PURDUE EXTENSION

RE-10-W

Renewable Energy

Fueling and Feeding America Through Renewable Resources

Considerations for Solar Photovoltaic (PV) Installations

Chad A. Martin, Renewable Energy Specialist
Klein E. Ileleji, Associate Professor & Extension Engineer

Agricultural & Biological Engineering Department
Purdue University

EXPERT REVIEWED

Introduction

As low-cost photovoltaic cells gain reliability and efficiency, solar-generated electricity is increasingly affordable. On Indiana farms, solar power drives irrigation pivot pump motors, farm building electricity, home electricity, and many other applications. Fluctuating energy prices and peak demand charges from utility companies could lead to solar applications gaining even greater acceptance as a viable approach to energy cost management.

There are several types of solar energy collection methods. The two most relevant to farms and businesses, which we are focusing on, are as follows:

1. Photovoltaic, or PV, systems consist of cells connected in an array. Usually, such systems create electricity for individual homesteads and farmsteads, or for distributed generation.
2. A second type uses a concave solar collector to concentrate energy for heat generation to run a turbine to generate electricity. Such concentrated solar systems are typically used for large-scale electricity generation.

This publication will focus on PV systems and provide guidelines to help determine if such a system is a good investment for your farm, business, or home.

What is a solar electric photovoltaic (PV) system?

In a photovoltaic system, multiple connected cells collect sunlight and convert the rays directly to electricity. Sunlight and semiconductor materials within the cell interact, generating electrons. The direct current (DC) is converted to usable alternating current (AC) through an inverter that typically is placed within the building or site where the utility meter is located.

Why install a solar PV system?

With any renewable energy system, intermittency is a challenge and can be a barrier for "going off the grid" completely. When the sun is not shining enough to generate ample power for your energy load requirements, electrical current is then received from the utility grid. However, in remote locations, establishing utility service can be cost-prohibitive —thus justifying solar PV with battery storage.

Some people appreciate the independence that a solar PV system can provide. Personal beliefs or convictions — preserving the finite fossil-fuel resources available on Earth, or reducing air pollution, for example — can be factors. Whatever the reasons, it's important to first research the options, visit with a solar PV dealer as well as someone who has installed one, and speak with your local utility provider.

Locating a system for successful electricity generation

A well-planned solar PV array is free from shading or obstructions to the sun's rays for most of the day. Orientation is directly linked to performance. Priority should be given to identifying systems that can be adjusted easily to angle toward the south-facing range, boosting efficiency and reliability.

Roofs can be sites for PV panels, shingles or tiles. For urban settings with ground space limitations, PV modules can be placed on covered parking areas and even on shades and window awnings. Appropriate sites are numerous; exposure to sunlight is the key.

Net metering and cost variables

Batteries can be used to store excess electricity that a PV system generates. However, battery storage costs can be prohibitive. That's why most PV systems near utility power access are "grid-tied," and consumers have a net metering arrangement with the utility.

When the PV array generates more energy than is consumed by the building or operation, the excess electricity can be sent to a utility grid. The utility monitors how much electric power a PV system generates as well as how much the consumer uses. The utility provides a credit to the consumer for excess generation sent to the power grid. It is critical that consumers communicate with the local utility provider early in the process, long before a solar PV system is installed. Some utilities provide a residential average retail rate in cents/kilowatt-hour. Be sure to identify the net metering policy and account for this rate before investing in a PV system. Ask whether the rate the utility pays for excess electricity that you generate is a retail or a wholesale rate. Also, is there a kilowatt-hour production capacity cap?

Because of the initial investment, a solar PV system is not cost-competitive with utility-supplied electricity, especially when the power service is nearby. However, the years to payback for a system investment can be shortened by:

- net metering or net billing;
- utility-generated power consumption offset;
- peak demand rate avoidance;
- federal/state grants and loan guarantees;
- depreciation for businesses;
- sales tax exemption; property tax exemption;
- state personal income tax credits;
- renewable energy credits.

For agricultural producers, there is an available depreciation benefit that does not apply to residential or non-business system installations. Farm solar system

On the farm: *How do you power, for example, an irrigation pivot pump motor? Solar-generated electricity is one answer. The agricultural industry is finding more ways to use solar power.*

installations in Indiana with retail net metering have a 92% chance of solar being cheaper than grid electricity; residential solar has a 50-50 chance of being break-even. Read Renewable Energy Publication RE-9-W for further information on "*Economic and policy evaluations of solar energy for Indiana businesses and residential applications*" by Jung and Tyner (2015).

Appropriate sizing of your system

By increasing the size and scale of a solar array, the cost per kilowatt-hour can decrease. For example, factor in the capacity of your inverter. Can it handle its maximum installed capacity, or should two inverter units be purchased? If the cost of installing a very small unit is the same as installing a medium-size array, then perhaps it makes sense to take advantage of the economies of scale.

The economic sizing of your PV system will depend on whether the utility's policy is net metering (which pays for excess kilowatts not used by the consumer) or net billing (which doesn't pay for excess kilowatts not used by the consumer.)

Some net metering policy agreements include a cap on a utility customer's kilowatt-hour production. This may have a direct impact on the scale of the system you install, and the rate given beyond the net metering cap could be a losing proposition. Additional caps may be placed upon some incentives or rebate programs, so check the fine print before making the final decision on the size of your solar PV installation. It is critical to not oversize the PV system, which produces more electric power than is required to meet the load demand.

Finding an installer

Pricing should not be the sole factor when selecting a contractor to install a solar PV system. Before choosing, do research on the types of available equipment, suppliers, and installers. You might talk with other solar PV system owners about their installers. Ask them about maintenance after the project is completed.

Your utility company might have a list of installers who have worked on similar projects in the area. Some utilities have certification requirements for installers. Contact the Solar Energy Industries Association (www.seia.org) to obtain a list of solar service providers. Midwest Renewable Energy Association (MREA) also certifies designers and installers who work in the Midwest. (www.midwestrenew.org)

When evaluating installers, be prepared. Among the questions you might ask:

- What grid-tied PV systems or stand-alone systems have they installed?
- How much experience — years in business, number of installations, training programs completed or certifications, etc. — do they have?
- Do they have the proper licenses to do the work?
- Any pending or active judgments against their prior work?
- On their website, are there examples of their work?
- Can their equipment be insured?

There are Internet resources available for reviewing contractors. The Better Business Bureau may be a resource, too.

Financing a solar PV system

First, consider the cost of electricity production from various sizes of solar PV systems. Take into account all investment costs, incentives, utility payout for excess power (retail or wholesale), and savings from self-generation. Then compare your electricity costs — from self-generation using PV, to the cost of utility power — and calculate the difference. This will help determine how many years before you recoup your investment. It also will help to determine what percentage of electricity needs you want a PV system to meet.

Toward the sun: *This solar PV array includes instructions on how and when to adjust the system, increasing efficiency and reliability.*

Examine past utility bills, demand charges, and the solar PV production potential of your property. Also, the type of loads (electrical equipment) and usage should be factored into the decision because this will affect the sizing and cost of your PV system.

Tax incentives are currently very critical to the economic viability of system installations. Available until the end of the year 2016 is the 30% federal income tax credit. This credit effectively reduces the solar installation cost by 30%, assuming you pay at least that much in taxes. Investigate additional rebates according to your state and local programs. Credits, grants and loans may be available for your project. Visit the Database of State Incentives for Renewables & Efficiency (DSIRE) at www.dsireusa.org.

A federal program available for farms and/or rural small businesses is offered through the U.S. Department of Agriculture Rural Development. Called REAP — Rural Energy for America Program — the competitive grant program may provide up to 25% of the project cost through a grant, or up to 50% of the project cost through a loan guarantee, or a combination of the two. This program has supported retrofitting projects for energy efficiency improvements. Visit http://www.rurdev.usda.gov/BCP_ReapResEei.html.

A valuable resource with tools and templates for preparing a USDA REAP grant application can be found at http://farmenergy.org/tools/tools-and-templates.

Professional grant writers are available for assisting with application preparation. A list may be available from your utility provider, through the Agricultural Marketing Resources Center database, http://www.agmrc.org/, or from a local USDA Rural Development office representative.

Paperwork shuffle: Permits, insurance, interconnection agreements, warranties

You may need to obtain one or more permits from city or county government offices before installing a system. All code requirements should follow the National Electrical Code. When your installer works closely with a building inspector, it's likely that the permit process will go more smoothly.

Some insurance companies have policies for on-farm systems. If yours doesn't, it may be possible for your agent to work with you and an installer to create a policy that will meet coverage requirements.

The Indiana Utility Regulatory Commission requires investor-owned utilities to provide interconnection agreements with people wishing to install a solar PV system. Rural electric cooperatives in Indiana do so on a voluntary basis.

An inspection should be done as a requirement. Your installer may need to make corrections if problems are uncovered. An inspection may be a prerequisite for qualifying for grants, loans, and other solar rebate programs.

A manufacturer's warranty should be made available for any malfunctions within at least the first two years of operation. The warranty should cover parts, labor, and removal of defective components, shipping, and reinstallation. Some manufacturers provide a longer warranty period. Read the warranty thoroughly and be sure there is a mutual understanding with the installer of the solar PV system.

Helpful resources

Purdue Extension renewable energy website: https://extension.purdue.edu/renewable-energy/solar-energy.shtml

National Renewable Energy Laboratory, National Center for Photovoltaics : www.nrel.gov/ncpv

U.S. Department of Energy Solar Energy Technologies Program: www.eere.energy.gov/solar

Database of State Incentives for Renewable Energy (DSIRE): www.dsireusa.org

USDA Rural Development Rural Energy for America Program (REAP): http://www.rurdev.usda.gov/BCP_ReapResEei.html

www.Farmenergy.org

eXtension Solar Energy in Agriculture Resources http://www.extension.org/pages/54905/solar-energy-in-agriculture-resources

Big, small … just right: *Several factors influence the size and scale of a well-planned solar PV installation. Bigger may not be better. Determining the load demand is important.*

References

Jung, J. and W. E. Tyner. 2015. Economic and Policy Evaluation of Solar Energy for Indiana Business and Residential Applications. Purdue University, Agricultural Economics, West Lafayette, Indiana. (Online), available at https://extension.purdue.edu/extmedia/RE/RE-9-W.pdf at retrieved August, 2015

NREL. 2004. A Consumer's Guide, Get Your Power from the Sun. National Renewable Energy Laboratory. [Online], available at http://www.nrel.gov/docs/fy04osti/35297.pdf at retrieved December, 2014.

NREL. 2014. Solar Energy Basics. National Renewable Energy Laboratory. [Online], available at http://www.nrel.gov/learning/re_solar.html at retrieved December, 2014.

USDA. 2014. USDA Rural Development Rural Energy for America Program (REAP). [Online], available at http://www.rurdev.usda.gov/BCP_ReapResEei.html at retrieved December, 2014.

Visit <www.extension.purdue.edu/renewable-energy> for free, downloadable copies of all of the publications in the Purdue Extension Renewable Energy series.

Jan. 2016