WATER EFFICIENCY
THE JOURNAL FOR WATER CONSERVATION PROFESSIONALS

Photo: LGVSD

No longer just for remote locations, solar power can provide low-cost electricity and even offset carbon dioxide emissions.

By Diane McDilda

Solar is becoming a more common means of providing electricity in remote locations. Projects relying on solar power range from water pumps in the mountains of West Virginia to cattle ranches in Texas. Solar power is responsible for life-saving water systems in Africa and South America. It's routinely used to power lighting and traffic signals as well as relay signals from mountaintops, bridges, and dams. But beyond remote locations, solar power can be an economical solution for providing low-cost electricity and even offsetting carbon dioxide emissions.

When comparing the expense of running power lines or dropping a pole, the cost of using solar makes it a viable electrical source. There's no rule of thumb when it comes to comparing costs of running electrical power versus installing a solar system. Based on the location of the project and the proximity to nearby power lines, bringing power to a site could range in order of magnitude from thousands to tens of thousands of dollars. When the cost to run a power line and drop a pole becomes a significant portion of the total project cost, solar becomes the more obvious alternative.

For remote locations, other alternatives to grid-connected power also include windmills. In the central and western United States, however, solar power is replacing old and weathered windmills to power pump systems used in watering cattle. With relatively no moving parts, solar power systems tend to require less maintenance than other alternative energy sources.

And depending on the application, the cost of going solar may be at least partially reimbursed by federal, state, and local entities. Erik Lensch, President of SC Solar Inc. in South Carolina described one unlikely source for funding—the United States Department of Agriculture (USDA). In an effort to protect the quality and quantity of water sources out west, the USDA is paying for the installation of groundwater wells and solar pumps.

"The USDA wants to protect water bodies by keeping cattle out," says Lensch. "There are a lot of funds available to protect watersheds including fences, wells, and pumps. And the solar pumping systems are made as simple as possible, just turnkey, plug-and-play."

Not only are cattle kept out of the water, but ranchers aren't burdened with the cost to install or maintain a viable water source. Lensch also adds that it's not just here in the states that people and the environment are benefiting from the ease of installing and operating solar pumps. He's sold systems to missionary groups headed to places like Uganda set on providing irrigation and drinking water to remote villages.

Solar has also become a popular substitute for utility power in areas where the cost of electricity is high, tax incentives and rebates are generous, and carbon dioxide emissions are a concern. In states like California, Arizona, New Mexico, and Colorado, rebates and incentive programs are encouraging those who may not have previously considered solar. Incentives offset the cost of installing the solar power system and decrease the amount of time for a system to pay for itself. But the initial system cost isn't the only monetary concern. A variable often left out of the payback equation is that once a solar system is paid for, the electricity is free. Grid-tied systems are never really paid off with sometimes hefty monthly allotments still going out for every kilowatt used.

For larger installations, solar can be used to successfully power operations where carbon emissions are limited or efforts are being made to reduce them. The Las Gallinas Valley Sanitation District (LGVSD) in San Rafael, CA, recently completed construction of a series of solar panels that span 3 acres. They're used to operate pumps that recycle wastewater effluent to irrigate pasturelands and discharge to ponds. Easements along the ponds and a freshwater marsh allow the public to bird-watch and observe other wildlife.

The solar panels will generate 571 kilowatts of electricity. And when comparing the cost to using grid-tied electricity, the LGVSD's board of directors expects to save $136,000 in the first year alone. Not only does solar offer a financial solution, but it will eliminate 890,000 pounds of carbon dioxide emissions annually.

Sara Hammes is senior director of marketing with EI Solutions, the company that designed and installed the solar units at the LGVSD. "Companies are having to take into account emissions as another component to the economic equation," says Hammes. "The project is environmental, but they definitely wouldn't have done it if it didn't save them money."

Photo: Indiana Utility

Photovoltaic Basics

People began looking seriously to the sun for power about 100 years ago. Initially, the sun's heat was used to generate steam, but before long other ways to efficiently convert the sun's energy to electricity were developed. Today, the basic setup of a solar power system includes four basic components: the solar panel, the inverter, the battery, and the controller.

A solar, or photovoltaic (PV), panel is made up of solar cells containing silicon. This element, which is found in sand, becomes electrically charged when exposed to sunlight. In the PV panel, this electric charge is directed to the output panel where it produces low-voltage direct current (DC) that ranges from 6 to 24 volts but is usually about 12 volts. The ability and efficiency of panels to collect DC power have increased significantly even over the past few years, meaning fewer panels are needed to obtain the same amount of energy. And many panels are offered today with exceptional warranties with the standard between 20 and 25 years.

Photo: Anne Tazewell

Neither water nor trees need conflict with solar power in either of these locations.

While the PVs create DC power, most equipment and appliances require alternating current (AC), which is more easily transmitted and what's out on the grid today. It's the job of the inverter to convert the solar DC to usable AC electricity. Batteries are used to store excess power harvested during the day so electricity is available at night or during cloudy weather. If equipment doesn't need to be operated at night, systems can be simplified by excluding the battery component. When batteries are part of the system, controllers are used to ensure that batteries are not overcharged and that electricity stored in them does not leak back to the solar panels at night.

Sizing a System

When it comes to sizing a solar system there are two main conditions that need to be taken into account: the power needed and the power available. In short, the power needed can be calculated by tallying up the loads. This includes listing the operating hours per day, listing the voltage needed for each load, and calculating the total weekly demand.

The solar power available varies throughout the year and across the country depending on proximity to the equator and elevation. While solar can be used most anywhere, some places are more amenable than others. The National Renewable Energy Laboratory (NREL) collects and publishes values and maps of the amount of solar radiation available in kilowatt-hours per square meter per day. Values vary with higher levels of 7.0 to 7.5 found in western Arizona and parts of Nevada, New Mexico, and Texas and much of the South and Southwest ranging from 6.0 to 7.0.

These numbers and the efficiency of the PV panels are then used to calculate the number of panels needed to operate equipment. Generally, systems are oversized to accommodate a number of cloudy days when solar radiation may be lower.

TOP

While consumers and those looking for solar power can size the system they think they'll need, it's best to consult with a professional contractor or manufacturer in the field. And there's no need to rely on just one. Like getting a second opinion from a doctor, it's recommended that those looking to solar power ask around for a variety of options and opinions. Companies like SC Solar in the East and Mohr Power Solar Inc. in the West will calculate the loads and determine the best equipment for an application.

Christopher Moss, general manager at Mohr Power, likes to call attention to the fact that solar equipment is much more efficient than it used to be.

"Chip efficiency has increased from 13% to 22%," Moss says. This means that fewer panels are needed to provide the same amount of energy. Besides panels becoming more efficient, newer types of equipment, such as pumps and lighting, are more energy efficient and demand less power. Whereas the size of the solar panels needed to run a standard home used to exceed the home's square footage, now panels capable of running a home can be contained within the area of the roof.

Depending on the type and location of the equipment, a tracking system may be advantageous in harnessing more solar power throughout the day and potentially reducing the number of panels needed. Tracking systems allow the solar panels to move following the sun's path as it travels from horizon to horizon, maximizing the amount of sunlight absorbed by the panels and stored in the battery.

With higher elevations and deeper water wells, tracking equipment is almost standard out west. Tracy Sauer of Southwest Texas Solar explains, "The deeper the well, the harder it is to get the water up. Having more sun hours during the day can give a couple of hundred more gallons of water."

Sauer gives the example of a cattle ranch that increased its yield from 1,200 to 1,800 gallons per day by installing a tracker. And ranchers are experts when it comes to calculating their water requirements,

because the volume needed is based on the number of heads of cattle in their herd.

Michael Brown of Allsolar Service Co. Inc. supplies and services solar equipment in central Florida and explains that installing tracking systems isn't always the way to go. In flatter terrains, like Florida, the atmosphere is thicker, particularly when the sun is closer to the horizon. While a tracker will allow more sunlight to be garnered, it will increase the cost of the system, and in the case where a comparison to electrical power is being made, it can extend the payback time. Like other components of a solar power system, ask multiple contractors if installing a tracking system would be beneficial.

When installing solar panels, the location can be paramount. Panels should face the southern exposure to gain the most benefit. Because the US is in the northern hemisphere, the sun comes in from the south, making south-facing panels more efficient. Likewise, for those in the southern hemisphere, panels should face north. While trees may encumber the solar panels, those looking to put in panels shouldn't get out their chainsaws just yet.

"I generally don't ask people to clear trees, unless it's a permit issue," Brown says. "But I have turned people down due to other problems with their location."

Anne Tazewell owns land and a small vacation home in southwestern Virginia and can attest that trees need not conflict with solar power. Solar panels on her property are used to power a water pump set at 450 feet below the land surface. Water is pumped via a Grundfos submersible pump to a storage tank located about 50 yards from the panels. Her mountain retreat is surrounded by national forest, making the trees an important part of the landscape.

Beyond the Pump

Some remote locations require more than pumping; they require monitoring specific conditions and relaying data and information to another location.

SunWize Technologies provides design and manufacturing for those looking to power projects beyond the grid's reach. One such application included the installation of solar panels to operate dissolved oxygen (DO) monitoring sites for the Northern Indiana Public Service Company (NIPSC). The sites are located along the Tippecanoe River and include solar-powered remote radios, DO analyzers, and a master radio. The output from the DO analyzers is wired to the radios, or remote terminal units (RTUs), which make the data transmittable and send it to the master radio. The master radio, or ModBus, interfaces with a Supervisory Control and Data Acquisition (SCADA) system, which allows the data to be tracked and historical trends to be analyzed.

SCADA systems and RTUs are inherently solar-friendly. Tony Sannella, president of Sage Designs Inc., explains, "The radios used to relay data operate on 12 volts of DC, which can be used directly from a solar panel. If 24 volts are needed, then two 12-volt systems can easily be operated in series."

Where solar energy is stored in a battery, radios can also be used to transmit the level of power remaining in the battery. Sannella worked on a project in Carson City, NV, where seven sites are set in the Sierra Nevada Mountains and used to monitor potable water tank storage levels and flows. Solar is used to power the sensing and radio equipment relaying information to the central administration building located in downtown Carson City. The volume of snow can make travel to the monitoring sites a chore, even dangerous. So along with sending out information on the data collected for the water tanks, the system also sends a signal indicating the power level in the battery.

"We are able to monitor the battery voltage back at the home office and can see if it's losing or not getting charge," explains Dennis Maple, control systems supervisor with Carson City. "It's very beneficial, because we used to have to go up routinely to check the batteries. Now we make fewer trips. During the winter, trips up to the sites are especially treacherous."

Because battery backup can make or break a solar power system that needs to operate in all kinds of conditions, another option is SOLARPack. Steve Goodman of Control Microsystems, the company that makes the product, says, "The SOLARPack is an intelligent battery maintenance device that optimizes

battery storage. Battery life is reduced when a battery isn't charged properly."

The SOLARPack powers an RTU while ensuring that the battery charges properly. Ironically, this equipment that relies on renewable solar energy is a common element in oil and gas industry projects.

Photo: Erik Lensch

Often used in remote locations, solar panels are tough enough to withstand the harsh surrounding environment.

Because solar is frequently used in remote locations, the environment can prove harsh on equipment. But solar has proven it can stand up against the elements including snow and winds. The Dry Tortugas National Park located in the Gulf of Mexico, 68 nautical miles west of Key West, FL, offers a good example of remote solar that includes a variety of applications and conditions. The system, designed and installed by SunWize, supports a historical lighthouse and employee housing. During the 2004 hurricane season, the park sustained winds of 120 miles per hour with gusts clocked at 133 miles per hour. While winds pounded the compound, the hybrid solar electric system never faulted and remained unscathed.

Solar-Ready Equipment

Depending on the application, equipment can be selected that more easily accommodates solar power either by the type of power it runs on, the simplicity of the system, or its inherent efficiency. Radios used to relay information normally run on DC power and don't need to be converted to AC, which makes providing data via solar power relatively straightforward.

An exciting development in the remote location and renewable energy market is the Grundfos SQFlex solar water pumping system, which is designed to operate on either DC or AC power. With no additional equipment or flipping of switches, this pump adapts to the type of electricity provided whether it comes straight from a PV panel or from a standard outlet.

Lensch sells the Grundfos pump and says that using DC directly, rather than converting it to AC, is the most efficient way to go. "It doesn't take nearly as much DC as AC to run because when electricity is converted from DC to AC about 10% of the power is lost," he says.

For now the Grundfos pump stands alone as the sole piece of equipment that can run on both DC and AC electricity, but it's hoped that with improvements in solar and mechanical technology more types of equipment will become available.

Traffic signals, pond aerators, security lighting, and surveillance cameras operate on AC power but are so standard that the size of solar panels, a battery, and an inverter are frequently sold off-the-shelf as turnkey packages. It's easier to equip standard AC operating systems with standardized packages rather than design and manufacture ones that have the ability to operate on DC.

Maintenance

Maintaining a solar power system can range from very little oversight to frequent inspections depending on what kind of equipment is incorporated and where the system is located. Batteries tend to require the most maintenance of any of the system components. There are several types of batteries available including gel, sealed, and flooded batteries. Conditions at the site dictate the type of battery used. Sealed batteries require the least maintenance, while gel batteries operate better in locations where freezing temperatures are likely. Flooded lead-acid batteries are relatively inexpensive but require that water levels be checked and distilled water be added as needed.

When it comes to holding on to electricity, sometimes it's less labor intensive to store what's been acquired with the solar power rather than store the electricity. For solar-powered pumps it's usually worth buying a larger storage tank and storing extra water rather than incorporating a battery into the system. That way, even without a battery, water is available on overcast days or at night. For Anne

Tazewell, her 500-gallon holding tank supports her and her husband by storing enough water for their needs.

After the battery, another maintenance issue includes cleaning the solar panel itself. When panels become dirty or obscured they operate less efficiently.

“Maintenance needs are really based on location and time of year,” says Lensch. “Spring may require more cleaning because of pollen. It’s easily done with water and a squeegee.”

Over time those employing solar panels may come up with their own tricks to minimize maintenance. Dennis Maple doesn’t have to deal with pollen in the Sierra Nevada Mountains, but he’s figured out that solar panels need to be angled just right not only to collect sufficient sunlight, but to encourage snow and ice to slide off more easily.

“We’ve had our solar panels for over 20 years and they’ve been reliable,” says Maple. “When power isn’t readily available or the cost to purchase it isn’t realistic, for us solar is the first alternative. We just have to hike up and clean off the snow sometimes.”

Diane McDilda is an environmental engineer and technical writer in Gainesville, FL.

WE May/June 2007

RETURN TO TABLE OF CONTENTS

Home | Search | Subscribe | About | News | Advertise | Register | Services | Industry Events
Keep Informed | Contact Us | Current Issue | Back Issues | Forester*Press* | StormCon

P.O. Box 3100 • Santa Barbara, CA 93130 • 805-682-1300