

Choosing to Live Off-grid: Energy Generation and Fuel Choices



What exactly does living off the grid mean? Simply put, it means having a dwelling that does not require a constant supply of energy from off-site sources, usually electricity or natural gas, in order to operate. Until recently, being independent of traditional utilities meant sacrificing many of the creature comforts that Americans have grown fond of in modern society.

Often these homes were found in remote or rural areas where access to the energy grid was difficult or impossible. A past example of living off-grid might have been a hunting cabin deep in the woods with an oil lamp, hand-powered well pump, and a wood-burning stove.

But with new battery technologies available, increased acceptance of renewable energy sources, and specialty appliances, an off-grid home can be as comfortable as any other modern home. Today, with a little education and a considerable amount of thoughtful planning, all the modern conveniences of city life can be taken into areas where power lines simply can't follow.

Over the past decade, living off the grid has won new converts. Whether it's a second home designed to be a summer or winter retreat, a permanent outpost far from crowds, or simply a desire to be energy independent, living without

COURSE OBJECTIVES

This learning unit will explore the use of electric generators in off-grid homes and explain how lifestyle choices, appliance selections, and backup fuel options are a critical part of successful off-grid living. After completing this course, you will be able to describe what an off-grid living situation is and why this kind of lifestyle is increasing in popularity. Describe the differences between an off-grid and electrical stand-by generator. List the advantages of utilizing propane as the primary energy source for off-grid living. And explain how lifestyle choices and appliance selections are a critical part of successful off-grid living.

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power poles or natural gas line has become an attractive notion.

One of the most common reasons that people choose to live off-grid is economic. Aside from the actual energy costs to run a home, rural power companies charge to install new electrical lines, a fee that has to be paid by the homeowner. Some homeowners report that these costs come in at more than \$6 per foot of line. That means if you live just two miles off the beaten path it could cost more than \$60,000 to be linked to the power grid. In some instances, the figure is even higher.

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Homes that are built in areas deemed environmentally sensitive could face a further obstacle. Power lines or buried cables can disturb or damage the local environment. In many instances, even if a homeowner is willing to pay to be connected to the local utility grid, it is simply not an option.

Moving away from dependence on traditional utilities and toward energy independence is increasing in popularity. At a national level, energy independence often means moving toward a point where the United States is no longer dependent on other nations to supply sources of energy. One way to achieve this is to have consumers use less energy. To help make the transition more attractive and affordable, the federal government as well as some state and local governments provide tax incentives and rebates on the costs for installing renewable and off-grid systems. For more information about available incentives, visit www.dsireusa.org.

The electric power grid in the United States was built in the 1890s and expanded over the years as technology advanced. Today, it consists of more

than 9,200 generating units with over 1 million megawatts of generating capacity connected to more than 300,000 miles of transmission lines. Even so, the grid is being stretched to its capacity.

A smart grid, one that increases power-load balancing by using computerized sensing and communications between the grid and consumers, is currently under development but will take many years to complete. For some people, the potential for the current grid to fail before the new grid is in place is incentive enough to move to generating their own power.

Off-grid homes are becoming increasingly popular. In 2011 alone approximately 14,600 new off-grid generators were installed in homes going off-grid for the first time and another 4,000 generators were installed to replace aging off-grid systems. This trend toward off-grid living is only expected to grow. In recent years, sales have increased for one leading manufacturer of off-grid generators by 10 percent per year. As consumers continue to look for ways to reduce energy costs, live in areas that are not conducive to grid connection, or find ways to increase self-sufficiency, the number of off-grid homes will continue to rise.

Where exactly are all these off-grid homes? While common sense dictates that these homes would be concentrated in sunny climates that can take advantage of solar power or windy areas that can use wind turbines, the truth is that off-grid homes are found in every state. In fact, modern off-grid living can be found around the world, with communities in the Bahamas, for example, going completely off utility energy grids.

GENERATORS AND SYSTEMS

An off-grid home does not have to be lit by candles at night. Modern living requires at least some electricity, which is generated with renewable resources, including solar and wind, and electric generators. There are several kinds of electric generators today, but only two are typically used to provide power to homes when traditional utilities are not available: standby and off-grid generators.

Both types of generators can supply a home with ample energy, but they are different in terms of operation and practical use. Knowing the difference between a standby and an off-grid electrical generator is important in order to understand off-grid living. In fact, applying the wrong type of generator to the task of supporting an off-grid home often voids the generator's warranty, potentially leaving the homeowner with all of the repair costs in the event of a breakdown, even those that would typically be covered by a warranty.

The standard off-grid power generation and storage system includes a renewable energy generator such as a windmill or solar panel or array, a battery bank to store the electricity, an inverter to convert the direct current to alternative current, and an electric generator.

When it comes to electrical storage capacity, an often-used analogy with off-grid living is to think storage capacity like a barrel of water. If you have a 10-gallon barrel of water and are draining it by two gallons per hour, in five hours the barrel will be empty.

However, if you add one gallon an hour, then the barrel won't be empty for 10 hours. To successfully manage your water supply you can either increase the amount of water you are adding, decrease the amount flowing out, or get a bigger barrel to extend the amount of time until the barrel is empty.

When applying this analogy to off-grid living and energy use in the home, the barrel is the battery pack, the flow out is the amount of electricity used to operate the home, and the flow into the barrel is the electricity generated by solar, wind, or hydro-power generation systems.

Every so often when the barrel runs low you will need to fill it to the top again, which is where a generator comes in. The electric generator acts as a buffer to ensure that year-round, in any situation, the home never runs short of electricity.

Renewable resources are those that are replenished by nature. Sun, wind, and water are the major renewable resources available to power homes. Which of these resources is used varies widely by region and climate. Solar

power is a good option for homes built in areas that see relatively few cloudy days and have prolonged stretches of sunny weather each year. Homes built in areas such as the deserts of the Southwest, the southern coasts, or parts of the central and mountain regions are all good candidates for solar power.

Wind turbines are a good choice for areas that experience a lot of wind throughout the year. Coastal areas are often candidates for this kind of power, as are areas around the Great Lakes and the Plains. Also, micro-hydro turbines can work for any area that is near a constantly running body of water, such as a large stream or river.

Unfortunately, renewable energy sources rarely provide enough consistent and reliable electricity to keep a home operating comfortably. Ideally, the renewable energy generation system installed would be robust enough to constantly keep the barrel full, but this is seldom the case. Most off-grid renewable energy systems supply 2 to 4 kilowatts of energy through a solar panel array, windmill generator, or a combination of both.

In southern climates with ample sunlight and low energy loads, most solar panel arrays can sustain the electrical needs of a home for about nine months out of the year, but have reduced electrical output during the winter months. In northern climates with shorter days, consistent power generation is only viable six months out of the year. Even with financial incentives in place, installing a renewable energy system large enough to provide ample electricity to a home year-round is both cost-prohibitive and impractical.

Electric generators are the safety net of the off-grid home. They can be installed nearly anywhere a homeowner wishes to build, even in rugged, remote areas. And, if clouds settle in or the wind stops, a generator is not affected. It will still provide energy to the home, even if conditions become extreme. This is especially important during winter when losing heat can be deadly.

Generators are not intended to run year-round. Instead, they keep the



batteries from becoming too depleted. In addition to losing power, a battery that has run completely down risks being damaged. With banks containing as many as 24 batteries, each of which ranges in cost from \$135 to \$1,600, protecting this investment is important.

Electric generators come in various styles, depending on need. Not all of them, however, are acceptable for off-grid use. Portable and standby generators can mistakenly be misused for off-grid applications. However, they each have specific functions

The most common generator is the portable generator, which is designed for short-term use. These small units are fueled by gasoline or diesel and, as the name indicates, can be transported and used nearly anywhere. Portable generators include 120-volt power outlets that accommodate appliances and power tools.

However, a portable generator is not a successful choice for off-grid living for several reasons. First, portable generators require manual operation, which means they must be physically started every time before use. They are typically small and provide limited output for limited hours. Portable generators also have specific safety concerns such as fuel spills, fire, and carbon monoxide poisoning.

Standby or emergency generators are meant for longer-term use. They are permanently mounted units that are meant to provide electricity to grid-fed structures during power outages. When the power supply is disrupted, standby generators automatically turn on within seconds. They are sized based on the specific energy requirements of a home during an outage. Most often standby generators supply electricity to appliances and lighting. If heating or cooling systems are electrically powered, a standby generator can power these systems during an extended outage too.

Using a portable or standby generator in an off-grid situation raises the possibility of misuse. Besides the risk of fire and carbon monoxide poisoning, using the wrong type of generator can void the manufacturer's warranty. With new standby generators costing as much as \$13,000, voiding the warranty can become expensive.

OFF-GRID GENERATORS

Off-grid generators are the only generators truly designed to meet the needs of an off-grid home. They are similar to standby generators, but are designed to provide backup power to non-utility sources. Electrical output is about the same or less than a standby generator because an off-grid

home is generally designed to have a much smaller load requirement than a traditional home. Because these generators are required to run more often for significantly longer hours than standby generators, they typically have different designs and warranties. Off-grid generators are usually water cooled and can be permanently mounted within the home with an exhaust vent leading outside to prevent carbon monoxide poisoning.

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When an off-grid generator is permanently mounted inside the home, it is not connected to the home directly. The generator is connected to an inverter charger, which sits between the generator, the battery bank, the renewable energy source, and the home. When the charge in the battery bank drops too low, the generator will supply power through the inverter and recharge the bank. Today's generators can even be set up so they will automatically engage when the batteries reach a specific low charge point, making sure the energy flow to the home is autonomous and uninterrupted.

Choosing a generator that will stand the test of time is important. If it breaks down, getting service and repair technicians to the site could be a problem. This is especially true with off-grid homes that are located in remote or rural areas where it can take weeks, if ever, to get services teams out to the location.

Despite all the careful choosing, however, no generator will last forever. An energy-efficient home will go a long way to prolonging its life. Because an off-grid generator only kicks in when the battery energy is too low, a home that lightly consumes energy will require less backup and the generator will be used

less. The more energy efficient the home the less power is required and the greater the time between recharging.

As the need for off-grid generators has grown, so have the advances in the technology. These advances mean that new generator motors can run for more 8,000 hours before needing to be replaced. And, unlike a standby generator that must constantly run to provide power to the home, a high-quality off-grid generator only needs to operate when the batteries need recharging. This can mean that an off-grid generator can help keep a home safe, secure, and comfortable for many years before exceeding the 8,000-hour service threshold.

Several other factors contribute to a generator's longer life. First newer generators run at a substantially lower RPM. This causes less wear on engine parts, as they aren't moving as fast and creating friction and wear. Maintenance, such as oil changes, on these generators only has to occur once every 500 hours of use. Another factor is the inclusion of hardened steel engine components, such as pistons. These components simply will not wear out as fast, which means the generator will last longer.

In the past, the output of generators was restricted to 120 volts. As most household energy needs are met with 120 volts, this was fine. However, it creates problems when trying to introduce larger appliances or machinery. Modern generators can output both 120 and 240 into the correct inverter and power just about anything a homeowner wants to plug in.

The lower RPMs of the new generators mean that not only will they last longer but they are also substantially quieter. In fact, a generator running at full capacity is no louder than a running refrigerator.

Another improvement is an improved oil recovery and circulation system, which dramatically slows oil degradation. Oil will stay cleaner and not break down nearly as fast as it does in older systems. This protects the engine parts, which in turn helps increase the usable life of a generator.

ENERGY SOURCES: PROS & CONS

Even with the most robust renewable energy solution installed, off-grid homes will still need a source of energy to power the generator. While there are several choices available, including diesel, propane has proven to be the most versatile, reliable, and safe fuel source for off-grid living.

Gasoline powered generators are typically portable generators or other small generators. As a fuel for generators, it is fine for small, limited use applications, but there are safety concerns. Exhaust from gasoline engines is potentially deadly and contains harmful emissions.

Spills and fumes can ignite, causing explosions and fires. Spills can also contaminate soil and groundwater, causing longer-term problems. And, left over time, gasoline will degrade and cause engine starting issues. As such, gasoline generators are not good candidates for off-grid scenarios.

Generators in off-grid applications are almost exclusively powered by diesel or propane. While each has its place in the market, there are significant issues with using diesel to fuel generators, including fuel degradation, exhaust emissions, and fuel gelling at cold temperatures.

Propane, in contrast, will not degrade or oxidize over time. Temperature changes don't have much effect on propane and it will easily ignite on the coldest winter day. It is readily available, easy to transport, and safe to use in generators. Propane emissions are also significantly lower than those of diesel-powered generators.

While diesel fuel can be used to run an off-grid generator, doing so has some serious drawbacks. Diesel will oxidize over time and must be treated with stabilizers to ensure the fuel doesn't go bad before use. Also, diesel is highly susceptible to condensation in the tank. When water is introduced to diesel, it can quickly promote the growth of microbes and organic compounds. These pollutants can degrade the fuel and produce clogging materials that can reduce performance and eventually ruin the engine.

A problem that is unique to diesel is that the colder it gets, the thicker it becomes. Diesel generators must be equipped with heat plugs that have to warm before the generator can be started. In extremely cold climates, diesel may gel to the point that it can create real challenges for generator fuel pumps. Diesel can also be an environmental hazard if spilled and can quickly foul drinking water if it seeps into wells.

Finally, for homeowners trying to minimize the amount of fuel and energy needed to operate their off-grid home, diesel often is not the most convenient choice. While other fuel types such as propane can power multiple appliances in the home, diesel is limited to generator use alone. This means that by choosing a diesel off-grid generator, the home will need to either exclusively use electricity to power all appliances or have a secondary fuel source to ensure a comfortable, stable living environment.

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Propane is readily available across the country, with more than 6,000 retail dealer locations throughout the United States. Distance from the source is rarely a problem for refueling a propane storage tank. Propane also offers homeowners the opportunity to have complete control over their energy supply. By storing propane on site, homeowners can create an island of energy independence, free from the whims of public utility systems or at the mercy of an aging and faulty electrical grid.

As an energy source, propane has many advantages over diesel. While

diesel fuel needs periodic conditioning to prevent spoilage, propane does not degrade over time nor does it promote the growth of microbes. Propane can be used nearly everywhere gasoline, diesel, or natural gas can be used.

In addition to generators, propane can supply the energy to many of the systems and appliances used in the home. Heating and cooling systems can both be run on propane, dramatically reducing electricity consumption. Many of the appliances found within the home can be run on propane as well.

These include space heaters, water heaters, dryers, refrigerators, fireplaces, and kitchen ranges. By using appliances that run on propane instead of electricity, the home will consume far less electricity, making off-grid living easier.

Because propane does not oxidize or lose its volatility it has no fuel maintenance issues. The natural temperature of propane in its condensed liquid form is -44 degrees Fahrenheit, which means even during the coldest of winters propane will not thicken or gel like diesel.

MATERIAL PROPERTIES OF PROPANE

Also, transporting and storing propane is safer than diesel. A propane tank is 20 times more puncture-resistant than a typical diesel tank. Large tanks can be buried underground because propane is a nontoxic, nonpoisonous fuel that doesn’t contaminate aquifers or soil. This allows homeowners to have the fuel they need without having a large tank in view.

Propane is among the most attractive options for lowering a home’s carbon footprint and avoiding greenhouse gas (GHG) emissions in every application considered. At the point of use, propane emits fewer GHGs than gasoline, diesel, heavy fuel oil, or E85 ethanol per unit of energy. Propane generators produce half of the ozone-forming emissions and zero evaporative emissions.

Propane is produced as a byproduct during natural gas processing and petroleum refining processes. Currently, more than 95 percent of the propane used in the United States is produced

in North America. This reduces the environmental impact associated with transporting the fuel.

Because propane is a gas, there is no chance of spillage (unlike gasoline or diesel), so there is no risk of groundwater poisoning or well-water contamination. In contrast, gasoline contains more than 150 chemicals, including small amounts of benzene, toluene, xylene, and sometimes lead, all of which can lead to significant health issues to humans and pets if exposed. To successfully create an off-grid living situation, the home must be built with reducing energy use in mind. This means more insulation, better air sealing, and, whenever possible, using as few electrical appliances as possible.

REDUCING POWER CONSUMPTION

There are three ways to improve an onsite power generation system and ensure that a home never runs out of electricity. The first requires a significant reduction in the amount of electricity needed to power the home.

The second is to use appliances that can fill more than a single need while consuming the same amount of energy. The third is to use a safe and stable energy source to make sure the home does not run out of power and that, ultimately, the off-grid lifestyle remains sustainable for the occupants.

Typically, energy use in an on-grid home is only restricted by the ability to pay the utility company for it. Off-grid living, however, means access to a much smaller amount of electricity at any given time. To avoid frequently running low on energy, off-grid homeowners need to practice conscientious conservation and considerably restrict the amount of energy they consume on a daily basis.

Another way to reduce the amount of electricity the home needs is to address “ghost loads,” or the energy appliances use when they are not turned on. Sometimes, the electricity is used for lights or readouts, such as the clock on a microwave oven or the VCR, or, in the case of some televisions, the electrical draw that is used to “quick start” the device. To limit consumption of electricity, select appliances without

clocks or have the clocks disabled. Also, use power strips to easily cut the power to TVs, computer systems, and other devices.

Reducing the amount of energy required to light a home would cut consumption dramatically. Ninety percent of energy consumed by traditional light bulbs is given off as heat, not light. Replacing these bulbs with compact fluorescent lamps (CFLs) or light-emitting diode (LED) bulbs will cut energy consumption by 75 percent.

Careful placement of lights in the home will also help to reduce energy consumption. Using task lights where needed and reducing ambient light elsewhere will cut energy use. For example, placing LED lights under kitchen cabinets will focus light exactly where it's needed without illuminating extraneous space.

When designing an off-grid home, extra attention needs to be paid to site and window placement to take advantage of daylighting opportunities. Ample natural light during the day can help reduce or eliminate the need for electric lights. Propane users can reduce the electrical light load through indoor or outdoor gas lighting. Outdoor gas lights now can be equipped with on/off switches, just like an electric light. Some models of indoor gas lights offer up lighting capacity to the equivalent of 100 watts.

There are many other ways to reduce the amount of electricity a home needs to operate. Modern building practices of better air sealing and improved insulation can reduce energy consumption by helping to prevent the temperature outdoors from changing the temperature indoors. Including these elements in an off-grid home design will automatically reduce energy use.

Heating and cooling systems account for about 56 percent of the energy use in a typical U.S. home, making it the largest energy expense for most homes. High-efficiency systems reduce amount of energy needed to achieve the desired results. Using radiant heat, for example, is much more efficient than forced-air or baseboard heaters and can reduce energy consumption dramatically.

Another way to automatically reduce energy consumption is to install high-efficiency appliances. Products and appliances that have earned the Energy Star efficiency rating from the Department of Energy will, by default, save more energy than those that have not earned the rating.

Most appliances are single use. The washing machine just washes items and the oven just bakes. However, there are appliances that can offer more than just one function. By doing more than one thing using the same energy, they can help conserve energy while keeping the home comfortable and meeting the needs of the homeowner.

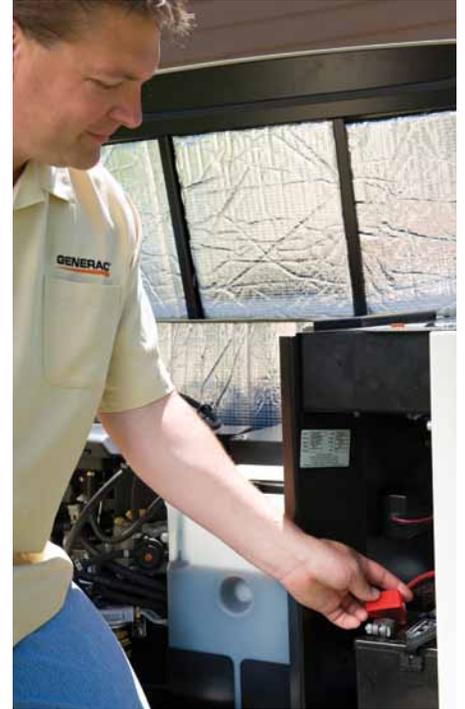
One example of a double-duty appliance is a water heater that can also provide the heat for radiant flooring. Before the hot water ends up in the shower, for example, it runs through the radiant floor tubing, heating the home. When the taps aren't open, a circulator keeps the hot water moving between the heater and the floor so the house stays warm.

Absorption, or gas-fired, heat pumps are another appliance that can do double duty. These propane-fueled pumps can heat homes in the winter and provide cooling during the summer using absorption and heat transfer. They are best suited for large residential homes, but newer models may be available for smaller dwellings in the future.

Besides powering a standby generator, propane is a multi-use fuel that can be used for central heating, space or domestic water heating, cooking appliances, clothes dryers, and fireplaces. Although not common in off-grid situations, propane can also be used to heat patios, hot tubs, and swimming pools.

Using propane-fueled appliances helps to make sure off-grid living is not only environmentally friendly but also comfortable and allows homeowners to use many modern conveniences.

Standard refrigerators and freezers consume more energy than is used for space heating, water heating, or lighting. While they have improved over the years, electric refrigerators



and freezers still draw a considerable amount of electricity.

Propane refrigerators do not require electricity to function, which makes them a great choice for homes with off-grid power systems. And, because they cool food using the absorption cooling method, there are no moving parts to make noise or break, making the propane refrigerator quiet and durable to operate.

Unlike a refrigerator, ovens and cooktops are used on demand. The amount of energy required over the long term will vary from household to household. However, off-grid households will find their energy conservation needs much better met by using a propane oven and cooktop as opposed to its electric counterparts. Ovens that use gas pilot lights or battery-powered ignition use no electricity at all.

Gas ranges are the preference for many cooks. The ability to easily control the cooking temperature allows for fine-tuning cooking speeds. And, while a more experienced chef will value this option, the fact that the heat turns completely off is a safety feature for all.

Because of the growing popularity of off-grid living and the unique challenges it presents to homeowners,

more and more innovative energy-efficient solutions are being offered each year. Today, a few gas appliance manufacturers specialize in off-grid appliances and some offer a traditional stove solution. These appliances combine a range top along with an oven, and also include built-in wall ovens and under-counter models.

One of the increasingly common uses of propane in the house is a gas fireplace. These provide the beauty and heat of a fire, but not the smoke, ash, and emissions of a wood-burning fireplace. In fact, propane fireplaces burn so cleanly that the Environmental Protection Agency does not require them to be certified.

Using a propane fireplace has safety advantages. When a wood fire dies down, it may take hours to completely extinguish. Inattention to the fireplace can have tragic results if a hot ember pops out into an unattended room. Propane fireplaces, in contrast, go out with the touch of a button and stay out. No embers are created, so there is no chance one will cause a fire.

Along with fireplaces, an outdoor gas grill can also be directly connected to the propane supply. Outdoor grills provide an important secondary service by reducing the home's cooling load during summer. Outdoor grilling can also spare a home from strong cooking odors.

The most energy-efficient way to dry clothes is on a line in the sun. Rainy and cold winters make hanging laundry out to dry impossible and very humid summers make it difficult at best. Clothes dryers, of course, take care of these issues. Propane clothes dryers are an excellent choice for the off-grid home. According to a Department of Energy agency, over the course of a year a propane dryer uses less than 4 percent of the energy used by an electric dryer. A propane dryer will also dry clothes faster, which helps cut down on the dryer heating the home in summer, and it dries using a moist heat, which cuts down on wrinkles and static.

Other systems also can be run on propane, including heating and cooling. There are several types of propane

furnaces and heating systems available for the home. Heating types can be forced air, convection, or radiant, depending on the needs of the homeowner.

Zone heaters only heat those areas of the home in use. This can be useful if only certain areas of the home are used at any one time. The remaining home is unheated, saving on energy

Air conditioning and cooling is vital to some parts of the country, especially those areas with high humidity. Propane air conditioners can help reduce the heat inside the home without letting the additional moisture from the humidity inside the home.

Forced-air heating systems are one option for off-grid homes, but are seldom the first choice because they consume a relatively large amount of electricity when compared to other heating alternatives.

Radiant floor heating systems can eliminate the need for a furnace and usually use a propane tankless water heater. This allows a single appliance to handle two functions: heating water and heating the home itself, with very little additional energy consumption.

Zone heaters have a variety of names, including space heaters and wall furnaces. They are most commonly used for heating only a specific area, such as a small room, without heating other areas of the home.

There are a variety of types and models on the market, ranging from freestanding to wall mounted, convection to radiant. Which style is best for homeowners will depend on their need. For example, permanently mounted heaters are great for those who wish to use zone heating exclusively to heat their homes.

Propane water heaters are a great choice for off-grid homes. They can be the traditional standing tank water heater or the newer tankless models that produce hot water on demand. Both run on propane, reduce energy costs, and are more effective in delivering hot water on demand.

Hot water is a creature comfort turned necessity. Anyone who has run out of hot water in the middle of a shower will

agree. Even though off-grid homes are focused on energy conservation, hot water is not something homeowners have to do without. Today's propane-fueled systems offer both energy conservation and warm showers.

Propane water heaters come in two main forms: traditional storage tank water heaters and on-demand or tankless water heaters. Storage water heaters work by heating and then maintaining the temperature of a tank full of water. This is the most common type of water heater found in homes today. However, it has to burn fuel simply to keep the stored water at a constant hot temperature, which reduces its efficiency.

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On-demand or tankless water heaters do not have large storage tanks. They have been used in Europe and Japan for some years and are now becoming popular in the United States. With these water is passed over a heated coil when the hot water tap is turned on. The water is almost instantaneously heated to a preset temperature. Tankless water heaters vary in size, from those that provide hot water to an entire home to single hot water outlet, giving the homeowner additional options and opportunities to reduce costs and require very little electricity, only enough to power the electronic controls and sensors.

In much of the country, ventilation can go a long way toward cooling a home. While this is by far the most energy-efficient option, it is simply not possible in areas with extreme heat or high humidity. Off-grid homes in these areas will need to find energy-efficient cooling options.

Absorption cooling is a great option for off-grid homes in high humidity areas where ventilation alone will not keep the home cool. Absorption air conditioning uses heat rather than electricity as the energy source and cools by condensing a refrigerant in one coil to release its heat, then reducing its pressure, and the refrigerant evaporates to absorb heat.

In areas of low humidity but high temperature, an evaporative or swamp cooler is an excellent choice for cooling. These coolers work by passing outdoor air over water-saturated pads, causing the water to evaporate into it. The 15 to 40 degree Fahrenheit-cooler air is then directed into the home and pushes warmer air out through windows.

AN OFF-GRID LIVING LABORATORY

The Herkimer Diamond Mines and KOA Kampground in Herkimer, N.Y., tested the idea of off-grid living when it built the world's first campground with a 100 percent off-grid solar-powered lodge in May of 2010.

The cabin was designed to provide a space where schools and scientists could see a combination of renewable energy living that is able to be run completely independent of outside energy sources.

The off-grid two-bedroom lodge is approximately 600 square feet and sleeps six comfortably. Everything about the project was intended to promote resource conservation and energy independence, from the energy system to the pillows. All the major appliances, including the heating system, refrigerator, and domestic hot water system, runs off propane, as does the generator that helps power them.

The generator installed in the cabin was specifically designed and built for off-grid living applications. It produces about 52 decibels (dB) of sound when running, or about as much as normal office noise. By comparison, most

standby generators produce more than 70 dB of noise, slightly louder than a vacuum cleaner.

Along with a simplified maintenance schedule that allows for 500 hours between servicing, the generator has a relatively low 2,600-rpm speed. Besides being quieter, the slower rpm reduces wear and tear on the generator.

The lodge uses 80 percent recycled products and is furnished with recycled glass dinnerware, reclaimed wood furniture, and even Eco Pure pillows made from recycled plastic bottles. The cabin is outfitted with LED lighting to further reduce electrical demand, has a rain water collection system, bamboo flooring, and a garden where guests can harvest their own vegetables. Like most off-grid homes though, the cabin is not without diversion or modern technologies; it also features two LCD televisions.

During peak demand, the cabin uses about 16 amps of total energy, or about as much as two regular toasters. A 1-kilowatt solar array on top of the lodge collects energy for the cabin, which reduces the need for the generator and saves on fuel expenditures. During the first season, the generator only required one oil change in 600 hours of use.

These results are in line with the expectations set out at the beginning of the project. Additional off-grid cabins are being planned for locations around the country and around the world.

While off-grid living is a relatively complex lifestyle to maintain comfortably, advances in technology now mean that an off-grid home can be just as comfortable as a conventional. Some people who choose an off-grid lifestyle have strong feelings about energy conservation, while others are concerned about increasing utility costs and energy independence.

> Complete this course by taking the online quiz at PropaneTrainingAcademy.com.



If you have propane-related questions, please go to www.buildwithpropane.com for contact information.