



SO YOU WANT TO GO OFF-GRID!

Living well on a small and finite amount of electricity, such as that produced by solar modules is not difficult, but requires some changes to lifestyle and thought processes.

Begin with following these three basic ideas:

1. Shift inappropriate loads to other forms of energy.
2. Reduce waste through efficiency, and increase conservation.
3. Use energy in proportion to the amount available.

The average home here in New Zealand uses 660 kWh of electricity per month, or about 22 kWh per day. This works out to a bill of about \$150 per month, plus line charges. By comparison, a 1 kW PV array in a modern off-grid power system produces about 4.5 kWh per day in summer and a bit less than 3 kWh per day in winter. This is less than 15% to 20% of the amount of electricity used by the typical home. Yet for plenty of off-grid homes in New Zealand, a 1 kW system yields more than adequate power to run all of the lights, appliances, and electronics that make a comfortable life.

A load analysis, a systematic and methodical listing of everything you expect to power in your home, has always been an essential part of off-grid power system design. For each load, the expected power consumption and hours of use are listed. There are no one-size-fits-all solutions. Each off-grid system is uniquely designed to its site, loads, budget, and the personal wishes of its owners.

Shifting Loads

All forms of energy are not created equal. Electricity is a specialised, high-quality form that is not suited to all Applications. It is great for lights, electronics, and motors, plus a few other specialised uses. By matching the best form of energy to its appropriate use, electricity consumption can be greatly reduced while enhancing comfort and convenience.

Five common uses of electricity in conventional on-grid homes won't typically show up in an off-grid home. Each consumes too much energy to be appropriate when the supply is limited by typical PV system costs. All five of these use electricity in ways best served by other forms of energy.

Central Heating:

Electricity may be used to run thermostats, pumps, and boiler controls, but in an off-grid system it is not usually turned into actual heat. The sun's heat is best used directly. Build or retrofit your home to hold in as much heat as possible by insulating the structure's walls, ceilings and/or roof spaces, and under floors. Seal gaps and cracks well. If you're building a new home, incorporate passive solar strategies by using properly sized north glazing and plenty of thermal mass.

Check this link for more information on passive solar building methods: <http://www.level.org.nz/passive-design/>

If you have or are planning in-floor radiant heat, active solar thermal collectors ("solar heat") can be installed to decrease or avoid boiler use. Otherwise (or in addition), plan to use wood or LPG/natural gas heaters to provide central heating.

Water Heating:

Use the sun directly to heat your water with a solar hot water system and use a high-efficiency LPG water heater as backup. On-Demand hot water heaters are an option for some homes. However, in areas where hard water predominates, the cost and hassle of the increased maintenance and repairs due to scaling build-up tend to offset potential energy savings.

Cooking:

Plan to use a gas hob and oven, not an electric one. But beware: Many gas ovens use electronic ignition "glow-bars" that can draw up to 500 watts continuously when the oven is on. An outdoor barbeque used for cooking in the summer months is also ideal.

Clothes Drying:

In most parts of the country, an outdoor clothesline or an indoor drying rack or clothes horse can be used year-round. To back up these strategies, however, your standard clothes dryer should use gas, not electricity, for heat.

Air-Conditioning: Space cooling is usually only needed during summer months, when more solar power is often Available, but conventional whole-house air conditioning is still too large of a load. Good passive design like having adequate overhangs to shade windows, having trees and shrubs shade the house, and using good ventilation Strategies, can often eliminate the need for any mechanical cooling.

More information on this link. <http://www.smarterhomes.org.nz/energy/cooling>



Improve Efficiency

Efficiency is always the first step in reducing consumption. Energy not consumed is energy that does not need to be produced. Every dollar spent on improving efficiency will greatly reduce the overall PV system costs

Lighting:

Compact fluorescent lightbulbs (CFLs) use one-third the energy of incandescent bulbs to generate the same amount of usable light, whereas the newer LED bulbs typically use approximately 5% to 15% of the energy of an equivalent incandescent bulb, but are still significantly more expensive than CFLs.

Consider task lighting rather than area lighting and focus light where it is needed, rather than lighting an entire room. Use multiple lights in different locations, switched separately. Being off-grid doesn't limit you to boring lighting. Plan your lighting to meet building code and functional needs with maximum efficiency. Then add decorative lighting wherever you wish—just control it separately, and use it with discretion and only when you have the energy reserves to afford it.

Refrigeration:

A refrigerator is one of the biggest electrical loads in an efficient home and is often the single largest daily user of electricity in an off-grid home. Older conventional refrigerators consume two to five times as much electricity as the most energy-efficient new models. Mainstream brands have become quite efficient in recent years and a few selected brands such as GRAM and ELCOLD are highly efficient. By using Energy Star guidelines and the daily energy consumption, "this model uses 231kWhr/year", you will be able to select the most energy efficient model to suit your needs.

If you want a full-size freezer, plan to locate it in an unheated outbuilding or portal, shaded from direct sun and preferably placed in a relatively cool space. In a cold climate, a freezer located outdoors will use very little electricity in the winter. Again, choose the most efficient modern model available. Chest freezers use less electricity than upright models because they do not lose as much cool air when the door is opened.

Also consider other ways of keeping food: Home bottled or canned preserves and vegetables can be a satisfying means of storing food without a freezer.

Clothes Washing:

Front-loading washing machines use less water than top loads, but generally they all have a heating element and should be avoided where possible, or only always use the cold wash cycle, or hot wash done when using the backup generator. The newer inverter type top load washing machines are generally low energy users and are connected to both hot and cold taps, and do not have a heating element. Some modern sine wave inverters are not compatible with high-efficiency, electronically controlled washers, so please check before you buy.

Computer:

A laptop uses less energy than a desktop model, as it's designed to run on stored battery power. But desktop models with LCD monitors are getting more efficient all the time. An inkjet printer uses less energy than a laser printer. Plug peripherals into plug strips so you can easily turn them off when they're not in use.

Heating:

Use an efficient wood/pellet burner or LPG alongside your passive solar heating options. The use of an electrical heating devices such as heat pump or fan heater is not possible when you are generating your own power.

Phantom loads:

point out their significance, phantom loads account for about 6% of your entire electricity consumption. Any appliances that include a remote control or have an internal power supply are probably phantom loads: stereos, TVs, DVD players, most computers and printers, and the AC adapters used with many small appliances, plus microwaves, and any appliances with an LCD screen which is lit up.

The only way to eliminate a phantom load is to physically or electrically unplug the device from its outlet. These loads can be plugged into a power strip, which is turned off when not in use. When building or renovating, add switches to conveniently control outlets intended for known phantom loads, such as audio/video equipment. Use a battery powered clock rather than a plug in model.



Off-Grid Design & Discretionary Loads

Off-grid home power systems are usually based on winter needs, since winter loads are typically greatest. Shorter, colder days mean more indoor activities and increased use of lights, and most homes will have added heating loads. Shorter days also mean less solar energy collected. A well-designed home power system in a sunny climate will typically meet 80% to 90% of the home's winter based electrical load, usually with an engine generator making up the rest. Just adding 10% to 20% more solar power capacity won't eliminate the need for occasional backup charging. Predictions of monthly solar irradiance are based on historical averages, and weather patterns never play by the rules of system design. Sometimes, weeks of bright winter sun and full batteries will prevail. Other times, occasional long cloudy periods will mean running a generator to keep batteries charged. Plus, occasional equalising (a controlled overcharge) of a battery bank is needed. A power system will need a substantially oversized array and battery bank to eliminate all generator charging, and most budgets don't allow this. Typically, the goal is to balance minimal generator charging, which will usually occur in winter, with a PV system that is sufficient to meet the majority of winter energy needs.

A solar power system that is sufficient during most of the winter will provide an excess of charging power the rest of the year, when days are longer and loads are typically fewer. Herein lies a wonderful paradox of off-grid living: After going to the effort to live within the bounds of the system's reduced output in winter, you may have more energy available than you can use in other seasons.

This is part of the magic of off-grid living: The role of the solar array is to provide energy to fill the batteries. Once the batteries are full, the charge controller turns off the power from the array, as there's nowhere else for it to go. At this time, any energy not used is energy wasted. But as the investment in the power system has been made already and the sun's energy is free, it might as well be used.

A **discretionary load** is any device that is consuming power that can be turned off or left unused when cloudy weather hits and/or the batteries are depleted. This is a normal and valuable aspect of the initial system design process. By identifying certain household loads as discretionary, the size and cost of the power system can be substantially reduced. Common household loads identified as discretionary include toaster ovens, coffee makers, clothes dryers, and cordless phones. A microwave oven is a discretionary load, although most modern off-grid homes have one. It uses much less energy than a toaster oven, mainly because it runs for only a few minutes at a time. But because most microwaves have phantom-load clock-timers, they should be installed on a power strip. When batteries have a low state of charge, use of these appliances should be avoided.

Phantom loads like home audio/video equipment, chargers for cordless tools, and the like may also be considered discretionary: Plugged into a power strip, they can be left on nine months of the year and turned off when not in use during the shorter days of winter. A modern large-screen TV and home theatre system is discretionary if there's a smaller TV for use during winter. "Discretionary" also means that the appliance may be used during cloudy periods, but may mean using the generator a bit to supplement solar charging.

For most people, toast is an important part of breakfast, a toaster is a basic tool of daily life, and toast is difficult to make any other way. And while a toaster draws a fair amount of power, its run time is just a few minutes.

During most of the year, you know that you can make your toast and do all of the other energy-using activities of daily life with the confidence that your batteries will be full by day's end, or, if that day is cloudy, within a day or two. In winter though, look out the window in the morning, then check your system monitor to see how full the batteries are. On a typical winter morning when the batteries are at, say, 85% full, and you expect them to be at 100% by day's end, enjoy your toast. If it looks bright and sunny outside, and you know the batteries will be fully charged by 3 p.m., you may get out the electric waffle iron, knowing that the half-hour use of the electric iron will be easily handled by the day's solar input. But if it has been stormy for the last three days, and your system monitor shows the batteries to be about 60%, and it's still cloudy, use your gas hob to make pancakes rather than toast.

Off-grid living means not that you go without the energy that you need, but that you live more in tune with the natural rhythms around you. Appreciating that your electricity comes from the sun, let your habits be defined by the daily and seasonal cycles of the sun's patterns where you live. By paying attention to such natural cycles, you will greatly reduce your dependence on a fossil-fuel backup generator.