years passed after Tucson’s solar village was first announced, Civano, a planned energy-efficient community, is now a reality. Every Civano home is at least 50 percent more efficient than the model energy code, and nearly a dozen of the 17 model homes built to date have photovoltaic systems on the roofs.

This 7,000 square foot Evergreen, Colorado home features a 2.4kW grid-tied, ground-mounted backup PV system. The system supplies power to a number of the family’s electric needs and provides backup power to the well pump, heat circuits, refrigerator, computer, security lights, and water heater, in the event of a utility power surge.

A 2kW grid-tied residential rooftop system in Fairfield, California.

This roof-mounted 10kW system powers a single residence overlooking the Pacific Ocean. Concorde sealed batteries and two Trace SW5548 inverters accompany 96 AstroPower 1206 modules, designed and installed by Pacific Solar Company.

Bonny Doon, near Santa Cruz, California. Although this home is grid-tied, the location is remote enough that they lose power fairly often during winter storms, making a battery back-up system perfect for them. The system features 24 SunPower 110W modules, a Trace SW4800 inverter, and four Bestek Trojan batteries. The installation, provided by Pacific Solar Company of Redwood City, California, provides most, but not all, of these electrical needs.

A 30W grid-tied residential rooftop system in Fairfield, California.
Some homeowners choose to have their photovoltaic system installed as an awning or patio cover, thereby alleviating the need for a roof-mounted system, while providing a desirable shaded area. [Photo courtesy Bill Brooks]

The Florida Solar Energy Center and a Lakeland, Florida homebuilder partnered to build and monitor this home, which demonstrates how energy-efficient strategies significantly increase a building’s energy load and increase the value of a building’s PV system. Photovoltaics, when installed in homes that have already been modified to take advantage of these energy-efficient options, can offer a large percentage of a homeowner’s electrical load. This 4kW PV system will provide the grid with solar energy, reducing the early evening peak utility use. [Photo courtesy Florida Solar Energy Center]

Bonny Doon, near Santa Cruz, California. Although this home is grid-tied, the location is remote enough that they lose power fairly often during winter storms, making a battery back-up system perfect for them. This system contains 96 Sunpower 1206 modules, two Trace SW5548 inverters, and four Rooded Trojan batteries. The installation, provided by Pacific Solar Company of Redwood City, California, provides most, but not all, of their electrical needs. [Photo courtesy Pacific Solar Company]

GRID-CONNECTED RESIDENTIAL

This roof-mounted 10kW system powers a single residence overlooking the Pacific Ocean. Concorde sealed batteries and two Trace SW5548 inverters are at the heart of the system, designed and installed by Pacific Solar Company. [Photo courtesy Pacific Solar Company]

Although 20 years passed after Tucson’s solar village was first announced, Civano, a planned energy-efficient community, is now a reality. Energy-efficient homes built to exceed 50 percent more efficient than the model energy code, and nearly a dozen of the 17 model homes built to date have photovoltaic systems on the south. [Photo courtesy Tucson Coalition for Solar]

This roof-mounted 10kW system in Bonny Doon, near Santa Cruz, California. Although this home is grid-tied, the location is remote enough that they lose power fairly often during winter storms, making a battery back-up system perfect for them. This system contains 96 Sunpower 1206 modules, two Trace SW5548 inverters, and four Rooded Trojan batteries. The installation, provided by Pacific Solar Company of Redwood City, California, provides most, but not all, of their electrical needs. [Photo courtesy Pacific Solar Company]

This 7,000 square foot Evergreen, Colorado home features a 2.4kW solar electric ground-mounted backup system. The system supplies power to the home’s electric heat pump, hot water heater, refrigerator, computer, security system, selected lights, and the security system, in the event of a utility power outage. [Photo courtesy Altair Energy]

A 2kW grid-tied residential rooftop system in Fairfield, California. [Photo courtesy BP Solar]
Photovoltaics is very often the preferred power source for residences in remote areas not served by the utility grid. Kyocera Solar, Inc. provided 600W skid-mounted PV systems for 100 homes on the Navajo Reservation. The installations were purchased and installed by the Navajo Tribal Utility Authority (NTUA). The Willey family, owners of Backwoods Solar Electric Systems, use photovoltaics to power their combination home and solar catalog business. The site is located on an Idaho mountain two miles from utility lines. The large remote Navajo Nation in Arizona and New Mexico is the ideal setting for photovoltaic power systems. The home site in the Whiterock Chapter of the Navajo Nation, where 22 identical systems were installed by AAS Solar. All systems include four Suntec 1000W modules on a pole mount, eight Enphase E.G300 325W derate-cyclist batteries, and a True DK series 14.8 kWh energy storage system. Enphase inverters are included in the system, which was designed and installed by The Solar Connection, Morro Bay, California. Energia’s 600 watt stand-alone panel incorporates BP-275 modules, a True sine wave inverter, and Exide batteries to provide electricity to a family living in a colonia Hispanic community. While only 5 miles from Juarez, New Mexico, about 15 families live without electric service. The Willey family, owners of Backwoods Solar Electric Systems, use photovoltaics to power their combination home and solar catalog business. The site is located on an Idaho mountain two miles from utility lines.

Why PV on a residence? PV is the logical choice when the cost of having electric lines run to a home is too expensive. PV may also be preferable because the alternative is a noisy, smelly generator or another power source less reliable than PV. Increasingly, however, there are instances where the grid is available, but the homeowner simply wants either the independence possible by owning a PV system, or feels strongly enough about environmental issues that the correct choice for that homeowner is some form of renewable energy in lieu of the electric grid. So-called ‘stand alone’ PV systems may be roof mounted, pole mounted, or ground mounted, all of which are depicted here. Each has some special design or installation requirements, but each can supply remote residential power quite reliably. STAND-ALONE RESIDENTIAL PV powers this off-grid 3,000 square foot energy efficient log home near Creston, California. Solar provides primary power with a 15kW generator for backup. Siemens modules, Zonneshine inverters, and Trojan batteries are included in the system, which was designed and installed by The Solar Connection, Morro Bay, California. In the Williamson Valley of Arizona, 18 Suntec Solar panels run along the roof edge (smaller panel is for hot water) of this off-grid home. Designed and installed by Pajarito Solar Systems, Chino Valley, Arizona, products provided by Hinson Solar. The installation uses a True sine wave inverter and Trojan batteries, together providing a 1.5kW array for the residence. EOSolar’s 600 watt stand-alone panel incorporates BP-275 modules, a True sine wave inverter, and Exide batteries to provide electricity to a family living in a colonia Hispanic community. While only 5 miles from Juarez, New Mexico, about 15 families live without electric service. The large remote Navajo Nation in Arizona and New Mexico is the ideal setting for photovoltaic power systems. The home site in the Whiterock Chapter of the Navajo Nation, where 22 identical systems were installed by AAS Solar. All systems include four Suntec 1000W modules on a pole mount, eight Enphase E.G300 325W derate-cyclist batteries, and a True DK series 14.8 kWh energy storage system. Enphase inverters are included in the system, which was designed and installed by The Solar Connection, Morro Bay, California. Energia’s 600 watt stand-alone panel incorporates BP-275 modules, a True sine wave inverter, and Exide batteries to provide electricity to a family living in a colonia Hispanic community. While only 5 miles from Juarez, New Mexico, about 15 families live without electric service. The Willey family, owners of Backwoods Solar Electric Systems, use photovoltaics to power their combination home and solar catalog business. The site is located on an Idaho mountain two miles from utility lines. The large remote Navajo Nation in Arizona and New Mexico is the ideal setting for photovoltaic power systems. The home site in the Whiterock Chapter of the Navajo Nation, where 22 identical systems were installed by AAS Solar. All systems include four Suntec 1000W modules on a pole mount, eight Enphase E.G300 325W derate-cyclist batteries, and a True DK series 14.8 kWh energy storage system. Enphase inverters are included in the system, which was designed and installed by The Solar Connection, Morro Bay, California. Energia’s 600 watt stand-alone panel incorporates BP-275 modules, a True sine wave inverter, and Exide batteries to provide electricity to a family living in a colonia Hispanic community. While only 5 miles from Juarez, New Mexico, about 15 families live without electric service. The Willey family, owners of Backwoods Solar Electric Systems, use photovoltaics to power their combination home and solar catalog business. The site is located on an Idaho mountain two miles from utility lines. The large remote Navajo Nation in Arizona and New Mexico is the ideal setting for photovoltaic power systems. The home site in the Whiterock Chapter of the Navajo Nation, where 22 identical systems were installed by AAS Solar. All systems include four Suntec 1000W modules on a pole mount, eight Enphase E.G300 325W derate-cyclist batteries, and a True DK series 14.8 kWh energy storage system. Enphase inverters are included in the system, which was designed and installed by The Solar Connection, Morro Bay, California. Energia’s 600 watt stand-alone panel incorporates BP-275 modules, a True sine wave inverter, and Exide batteries to provide electricity to a family living in a colonia Hispanic community. While only 5 miles from Juarez, New Mexico, about 15 families live without electric service.
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Remote residences are but one place where a photovoltaic array such as these can be used effectively. (Photo courtesy Green Electric Solar Systems, Inc.)

Energia's 600 watt stand-alone ( Paid by) using BP-275 modules, a Trace sine wave inverter, and Enide batteries) provides electricity to a small living on Pajarito Mesa, a colonia or unincorporated Hispanic community. While only 3 miles from Albuquerque, New Mexico, about 15 families live without electric service. (Photo courtesy Energia's 600 watt stand-alone (Paid by)

The large remote Navajo Nation in Arizona and New Mexico is the ideal setting for photovoltaic power systems. This home in the Whiterhine Chapter of the Navajo Nation, where 22 identical systems were installed by AAS Solar. All systems include four 600W modules on a pole mount, right size G3-540-231A AH deep-cycle batteries, and a Trace DR series 2400W inverter. Energy provided is used for lighting, some small appliances, and very efficient small refrigerators. (Photo courtesy AAS Solar)

In the Williamson Valley of Arizona, 18 Systems Solar panels run along the roof edge (solar panel is a line within look). This off-grid home is powered by a Siemens 11kW system, three Trace inverters and regulators, and Trojan batteries. Part of the PV is grid-tied covered and part is roof mounted. Hinsin Solar Systems provided all of the panels and components. The large system powers, among other things, a home projection theater, ham radio studios, fountains, and a music studio. (Photo courtesy Carol Hill, Serenity Studios)

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Solar electric ice making plant in Chorreras, Chihuahua, Mexico, introduced by SunWize Technologies. The Plantade Hielo SunWize has brought economic independence to the cooperative.

A Pennsylvania llama farm benefits from photovoltaics. In the summertime, the animals love sitting in front of fans. Costs would have been prohibitive to electrify each pen individually. The system provides 300 watts of solar electricity, enough for one handler.

Water pumping is a common need on remote ranching locations, such as this one in Texas. This system is trailer-mounted so it can be moved from site to site, as appropriate. Planergy, Austin, Texas, designed and installed the 900 watt PV array at the Hickory Ridge Farm in Chelsa, Michigan. The system is a hybrid, with diesel back-up, and was designed for minimal maintenance.

Ranching operations could benefit from a PV-powered gate opener, such as this one installed at Maroon Lake near Aspen, Colorado, in the White River National Forest.

In short, farmers and ranchers often choose PV because it saves money. Utilities, likewise, offer PV services because it saves money.

As with any use of PV, the agricultural applications are limited only by one’s imagination.
SunWize Technologies introduced the first commercial, completely automatic solar electric ice making plant in Chorreras, Chihuahua, Mexico, to benefit a fishing cooperative of about 70 families. Previously, the coop depended on buyers traveling from Chihuahua to purchase and transport their catch, since they had no refrigeration capabilities of their own. The Planta de Hielo SunWize has brought economic independence to the cooperative. [Photo courtesy SunWize Technologies, Inc., a Besicorp Ltd. Company]

A Pennsylvania llama farm benefits from photovoltaics. In the summertime the animals love sitting in front of fans. Costs would have been prohibitive to electrify each of the llama ‘condos’ by any means other than PV, so each home has been fitted with 300 watts of solar electricity (four 75-watt AstroPower panels each). [Photo courtesy Atlantic Solar]

Water pumping is a common need on remote ranching locations, such as this one in Texas. The system is trailer-mounted so it can be moved from site to site. Planergy commissioned this PV-powered water pump for the Texas PV Coalition. Southwest PV, Solarx, and AeroVironment furnished special pricing or donated parts to install on the trailer, which is owned by Southwest Texas Solar Services. [Photo courtesy Planergy]

Dorr Corporation, Midland, Michigan, designed and installed this 900 watt PV array at the Hickory Ridge Farm in Chelsa, Michigan. The system is a hybrid, with diesel generator, wind, and utility power sources in addition to the PV, all powering a farm home and shop. The system includes ten Siemens Solar SR-90 PV modules, a 14 kWh 24-volt bank of Concorde sealed AGM batteries, and a Trace 4.0 kVA sinewave inverter. [Photo courtesy Dorr Corporation]

Ranching operations could benefit from a PV-powered gate opener, such as this one installed at Maroon Lake near Aspen, Colorado, in the White River National Forest. [Photo courtesy Sandia National Laboratories]
Facility power means different things to different people. For purposes of Power Where You Need It, we use the term in a pure sense: power for a facility or a building.

Sandia National Laboratories has a long history of assisting the federal government with renewables. In Renew series has featured more than one hundred such installations, no small number of which were PV power for a facility. The facility may have been a restroom, a camp headquarters, or a ranger station.

Likewise, facility power can range from a few watts to ten kilowatts, or larger.

Photovoltaics offers government agencies the ability to replace noisy or polluting generators with clean, quiet power.

Facility power within the federal agencies such as the National Park Service, the USDA Forest Service, and the Bureau of Land Management can only continue to grow because an increasingly informed public will demand that pristine sites be protected and clean power be used to provide improved recreational services.

One of the most successful photovoltaic facility power installations has been the one at Chaparral, Pinnacles National Monument, California, for the National Park Service. A 10kW roof-mounted array (Solarex modules) provides facility power to park residences, a ranger contact station, a maintenance building, and a campground. The hybrid system (installed by Applied Power Corporation) includes a 20kW propane generator and totally eliminates the use and storage of diesel fuel in the Chaparral area. (Photo courtesy Sandia National Laboratories)

A 25kW stand-alone PV system (Siemens modules with battery storage, a Trace inverter, and a 30kW propane back-up generator), was provided for Joshua Tree National Park near Palm Spring, California, for the National Park Service, by Southern California Edison and Kyocera Solar, Inc. Park Service personnel say the stand-alone system has cut their operating costs by 90 percent with a reduced time of pollutant emissions, from two diesel generators that the system replaced. Depicted are the main system and the Cottonwood system. (Photos courtesy Sandia National Laboratories)

This large-scale (5kW+) central power station provides all the power required for this island located in the U.S. near the Gulf of Mexico. The system contains 120kWh hours of storage using nickel-iron batteries, to provide power to four homes and a marina. The system was provided by Solar Electric Power Company, Ltd. (SEPCO), Stuart, Florida. (Photo courtesy SEPCO)
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This installation at Salinas Pueblo Missions National Monument, New Mexico, is somewhat different from the other systems shown here. Salinas is grid-connected and the system shown supplies the needs of the building during much of the year and provides an additional 20kW system to handle any unexpected power needs. The system was provided by Solar Electric Power Company, Ltd. (SEPCO), Stuart, Florida. (Photo courtesy Sandia National Laboratories)
The City of Cocoa Beach, Florida, is lighted with Solar Electric Power Company systems. The City uses PV lighting for their entrance signs, which power energy-efficient neon tubes for dazzling brightness.

The North Carolina Department of Transportation uses PV-powered lighting at its park and ride lot in Raleigh. This is a fairly common and truly appropriate use of photovoltaics.

Solar Outdoor Lighting provides a solar powered Rural Area Light (shown here) that has been used many times to light livestock pens, barns, or any other ‘dark’ areas at ranching and farming locations. This particular system is designed to operate five consecutive nights without sunlight. Panels are by Solarex.

A large GSA parking facility outside the federal building and court house in Puerto Rico, takes advantage of two 64W PV arrays for lighting. The installation, provided by Solar Outdoor Lighting,wc the combination of single and double fixtures, using a total of 23 lights in an area approximately 980 by 640 feet.

A registered historic site, the Okeechobee, Florida City Hall, takes advantage of photovoltaics for powering decorative lighting fixtures that line the entrance corridor. Solar Electric Power Company (SEPCO™) provided the illumination at this site—one of the nation’s oldest city buildings. The inset photo shows the array at the rear of the building.

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But illumination for its own sake isn’t the whole story. Studies show that lights in developing countries mean a longer, more productive work day and a community drawn closer together.

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If a homeowner decides that a single pole-mounted security light fits the bill for a dark corner of his property—and an electric line is nowhere around—then PV is the perfect solution.

Many cases PV systems can provide light for a fraction of what it would cost to extend a utility line. Indeed, PV systems are powering lights around the world.

The most efficient systems use fluorescent lamps, but other types of lamps, such as halogen or low-pressure sodium, have also been used in conjunction with PV. Batteries are always a component of PV-powered lighting systems, so that power is created when the sun shines, stored in the battery, and enjoyed when the sun has ceased to shine.

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SEPCO’s photovoltaic lighting system at the Greater Orlando International Airport was selected as PV Project of the Year in 1998. The lights are installed throughout the airport grounds: in the employee parking lot, at security entrance checkpoints, and at transit shelters. (Photo courtesy Solar Electric Power Company, Ltd. – SEPCO)

Uni-Kit lighting systems is but one of the many available to provide electric lights in remote areas around the globe. In developing countries, rural PV systems have replaced the kerosene lantern for lights in a certain application. Here, a young woman in Chiapas, Mexico carries the system up a mountain road leading to her village. (Photo courtesy United Solar Systems Corp.)

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SECURITY LIGHTING

A one-room school house in Maryland hosts PV to power a security system used to protect this historic treasure. The system is a 166 watt Solarex array. [Photo courtesy Atlantic Solar Products]

Solar parking lot lights are installed along the east side of the bachelor officers’ quarters at the Marine Corps Air Station, Yuma, Arizona. Solar Outdoor Lighting provided the lights, which are not grid connected. They are 150W fluorescent-type fixtures with reflectors. [Photo courtesy U.S. Marine Corps]

While waiting for the bus, riders can feel more secure with the lighting that PV provides. In many instances, it is more cost effective for PV to be used in these isolated situations than it would be to run power from the grid. Shown here is one of several systems provided in Houston, Texas. [Photo courtesy SEPCO]

Perimeter security lighting is essential at the NASA Kennedy Space Center tracking station, operated by Allied Signal. A total of 39 lights are in service. [Photo courtesy Solar Outdoor Lighting]

Solar lighting provides security at the entrance to Pittman Work Center, Ocala National Forest, Seminole Ranger District, Florida. The Model PM 150 features a dome-style Cobrahead fixture and is installed on a fiberglass pole. The light was provided by Solar Outdoor Lighting. [Photo courtesy Solar Outdoor Lighting]

Photovoltaics provided an ideal solution for Wendy’s, Atlanta, Georgia. The restaurant needed lights for safety reasons behind their facility. Although the utility grid was close by, tying to the grid would have proven much more expensive than installing the PV powered lights. [Photo courtesy Sandia National Laboratories]

An 18 watt Solarex panel provides power for a parking lot security system and lights. [Photo courtesy Atlantic Solar Products]

Police departments across the U.S. appreciate lighted lots—and often PV is the power of choice for such applications. These Double Floodlight systems were provided by SEPCO. Security is better ensured when law enforcement officers can quickly see entire lots without having to drive the area. [Photo courtesy SEPCO]
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Yuma Proving Ground uses small PV arrays to provide security lights at vital locations. [Photo courtesy U.S. Army]

Police departments across the U.S. appreciate lighted lots—and often PV is the power of choice for such applications. These Double PowerFlood Systems were provided by SEPCO. Security is better ensured when law enforcement officers can quickly see entire lots without having to drive the area. [Photo courtesy SEPCO™ – Solar Electric Power Company, Ltd.]
The whole sphere of transportation is ripe for photovoltaics. Indeed, railroads depend heavily on PV as a power source for control and safety in rail yards and elsewhere. Often this use is a function of economies, but often reliability is the rail industry’s primary concern. And photovoltaics is nothing if not reliable.

Batteries are an integral part of many forms of transportation. But batteries have an inherent problem in that they self-discharge over time if they are not being used. To overcome this problem, the Detroit area national guard—which meets only every two weeks—has installed PV-powered trickle charge units to keep their batteries at a high state of charge.

Solar electric cars (charged with a PV system that sometimes also powers a residence or business) are an option appreciated by motorists whose daily needs can accommodate fairly short mileage.

Included in these photographs are various forms of highway transport, but also some useful ‘aids to transport’ which—with PV—help ensure our safety in an attractively economical trade-off.
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Included in these photographs are various forms of highway transport, but also some useful ‘aids to transport’ which—with PV—help ensure our safety in an attractively economical trade-off.
Along America’s waterways, one of the earliest terrestrial uses of PV are navigational buoys and other aids to navigation. The loads required for these applications are typically small, the installations are remote, and the utility grid is not generally accessible, making PV a perfect match for this use.

Applications may range from lighthouse beacon power to a small single-module system posted on a lovely stretch of riverbank. But because these signals, sirens, and lights are all lifesaving measures, system reliability is paramount. PV provides that critical reliability.

The United States Coast Guard has converted all its navigational buoys from primary batteries to PV-powered rechargeable batteries, thus saving millions of dollars in battery replacement costs alone.

In fact, warning signs, signals and lights—typically navigational beacons—are one of the most popular applications for PV in the United States.

The U.S. Coast Guard has converted all its navigational buoys from primary batteries to PV-powered rechargeable batteries and is saving millions of dollars a year in the cost of servicing and maintaining them. This single-module version is typical of more than 14,000 sites that the U.S. Coast Guard has converted. The module is secured in protective covers to protect against vandalism.

Northern Power Systems provided the world’s largest solar-powered obstruction lighting system for a 161kV transmission line crossing the Mississippi River between Missouri and Tennessee. Power for the beacon, which is fully compliant with FAA requirements, is provided by an integrated terrestrial-solar system, consisting of 78 PV modules on the tower. Power produced is stored in a deep-cycle battery bank. The project is an alliance between a Missouri utility and the Tennessee Valley Authority. The strobe beacon flashes 60 times per minute and operates 24 hours a day.

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Photovoltaics powers the navigational light at the Bureau of Land Management’s Turn Point Light Station, Stuart Island, San Juan Islands, Washington. The system was designed and installed by Currin Corporation, Midland, Michigan. The subarray shown here is typical of more than 14,000 sites that the U.S. Coast Guard has converted.

A 100W Solar Electric Power assembly operates a digital camera monitoring system, which scans a major waterway for marine traffic. The system operation and location are confidential, as is the equipment, power alarms, and power remote video surveillance systems, to name just a few security-type applications.

Aids to navigation are some of the most popular uses for photovoltaics. Pictured here is a PV array for the Au Sable Light Station complex. The highest subarray, with the horizontal “A” arrays, are visible, with the former lighthouse below. The system was designed and installed by Currin Corporation, Midland, Michigan. The PV system shown here is typical of more than 14,000 sites that the U.S. Coast Guard has converted.

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Elsewhere in Power Where You Need It, we have featured dozens of applications where photovoltaics plays a part—or takes the lead—when it comes to our national infrastructure. Webster defines infrastructure as an “underlying foundation or basic framework.” Here, infrastructure is meant to include all the many fundamental, vital ways in which we are inter-connected: Our means of travel (roads, waterways, and railways); our means of power (our electric grid); and our telecommunications systems.

Shown here are examples of other components of a basic national infrastructure: satellites, telephones, cable television, subway transportation, oil and gas pipelines, and water systems.

Photovoltaics has even played a part in our airways: in Antarctica, PV-powered runway lights have been used.

Other Infrastructure

Photovoltaic power for remote applications is a superior use of the technology. Here, a Harris Power Systems 48-watt Sun Tel cellular data unit powers a water pipe flow monitor in the Houston area. Water utilities throughout the country use meter systems. Photovoltaics has even played a part in our airways: in Antarctica, PV-powered runway lights have been used.

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On a lonely stretch of beach between two Florida cities, a cable TV operator discovers greatly increased customer service through the use of solar energy. This system is powered by a 90W SEPCO system, which contains 21kWhs of sealed Gel battery storage located at the far side of the array.

A Hutton Communications installation for an natural gas utility provides flow monitoring for oil pipelines and wells in Oklahoma and elsewhere. This type of remote telemetry is an ideal application for photovoltaics.

An emergency call box is a common use for a small photovoltaics panel.

A Siemens panel provides power for a public telephone where there would otherwise be none. This type of application is an excellent match for PV whether in a foreign country or in the United States.

SunWize, a Besicorp Company, provided a site-built PV-generator hybrid system for North America’s first completely off-grid and fine line telecommunication system, the central office of the India Telephone Company (New York). This project proved, in effect, that a small continuous load practically the TV connection for India’s long distance conversations via voice and data. The telephone system was built from a remote power generator rather than lack of grid service.

In 1997 Mars Pathfinder satellite, one of several NASA explorations of the Red Planet.

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About 15 miles south of Fairbanks, Alaska, a small PV panel and a solar thermal panel prove perfect for one of PV’s more diverse applications. An anodesite station is pumped through piping to a reservoir, where it keeps the surface warm enough to bear the water to its crest under the higher. Otherwise, that same water would run over the highway, creating treacherous icy conditions. This principle could similarly work in their own gardens and the lake.

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About 15 miles south of Fairbanks, Alaska, a small PV panel (and a solar thermal panel) prove perfect for one of PV’s more diverse applications. An arctic river runs into a canal, when it melts the water warms enough to thaw the ice as it runs on under the highway. Otherwise, that same water would run over the highways, causing treacherously icy conditions. This principle can be used in three main areas: the Arctic, wherever water is useful and the climate is cold enough to make the ice thawable. (Photo courtesy National Aeronautics and Space Administration)
When considered on a worldwide basis, telecommunications provides the lion’s share of market opportunities for photovoltaics. Even in the U.S., there is a very large market for telecommunications both in the private sector and among military and government agencies.

Telecommunications applications range from small emergency-call boxes to large microwave repeaters, and everything in between. The list of telecom applications grows continuously: relay towers, radio systems, remotely controlled systems, and cellular telephones, to name just a few. These systems range from a few watts to several kilowatts. PV is ideal for communications because the PV-charged battery provides a stable dc voltage and meets varying current demands. PV systems are reliable—and with little maintenance.

There are thousands of telecommunications systems in use powered either by PV alone or powered by PV in conjunction with another fuel source, such as diesel. These systems, without fail, have proven that PV can increase the reliability and spatial coverage of telecommunications systems of all types.

A solar-powered remote telemetry system provided by Solar Depot, San Rafael, California. This is a common application for photovoltaics. (Photo courtesy Solar Depot)

Northern Power supplied this Telcel® PV stand-alone system to Cubic Corporation for a U.S. Air Force Tactical Air Combat Maneuvering and Instrumentation Range located on Nellis Air Force Base outside Las Vegas, Nevada. The site is remote and requires a reliable and continuous power supply. A Telcel® PV Stand-Alone System was designed by Inoke Energy to provide the power for the installation. The system consists of a Telcel® SC-10 controller. (Photo courtesy Northern Power Systems)

A state-of-the-art communications repeater was installed on Mt. Washington, part of the Manzano Mountains, Albuquerque, New Mexico. A 1976 test unit was replaced in an ongoing communications tower. The major processor and a communications building are part of the background. This installation serves as a test for communication sites far from the federal Air Force personnel and Department of Energy security zones, as well as the Sandia National Laboratories personnel. It is the only communications site for air/ground personnel performing field exercises in the area. Direct Power and Water, Albuquerque, performed the design and construction. (Photos courtesy Sandia National Laboratories)
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Northern Power Systems designed, manufactured, and installed a hybrid MicroGrid™ PV/diesel system on a 10,200 'mountaintop site (Mt. Callaghan) in Central Nevada. The array serves as a master site for the Top Gun Tactical Air Combat Training System upgrade on the U.S. Navy’s Fallon Range. The power system consists of an 11,872-peak watt PV array coupled with a 20kW diesel generator. (Photo courtesy Northern Power Systems)

Solar Depot installed this solar-powered pair-gain system. This application is well suited to PV. The twisted pairs of wire, stretching far enough that they lose their signal, benefit from the addition of a PV-powered amplifier. (Photo courtesy Solar Depot)

Cellular repeaters are often very large or for other reasons are not always good candidates for photovoltaics. This installation by Solar Depot, however, was an appropriate application of PV for this purpose. (Photo courtesy Solar Depot)
There are virtually thousands of reasonable and logical ways for utility companies to use photovoltaics, all of which have an immediate payback—all of which prove that PV can be a less expensive option than conventional service.

Many utility companies are using PV for their isolated, low energy, or low-revenue loads that are costly to operate via conventional means. PV can provide service to low-revenue loads where line extensions would be unfeasible.

Communications, warning signals, sectionalizing switches, cathodic protection, lighting, monitoring, and battery charging head up a growing list of appropriate applications for PV within utilities. Others include automated gas meters and gas-flow computers, gas samplers, and the like.

Participation across the U.S. by utility companies is still rather uneven. There are utilities that have determined that PV is their most reasonable option for many small loads—and there are utilities that have not yet made the decision to include photovoltaics among their options.

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Utility Applications

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From a few watts to several kilowatts—the opportunities for utility incorporation of PV are wide open.
A 100W solar electric power assembly operates a digital computer monitoring system that measures a city’s incoming water supply. PV performs reliably over the long term in monitoring the flow of water, gas, oil, and so on. (Photo courtesy Solar Electric Power Company – SEPCO)

Kyocera Solar provided two 82kW grid-connected PV systems for Arizona Public Service to serve the Phoenix area. Shown here is APS’s installation at Flagstaff. A twin installation (inset) is at Ocotillo. The applications are in support of the green pricing Solar Partners program. Modules are Siemens Solar’s SP-75. UPG, now a part of Kyocera, was the project contractor; each system includes six UPG Model 16500C inverters. (Photos courtesy Kyocera Solar, Inc.)

Cathodic protection of pipelines is one of the most appropriate and common uses for photovoltaics by utility companies, as it provides an economical and effective solution to corrosion problems. The solution is an electrical current from a PV source to counteract the natural corrosive currents generated around buried metallic devices. (Photo courtesy Kyocera Solar, Inc.)

Remote telemetry for monitoring oil, gas, and water pipelines is a common application for photovoltaics. Kyocera Solar, Inc. installed this monitoring system. (Photo courtesy Kyocera Solar, Inc.)
A 100W Solar Electric Power assembly operates a digital computer monitoring system that measures a city’s incoming water supply. PV performs reliably over the long term in monitoring the flow of water, gas, oil, and so on. [Photo courtesy Solar Electric Power Company – SEPCO]

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One of two 100kW single-axis grid-connected PV tracking systems installed by Kyocera Solar for the Salt River Project, Phoenix, Arizona. The modules are Siemens SP-75s. [Photo courtesy Kyocera Solar, Inc.]

PV powers this utility translator for Salish Kootenai Community College. The installation on Train Creek Look Out, St. Ignatius, consists of 24 Solarex MX-80W modules, delivering 1950W output in peak sun. Storage is in 1233W industrial batteries; charge regulators are SCI TPC. [Photo courtesy Kyocera Solar, Inc.]

Remote telemetry for monitoring oil, gas, and water pipelines is a common application for photovoltaics. Kyocera Solar, Inc. installed this monitoring system. [Photo courtesy Kyocera Solar, Inc.]

Solarex provided this 7kW remote system for Southern California Edison at Big Creek, Mammoth Lakes. Shown is one of the arrays featuring 60 MSX-60 modules. [Photo courtesy Solarex]

Kyocera Solar provided two 60kW grid-connected PV systems for Arizona Public Service to survey the Phoenix area. Shown here is APS’s installation at Desert Pines. A twin installation (inset) is at Osceola. The applications are in support of the green pricing Solar Partners program. Modules are Siemens Solar’s SP-75s. UNG, now a part of Kyocera, won the project contracts; each system includes six UNG Model 6500C inverters. [Photo courtesy Kyocera Solar, Inc.]
The U.S. military complex (Army, Navy, Air Force, Marines, Coast Guard, and national and state militias) have many very remote sites in their arsenals. This fact makes PV particularly valuable for some military applications.

Several military telecommunications applications may be seen in other sections of this book as well. The applications of interest to military procurers of PV are quite diverse, particularly when size is taken into consideration. Some of the military’s sites consist of a simple, small PV array tied to one battery. Others, such as the huge grid-tied array at the Yuma Proving Ground, provide power for an entire building complex and more.

The functions of the military’s many PV installations are diverse too, ranging from one of the most fundamental applications—water pumping—to one of the most futuristic—satellites.

Whatever the size, whatever the application, it is a fact that the Department of Defense is the largest energy consumer in the federal government, so it follows that the military complex will continue to find ways to integrate renewable energy—including photovoltaics—into their plans.

- A 1200 watt portable, reworkable solar array was also used to provide power for the U.S. government in Operation Desert Shield. This particular installation is portable, [Photo courtesy Atlantic Solar Products]

- Portable solar charging units provide power even with bullet holes and partial shade. Several companies manufacture these lightweight, tough units for use not only by military units, but also for emergency remote communications or emergency power on the range. Shown here is Uni-Solar’s Uni-Pac, which uses their triple junction technology. [Photo courtesy United Solar Systems Corp.]
MILITARY USES

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The U.S. Army installation at Ft. Carson, Colorado, takes advantage of photovoltaics for a water pumping project. (Photo courtesy U.S. Army)

A 1200 watt portable, rechargeable solar array was also the preferred power for the U.S. government in operation Desert Shield. The panel set is shown. (Photo courtesy Atlantic Solar Products)

Portable solar charging units provide power even with bullet holes and partial shade. Several companies manufacture these lightweight, tough units for use not only by military units, but also for various remote communications or emergency power applications. Shown here is Uni-Solar’s Uni-Pac, which uses their triple junction technology. (Photo courtesy United Solar Systems Corp.)

First Solar (formerly Solar Cells, Inc.), Toledo, Ohio, provided this 25kW dc system used at the Naval Air Warfare Center, Weapons Division, China Lake, California, at a fuel cell project. The 72 panels were designed to offset the peak load of the Fort and also provide the west-facing offices with much needed afternoon shade. (Photo courtesy First Solar, LLC)

Portable solar panels are used for remote facilities, such as this area lighting at a remote training facility. The panel set is shown installed on a tower that will be erected in a desert.

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The military often uses photovoltaics to power remote facilities, such as this area lighting at a remote training facility. The panel set is shown installed on a tower that will be erected in a desert.

A major defense contractor needed an instrumentation power source that would be reliable even if military base power was lost. (Photo courtesy Everpower Solar)
Reynolds Aluminum uses a trailer-mounted PV system to monitor the air quality around a bauxite tailings "pond" covering several hundred acres near Corpus Christi, Texas. The trailer was customized by Direct Power and Water, Albuquerque, New Mexico. Samples are taken for 24-hour periods every seven days. The power system is configured for 24VDC and consists of five Sunways 25-75W modules using a battery bank of 10 Deka 6L16, 375 AH batteries. A Statpower 1,500W inverter is used to power the sampler and other related equipment.

Simpler Solar, Tallahassee, Florida, provided this collage of components of their solar pond aeration system. As rainwater washes over streets, roofs, farm lands, and so on, it builds up an excess of nutrients that result in excessive weed and algae growth. This accumulation consumes much of the oxygen in ponds. Aeration systems bring new life to these bodies of water, and they are especially needed to be powered by photovoltaics.

Professor Emeritus Bill Peterson, University of Illinois Agricultural Engineering Department is funded partly by the Illinois Bureau of Energy and Recycling (and partly by the National Renewable Energy Laboratory) to demonstrate PV projects from his mobile Bailey trailer. He uses a number of documents from Sandia Photovoltaic Systems Assistance Center to educate his audiences, where numerous reports are placed that use many possibilities for using PV to save the environment.

Protecting the fragile environment was a strong motivation for having PV installed at his north Florida home, according to Al Ford, great-grandson of the famous automaker. Living through the aftermath of Hurricane Andrew—months of the running water and flush toilets at an air conditioning—was an equally convincing reason to turn to PV. The large system includes Siemens panels, Zonemate trackers, Tian Engineering inverters, and Trojan batteries. (Photo courtesy Energy Conservation Services of North Florida)

A Dankoff Solar centrifugal pump removes excess treated wastewater from a wetlands treatment system by means of spray irrigation. Second Nature Systems, Kennard, Texas, installed the solar Irrigation system at the Tramino Station gas pipeline area and industrial washdown near Sour Lake, Texas. Modules are from BP Solar. The array provides 675 watts of peak power. (Photo courtesy Second Nature Systems)

Lamar Buffalo Ranch, Wyoming, within Yellowstone National Park, uses a 5kW remote power PV system for electricity for NPS rangers, as well as instructors and students who convene there during the summer for ecology classes. (Photo courtesy SnowWater)

At the Miner Institute in Chazy, New York, an 1800W PV/propane generator hybrid system provides utility grade electricity to power a variety of instruments. This environmental research facility monitors the effect of environmental changes on atmospheric carbon cycles from the temperate forest. The PV array consists of 23 SunPower modules, SunWize Technologies, a Bayonne company, provided the system, which was developed in partnership with the New York State Energy Research and Development Authority. (Photo courtesy SunWize)
Consider for a moment the impact that a power source such as photovoltaics can make on the earth’s environment. It is clean and considered non-polluting. It is a renewable energy source that consumes a reasonably small amount of the earth’s resources to produce electricity. It is silent. Few resources are needed to keep it running, day, after day, after day, anywhere the sun shines.

So, PV as a power source is itself a huge, positive influence on our environment. With that as an incontrovertible fact, what we feature here are ways in which PV is being used to promote environmentally sound projects—good works that use PV in a number of diverse ways.

The U.S. Geological Survey uses this portable Solarex solar system to take ice core samples from glaciers to study air quality. This photo was taken at Fremont Glacier, Wyoming, but the USGS has since taken the system all over the world. [Photo courtesy Applied Power Corporation]

Live Oak Solar’s portable T-REX PV system is on its way to a residential construction site in northern California. The PV unit was quiet enough to provide the necessary noise abatement for night-time building. [Photo courtesy Live Oak Solar]

Professor Emeritus Bill Peterson, University of Illinois, Agricultural Engineering Department is funded partly by the Illinois Bureau of Energy and Recycling (and partly by the National Renewable Energy Laboratory) to demonstrate PV projects from his mobile Rural Tech. He uses a number of documents from Sander Photovoltaics Systems Assistance Center to educate his audience, whom Peterson reports are pleased when they see the many possibilities for using PV to save the environment. [Photo courtesy Professor Bill Peterson]

Protecting the fragile environment was a strong motivation for having PV installed at his north Florida home, according to Al Ford, great-grandson of the famous automaker. Living in a wetlands rehydration system installed by Solar Electric Power Company, Florida, a 900W assembly operates two remote water pumps in a 24V PV direct configuration. The pumps provide an average of over 10,000 gallons daily. The water is directed onto a designated wetlands replacement area. [Photo courtesy SEPCO]

A Dankoff Solar centrifugal pump removes excess treated wastewater from a wetlands treatment system by means of spray irrigation. Second Nature Systems, Kennard, Texas, installed the solar irrigation system at the Trinity State gas pipeline reservoir and industrial washdown near Sour Lake, Texas. Modules are from BPSolar. The array provides 675 watts of peak power. [Photo courtesy Second Nature Systems]
hurricane strikes, bringing with it a tremendously destructive force that leaves a community without power. Or a flood, tornado, or earthquake occurs with little warning, disrupting normal communications. Emergency management teams, the national guard, and a myriad of other organizations respond with massive relief and rebuilding efforts. Food, water, and medical supplies are provided to survivors.

This scenario, unfortunately repeated numerous times a year, is one in which photovoltaics can play a vital role. Portable power systems, such as those equipped with PV, are capable of providing the electrical needs for vaccine refrigeration, microscopes and other medical equipment, lighting, radios, fans, communications, and traffic control devices, to name just a few. The energy provided is clean, quiet, and reliable. Standalone systems require no refueling, and they can operate for long periods of time. In fact, PV-powered systems are particularly appropriate for low-power needs and long-term use.

Portable photovoltaic power has been on the scene during Hurricanes Andrew, Hugo, Erin and Luis; at the destruction after the Northridge, California, earthquake; and at other catastrophic events. Continued training of emergency management teams will create an even larger niche for photovoltaics in these unfortunate situations.
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Some of the greatest human interest stories relating to photovoltaics come from the one-on-one impact that PV can make in the health of people in the developing world. PV is used to refrigerate vaccine, to create safe drinking water, to keep life-saving blood supplies under refrigeration, to pump fresh water where there was only a polluted stream before.

And PV can have that same impact on the safety of people, too. For firefighters use PV in numerous ways. PV is used to ensure that test ban treaties are honored. In fact, the uses for PV are so diverse that they are limited only by the imagination of the user.

Whatever the future applications of PV may be, it is a certainty that it will continue to make us healthier and safer.

---

A project undertaken by Direct Global Power, Schenectady, and the New York State Police proved the efficacy of a PV power option atop Cathead Mountain (shown here) and Black Mountain, both within the Adirondack Preserve. Thirty-six Siemens modules designed to produce about 2kW under peak conditions augment existing systems at both locales. Reliability and spatial coverage of the State Police’s radio communications systems have been increased. [Photo courtesy Direct Global Power, Inc.]

Some perfectly viable applications for photovoltaics may result in curiously interesting photographs, but small PV-powered refrigeration units for items such as vaccines are used by first-light racing cars, base camps, and staging areas. They provide power for integrated flood lighting, as reverse power for computers, radio battery charging, and communications equipment. [Photo courtesy PowersGrid Corporation]

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A PV hybrid system (2.2kW PV array and two diesel generators) powers this International Nuclear Test Ban Treaty seismic monitoring station in Antarctica. The system, located at Bull Pass, was designed, manufactured, and installed by Northern Power Systems, Waitsfield, Vermont. [Photo courtesy Northern Power]

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A PV-fed water treatment plant is part of the Army’s Yuma Proving Ground complex. Shown here are the plant, the processing tanks, and the “long line” 12.47KV switch. [Photo courtesy U.S. Army]

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In northern California, where wildfires sometimes destroy thousands of acres of land, these deployable PowerPods are used by firefighting aircraft base camps and staging areas. They provide power for integrated flood lighting, as reverse power for computers, radio battery charging, and communications equipment. [Photo courtesy PowersGrid Corporation]

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A PV-fed water treatment plant is part of the Army’s Yuma Proving Ground complex. Shown here are the plant, the processing tanks, and the “long line” 12.47KV switch. [Photo courtesy U.S. Army]

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Whatever the future applications of PV may be, it is a certainty that it will continue to make us healthier and safer.
CREATING BEAUTY. CREATING CONVENIENCE. Creating pleasure. Photovoltaics have a wonderful impact on our bottom line. They can have a powerful impact on our everyday lives, whether we’re working or playing.

Solar-powered calculators and watches have more than twenty years of successful history; in fact, they are already a part of our daily lives. Some predict that someday automobiles will be equipped with PV on car roofs or hoods so that satellite links can supply ‘video on demand’ for the back-seat.

Now solar is being marketed in conjunction with other consumer products as well. Some of those shown here, but only the future will tell what other uses there may be for PV powered objects in our daily lives. Some predict that soon automobiles will all be equipped with PV on car roofs or hoods so that satellite links can supply ‘video on demand for the back-seat.’

The next two double-page spreads are dedicated to PV for recreational purposes or for enhancing everyday life.

Take a look around you. The possibilities are endless.

PV modules are roof mounted (or solar stilts) on the General Nathaniel Tower Observatory located near Belen, New Mexico. The installation was designed and engineered by Energy Photovoltaics and paid for by the Albuquerque Astronomical Society to provide power for the observatory. The array is capable of producing 320 watts of power.

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A rather large market exists for small PV arrays to power lights and household appliances in recreational vehicles. Shown here are two Uni-Power US-2 modules used for battery charging in an RV. (Photo courtesy United Solar Systems Corp.)

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Creating beauty. Creating convenience. Creating pleasure. Photovoltaics can change our lives and change the look of the world around us. PV—a quiet, clean source of energy—is, in fact, used because it keeps America beautiful.

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Lawnmowers in the U.S. burn nearly 800 million gallons of gas each year. One response is this SolarMower™.

This solar-powered lantern is great for camping or emergency use. Have light anywhere you need it, free of lines, propane tanks, and messy lamp gas or oil. A full charge provides 4-6 hours of light.

The Indian Pueblo Cultural Center, Albuquerque, New Mexico, integrates a PV awning beautifully with its building. The Ziade design was cut to fit with the system, which incorporated AstroPower modules. The solar carport is the largest commercial PV array in the state.

Solar takes a happy turn at a seaside park at the Santa Monica Pier (California) where a 50kW Siemens Solar system will be installed when the popular Laguna Beach boardwalk becomes a reality. The existing PV will be augmented with a new 50kW PV system for water pumping to power the wave house, a democracy for kids, and other buildings. A wind turbine will provide 10kW of electricity. The ranch is 10 miles off-grid.

Everyday life for children of the Laguna Pueblo in New Mexico will be enhanced when the proposed Laguna Youth Facility at the old Majors Ranch becomes a reality. The existing PV will be augmented with 349, 75W panels for water pumping to power the wave house, a democracy for kids, and other buildings. A wind turbine will provide 10kW of electricity. The ranch is 10 miles off-grid.

MAKING EVERYDAY LIFE BETTER

PV provides portable power for computers. This SunFridge unit means you can work away from the electrical grid as long as the sun is shining to power the portable energy system.

This PV-powered, grid-connected clock tower is the centerpiece of Sun Microsystems' $200 million campus in Burlington, Massachusetts. Modules were provided by ASE Americas. The outstanding design was created by architect Sun-Hok.

PV provides power where you need it on recreational vehicles of all kinds—even those on water.

PV for wireless communications is a welcome addition. If you’re stranded because of an auto malfunction, car phones—made possible by solar power—provide security, safety, and relief.

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The Indian Pueblo Cultural Center, Albuquerque, New Mexico, integrates a PV awning beautifully with its building. The Zia design was cut into the ceramic panels, creating a stunning effect when sunlight hits the surface. The awning extends over the sidewalk below.

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Everyday life for children of the Laguna Pueblo in New Mexico will be enhanced when the proposed Laguna Youth Facility at the old Majors Ranch becomes a reality. The existing PV will be augmented with 200 kW of PV, both electricity and a 120 kW PV system for water pumping to power the new house, a classroom for kids, and other outbuildings. A wind turbine will provide 10 kW of electricity. The ranch is 10 miles off-grid.

Solar-powered refrigerators provide the security of foodstuffs in emergency or back-up power situations. Shown here is the SolarFridge by Simpler Solar, Tallahassee, Florida.

Serenity Studio, Prescott, Arizona, is the first known solar-powered sound recording studio in the U.S. PV power ensures no electrical surges or power outages. The studio uses about 1000 watts of power in full operation and is powered by 14 Siemens 75 W panels with a T race inverter—and by PV on an adjoining roof.

The design of this solar-powered fountain integrates PV cells on a curved surface to catch the changing angles of the sun. They are specially sized, configured, and wired polycrystalline cells on custom-designed modules from Kyocera Solar. The fountain is depicted among the Cooper-Hewitt National Design Museum’s images in their “Under the Sun” exhibit.

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There’s much in this book worth repeating, but one of the most important points is that photovoltaics is a universal power source.
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The Boeing Orbiter III became the first hot air balloon to circle the globe non-stop. Morningstar’s ProStar controllers were used to manage the electricity generated by the 20 Solarex panels hanging under the gondola. Energy for all on-board equipment—telecommunications and navigation instruments, lighting, and water heater—was stored in five batteries. [Photo courtesy NASA]

STILL FLYING HIGH

There’s much in this book worth repeating, but one of the most important points is that photovoltaics is a universal power source.
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