



E³A: Understanding Energy

Understanding Energy

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Net Metering

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Off-grid living

Living off-grid refers to living in a self-sustaining manner without reliance on one or more utilities. Some consider disconnecting from the electrical utility to be off-grid, but others have a more comprehensive view of the term. For our purposes, off-grid is concerned only with disconnecting from the electrical utility.

There are many reasons why people do not connect to the utility grid. Off-grid applications are common among agricultural producers with stock water facilities too remote for an on-grid electrical supply. Homeowners might choose to go off-grid because of the prohibitive cost of running electrical service to their home. Some homeowners go off-grid out of concern for the environment and a desire to reduce dependence on fossil fuels. Others like the idea of being self-sufficient and being rid of monthly utility bills.

No matter your motivation for considering off-grid living, a few facts about being off-grid may help determine whether it is right for you.

System design

An off-grid system can be complicated. In addition to considering one or more sources of electrical generation, you must consider the load, storage, voltage and quality of the electricity. In off-grid agricultural applications, such as stock water facilities, these considerations are not overly complicated. In a home, there are many system design considerations, including how to heat your living space and water. Qualified off-grid system designers can assist with these decisions, but finding a qualified designer can be difficult. If you intend to design your own off-grid system, consider attending classes, such as those offered by Solar Energy International, to learn more about appropriate system design. Additionally, some local vocational schools offer classes in alternative energy design and installation.

You can design a building or incorporate solar thermal technologies as an alternative to propane-based space heating. A building can generate natural heat and cooling using passive solar design principles, such as orienting the building on its northwest axis. In the northern hemisphere, the sun's lower-angled winter rays enter through south-facing windows. Thermal mass materials, such as masonry flooring, absorb the energy and radiate it as heat. Roof overhangs and awnings block the sun's higher-angled summer rays to keep the building cooler. Buildings designed with passive solar principles in mind are well-insulated to help retain conditioned air. This strategy is called passive solar because these design elements have no moving parts.

Passive solar buildings can also include active elements, such as fans for air distribution or heat recovery ventilators. Solar air collectors can be used to generate heated air and can be retrofitted into a wall or roof of an existing building. They use the sun's energy to heat individual rooms and supplement HVAC systems, or to preheat ventilation air.

Off-grid-buildings can use propane or solar thermal technology to heat water. For more information on solar hot water systems, refer to the E³A solar hot water module. However, be aware that solar hot water systems used in areas with cold winters typically require electricity for controls and to pump liquids through the collectors.



Investment in renewable energy technologies

Off-grid applications still require a source of power. Petroleum-fueled generators are an option, but renewable energy forms such as solar or wind are usually more cost effective for off-grid applications.

Batteries and balance-of-system equipment

Safe handling of electrical current generated in an off-grid application requires additional equipment to condition and transmit the electricity. This equipment can account for up to half of your total system cost (DOE, 2011). The equipment and expense varies with system design, but there are several typical components of an off-grid system.

Batteries

When your renewable energy system is not producing energy or is producing at low levels, you will rely on stored energy. Batteries store the energy produced by renewable energy sources and the backup generator.

Deep-cycle batteries, such as lead-acid, are best for off-grid applications because they can repeatedly charge and discharge up to 80 percent of their capacity without significant wear on the battery. Shallow-charge batteries, such as those used in a car, can only be drawn down by about 20 percent, and are not recommended.

Deep-cycle batteries can be expensive, but their cost depends on their intended load and the amount of storage required. For example, some homeowners are comfortable storing one to three days' worth of electricity, whereas others might feel they need to store more. Homeowners also need to consider battery space and location. For health and safety reasons, batteries need to be stored in an area that is accessible and well-ventilated but isolated from living areas. New home construction can plan for a battery storage area, but existing structures may require retrofitting to accommodate batteries.

Charge controllers

Charge control devices regulate the flow of electricity between the renewable energy generation source and the battery. The charge controller senses the demand for electricity and the charge of the batteries. When batteries are fully charged and there is no further need for electricity, the controller stops the flow of electricity to the batteries or diverts it to a shunt or dump load. In home applications, the dump load may be an electric water heater. Some rural residences use the dump load to heat livestock water tanks in winter months. When batteries are low, the controller stops the flow of

electricity to the home until the batteries reach a certain level of charge, which extends battery life. Cost of charge controllers vary by system load and the features.

Inverters: power conditioning equipment

Most renewable energy technologies generate direct current (DC) electricity. However, most electrical appliances in the United States run on 60 hertz alternating current (AC) electricity. Some off-grid applications use DC equipment or appliances, but AC electricity is more common, especially in home applications. Inverters serve several purposes:

- Conversion of constant DC power to oscillating AC power
- Converts DC to AC, but also converts a backup generator's AC into DC for charging batteries
- Regulates the frequency of the AC cycles to 60 cycles per second
- Manages voltage consistency, or the extent to which the output voltage fluctuates
- Regulates the quality of the AC sine curve, whether the shape of the AC wave is jagged or smooth

Power quality is especially important if you intend to operate sensitive electronic equipment such as a computer or high-definition television, which cannot handle much power distortion.

The cost of an inverter varies based on the quality of the power produced and the features included in your power-conditioning package. The conditioning equipment you require needs to match the voltage, phase, frequency and sine wave profiles of your generation source. A qualified off-grid system designer can help you with this.

Safety equipment

Ensure your system has safety features installed. Three common safety elements are safety disconnects (which either disconnect the system in the event of a malfunction or can be disconnected when you are performing system maintenance), grounding equipment and surge protectors.

Meters and instrumentation

Meters and monitoring equipment allow you to track generation system output, as well as battery charge and your consumption. Costs vary based on your desired level of monitoring.

System cost and finance

A key benefit of being off-grid for many consumers is getting rid of utility bills. However, as you consider living off-grid, do not forget that you may have upfront costs associated with installing your system. Upfront costs of off-grid systems tend to be higher than grid-connected renewable energy systems, especially as additional system components add to the expense. Also remember that you

will have annual operation and maintenance expenses associated with your system. As part of your research process when considering living off-grid, consider how you will finance your system and what terms are available to you. Talk to your home mortgage lender, though some conventional lenders do not offer loans for or require additional appraisal requirements for off-grid homes.

Backup generation and hybrid systems

To maintain a level of battery charge and ensure the availability of electricity, you will need a backup generation source or a hybrid system. Hybrid systems use more than one renewable energy source — usually wind and solar — to provide consistent generation of electricity. For example, the wind is probably blowing when it is stormy and the solar generator's output is reduced.

Although hybrid systems can provide more consistent power, many off-grid homeowners also have backup generators. Generators are used to recharge batteries and supply electricity to the home if the renewable energy systems are offline, or if load demands draw batteries down to the point where additional generation is necessary to recover a charge.

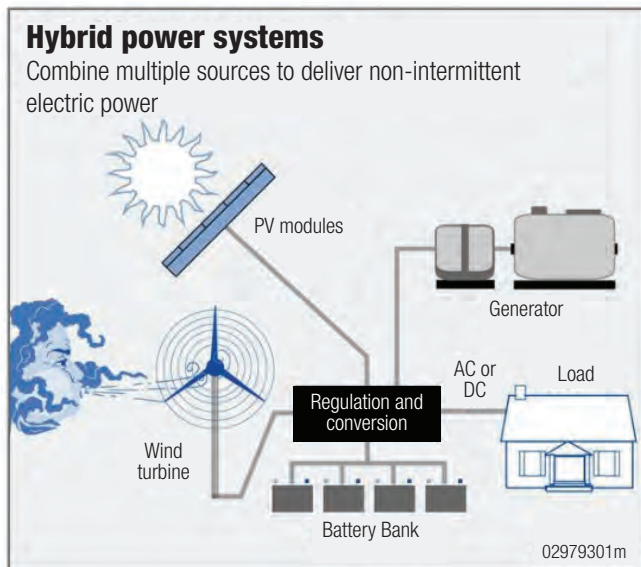


Photo credit: Department of Energy

Conservation as a lifestyle in an off-grid home

All off-grid systems must account for conservation and storage of electricity. Unless you invest in a system that can accommodate every convenience, living off-grid magnifies these considerations:

- Usage decisions might depend upon the amount of available electricity. Using a hair dryer while running the automatic coffee pot and microwaving something for breakfast may be too much load for your system at one time.
- You need to continually monitor your system. Some monitoring is done almost daily, such as checking

battery charge to ensure the system is generating electricity. Other activities, such as monitoring water levels in the batteries, can be done less frequently.

- You might need to invest in a propane-fueled refrigerator or propane-fueled clothes dryer — or decide to forego a dryer and other appliances. Large electrical loads are undesirable in an off-grid home because of the amount of electricity required to support their operation. You may wish to consider heating your home with a wood-burning furnace.

Off-grid living is possible, but it requires a heightened awareness of energy consumption and system design is especially important. Do-it-yourselfers may welcome the challenge of researching and training to design an optimized system, but these are complex systems and selecting a qualified system designer may be your best option. Consult your insurance agent to ensure your home is covered with the alternative energy system you install.

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