



SOLAR ELECTRIC SYSTEMS

Making Wyoming's sunny skies work for you

By Milton Geiger

Solar electric or photovoltaic (PV) systems are the most common small renewable energy installations in the world.

The promise of using sunlight to generate electricity has excited people since the PV effect was first observed in 1839. Many in Wyoming use this incredible technology to generate clean, renewable energy.

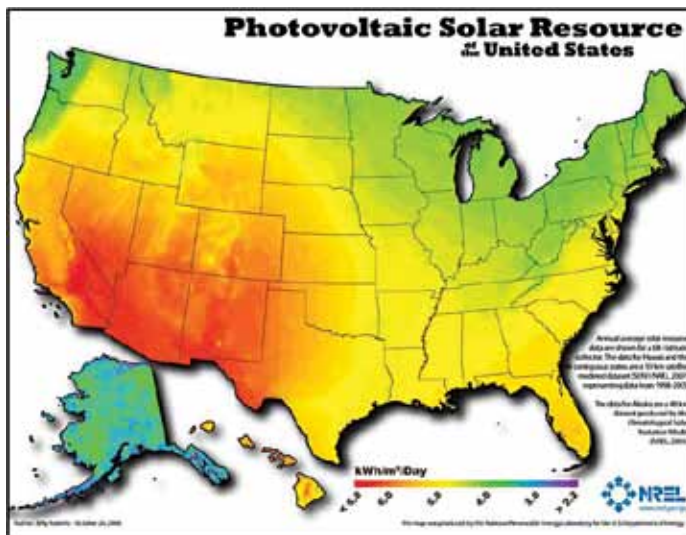
Many look at solar panels and assume the process of creating electricity is akin to magic! Solar electric panels are capable of producing electricity without moving parts. Photovoltaic cells use specially treated semiconductors, such as silicon, that have layers with positive or negative charges. The sunlight (photons) striking the photovoltaic cell knocks an electron loose, thus creating direct current (DC) electricity. The DC electricity passes through an inverter to change it to alternating current (AC) because all utility-served homes in the United States use AC.

Sunny Wyoming

Not all sunlight is equal for the production of electricity. Some areas of the United States receive more solar radiation (insolation) than other areas. Fortunately, Wyoming has an excellent solar resource. We actually have a better

solar resource for photovoltaics than the Sunshine State of Florida (see map).

The average insolation in Wyoming ranges from a low of 5.15 kWh/meter²/day in Jackson to a high of 5.45 kWh/meter²/day in Cheyenne. As an example of the importance of insolation, a solar array would produce approximately 9 percent more electricity in Cheyenne than in Jackson.



Wyoming has a very good to excellent solar resource for photovoltaic installations. The sunny climate, elevation, and cold weather (like any electric device, PV panels are more efficient when cold) means that Wyoming has a better solar resource than the "Sunshine State" of Florida! (Map courtesy National Renewable Energy Laboratory)

This great solar resource is a product of our climate (lots of sunshine), our elevation (less atmospheric absorption), and our cold temperatures. Climate and elevation make sense to most people. The cold weather actually helps the production of solar electric systems due to lower temperatures reducing electrical resistance hence increasing efficiency. Solar electric panels produce very well under cold sun, especially when snow helps reflect even more sunlight to the panels!

Although the quality of the solar resource for an area is relatively easy to determine (see box, page 14), the siting of solar electric panels is very important. Solar electric panels must have an unobstructed southern exposure, ideally in both high-angle

summer sun and low-angle winter sun. Some variation from true south may be acceptable, but the view must be unobstructed, as even a little shading can markedly reduce the overall production of a panel.

Also, panels must be at the proper angle to collect the most energy possible. For fixed solar panels, an



The UW Cooperative Extension Service wind/solar demonstration system at the Natrona County Agricultural Resource and Learning Center offers Wyomingites a chance to see how both an on-grid and battery-based system function. The 4.2 kW solar array technically allows one of the offices in the building to be "off-grid." The system was completed with UW CES, UW School of Energy Resources, Natrona County, and Rocky Mountain Power Blue Sky Program funding.

installation at approximately the same angle as your latitude (e.g., 41-45°) is most effective for year-round collection. Additional production can be gained from tilting the panels plus 15° in the winter and minus 15° in the summer. Solar trackers are another option to enhance production, as they automatically alter azimuth and/or tilt. Trackers add to cost

and complexity because they introduce moving parts to the system.

Why Solar Electric Systems are Great

The excitement generated by the emergence of the solar industry is palpable, with more systems being installed than ever before. This excitement is deserved, as solar electric systems have numerous advantages compared to other renewable energy systems, including: robust design, simple maintenance, predictable electricity production, compatibility with "in-town" installations (as opposed to small wind), and an ever-increasing number of qualified installers.

Solar panels often come with 20-25 year warranties. They offer strong resistance to hail and wind when properly installed. Once installed, homeowners do not have to check fluids or service bearings – no moving parts exist. Inverters need to be monitored and often replaced after 10-15 years, but, otherwise, systems are generally maintenance-free aside from the occasional rinse!

Finally, the option to have roof- or ground-mounted unobtrusive solar panels means they can be installed virtually anywhere with a clear southern exposure!

Increased consumer interest and numerous training programs have created more qualified installers working in Wyoming. A list of Wyoming-based installers is provided on the UW Energy Extension website (go to www.uwyo.edu/ces, click Extension Educational Program Areas on left-hand



TOOLS FOR ASSESSING YOUR SOLAR RESOURCE

The National Renewable Energy Lab offers a useful and entertaining tool, In My Backyard (IMBY), that lets Wyomingites evaluate solar and wind energy opportunities at their properties.

The Google Maps-based software allows you to draw the solar panels on your roof or elsewhere on your property. The program estimates overall production and provides some rudimentary evaluation of payback based upon estimated installed costs. For example, a theoretical 5 kW installation above my office in the College of Agriculture and Natural Resources is estimated to produce 7,497 kilowatt-hours annually, with the highest monthly production in March. A link to the IMBY program is available from UW CES's Energy Extension website (address directions at right).

side, then Renewable Energy). When you talk to an installer, ask about his/her qualifications, in particular if he/she has, or is seeking, the North American Board of Certified Energy Professionals solar certification.

Why They're Not Already Everywhere

There are several reasons solar electric panels are not more common in Wyoming, but the prime reason is cost. The variability of sunshine, combined with the significant upfront cost of panels, precludes large-scale adoption in Wyoming. For small-scale systems, the installed cost ranges from \$6-\$8.50/watt of installed capacity. For example, to produce enough electricity for a Casper home using 1,000 kilowatt-hours a month, a \$50,000-\$70,000 system would need to be installed. Despite the "fuel" being free after installation, the systems still produce energy more expensively than utilities in Wyoming.

Fortunately, there are some important incentives, such as the 30-percent federal tax credit, that help reduce the cost for homeowners and businesses. More information on incentives, including additional opportunities for businesses, is available from UW's Energy Extension website.

Evaluating your own personal payback

Despite the intimidating costs, there are other important reasons for owning a solar electric system that are not readily reported in a "simple payback calculation." See Ben Rashford's breakdown of financial returns, "How to determine if that renewable energy project makes economic sense," in the Summer *Barnyards & Backyards* 2010 issue for more information.

SOLAR ELECTRIC FOR OFF-GRID RESIDENCES

Solar electric systems are very popular for off-grid applications in which either the electric grid is unavailable, too expensive to access, or people have voluntarily severed relationships with their electric utilities. Solar electric systems are often part of these systems and can be integrated with other sources of electricity, such as wind. Electricity is stored in batteries for times when the sun is not available. On-grid systems do not require battery storage, but some people wish to have this option. Integrated battery storage with grid connection adds cost, but it also allows users to have backup electricity if the electrical service should ever fail. To allow backup electricity, additional safety measures are also required to ensure electric utility employees are not harmed by the unintentional "back feeding." Without additional features, typical grid-tied solar electric systems with no integrated battery storage will not operate if utility power is lost.

Long paybacks may be appropriate for people who value the environmental benefits of the system, such as reduced emission of greenhouse gases, or other pollutants. Others may especially value personal or national energy independence or are simply fascinated with the technical aspects of solar electric systems. Only you can determine if solar electric fits your Wyoming lifestyle.

(Photo courtesy Steve Fletcher)

SOLAR POWERED LIVESTOCK WATER PUMPING

Solar electric panels can offer a reliable and cost-effective alternative to diesel (gasoline, propane, etc.) and electric utility line extensions for pumping water for livestock or other remote applications. The predictable production of solar panels can be coupled with robust DC pumps that remove the need for an expensive inverter. As water can be stored cost-effectively (build a bigger tank), there is no need to have batteries for cloudy days or at night. The system is simply sized to pump enough water during strong sun days to have reserves available. These systems are growing more popular among Wyoming landowners. If interested in this type of system, please contact your University of Wyoming Cooperative Extension Service or Natural Resources Conservation Service office for more information.

Using solar to pump water for livestock can be very cost-effective compared to fossil-fueled powered generators.



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