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OFF OR ON GRID?

GETTING REAL

by Ian Woofenden

Dreaming of cutting the cord and getting rid of the big bad utility? Perhaps you should think again. Renewable electricity has lots of benefits, but stand-alone (off-grid) systems are more expensive and complex, and require more maintenance than batteryless grid-tied systems. And there are other big advantages to installing renewable energy systems *on* the grid. Before you make your decision about whether to be off grid or not, let's take a closer look at the pros and cons.

System Types

Three basic categories of renewable electricity systems are available today (though the future may hold more!).

Stand-alone off-grid systems are completely independent of the utility grid. With the exception of direct-use systems like water pumping or PV-powered ventilation, stand-alone RE systems must have batteries to provide energy storage during times of low input or high usage.

Battery-based grid-tie systems are quite similar to stand-alone systems. They also use batteries, but they are connected to the utility grid, so they can send out to the grid any surplus electricity generated by the RE system, and use utility electricity when needed.

Batteryless grid-tie systems are the simplest of all systems, having only the energy generation technology (be it PV modules, or a wind or microhydro turbine) and an inverter connected to the utility grid. They do not have batteries, which points to their primary drawback—they have no backup capability. When the grid goes down, these systems also shut down.

Off-Grid Advantages

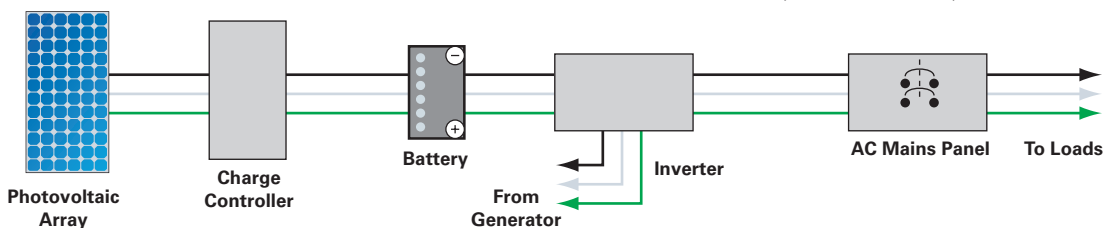
Independence is chief among the reasons for wanting an off-grid system where the grid is available. Off-grid systems are not subject to the terms or policies of the local utility, nor are system owners subjected to rate increases, blackouts, or brownouts.

If you're shopping for rural property, you'll probably find that off-grid parcels are less expensive. Most people aren't ready to take on being their own utility, and the land is priced according to this value system. Being off-grid can also be cheaper than getting a utility line extended to a property. But bear in mind that with off-grid renewable electricity systems, there are up-front *and* ongoing costs.

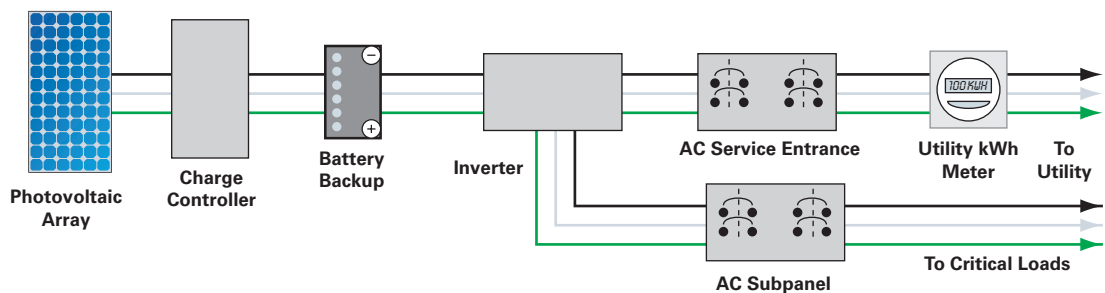
Off-grid systems may have a slight edge over grid-tied systems when it comes to expandability. While both are modular, it's often easier to grow an off-grid system as you can afford it. In fact, many off-gridders with limited incomes find this to be the norm—gradual weaning from fossil-fueled generators by adding more renewable capacity. With lower array voltages (12 to 72 VDC nominal), one to four modules can be added at a time. Batteryless grid-tie systems run in the 150 to 600 VDC range, and specific inverters have voltage windows and efficiency curves, so that adding to them requires more modules and, possibly, another inverter.

SYSTEM TYPES

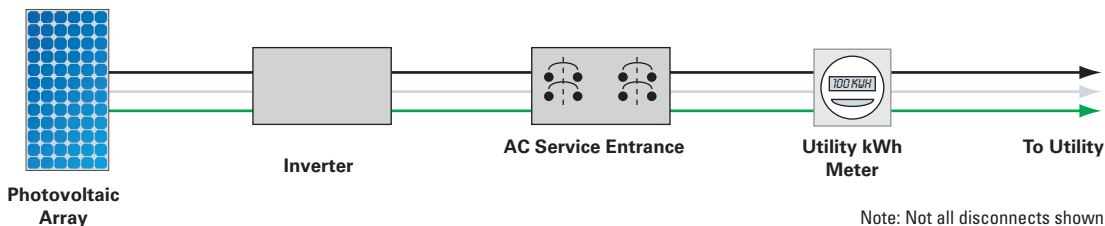
STAND-ALONE (OFF-GRID) SYSTEM



BATTERY-BASED GRID-TIE SYSTEM



BATTERYLESS GRID-TIE SYSTEM



Note: Not all disconnects shown



An off-grid system will require batteries and a charge controller, as well as an inverter and disconnects common to all system configurations.

Unless you can afford an oversized system, off-grid systems tend to force you to use electricity efficiently. This is a big advantage if you also hold environmental values. Some of the most energy-efficient homes in the country belong to off-grid folks. When you have to make all your energy with only the available resources at your site, you *think* about how to use that energy wisely.

There are many less tangible advantages of being off grid as well, including the satisfaction and peace of mind that goes with using electricity responsibly. And maybe your neighbors will begin to think you are way ahead of your time.

Off-Grid Disadvantages

When you make the decision to go off grid, you take on the duties of the cursed utility you were trying to avoid. My experience is that you tend to curse them less and appreciate them more as you tackle these responsibilities.

First and foremost, making all of your own electricity is costly. If you are already on the grid, it's unlikely that

installing an off-grid RE system will provide you with cheaper electricity, unless your area has generous incentives, very high utility rates, or both. (Note that most financial incentive programs apply to on-grid systems and do not apply to batteries.) Of course, if you're a long-term thinker, this changes the picture. But most people conclude that "going off grid" to save money is not a winning concept. With existing off-grid property, you need to weigh the cost of line extension against installing an off-grid RE system. In some areas, utility line extension can exceed \$20 per running foot.

System maintenance and troubleshooting are serious, ongoing responsibilities with off-grid systems. When you pay your utility bill, you're paying for those hard workers in business suits and coveralls to take care of things. If *you* are the utility, you have to do the work all by yourself, *plus* buy the coveralls.

Off-grid systems use batteries to store electricity and provide it for your home, but batteries don't last forever. In fact, they will need replacement every five to fifteen years (typically less than ten, unless you have deep pockets for high-quality, industrial-type batteries). A minimal bank of batteries will cost at least \$1,000, and long-lasting industrial batteries for the same application might cost three to four times that much. And it's not just the cost in dollars that's a disadvantage. There's maintenance and replacement time, aching backs from lifting that heavy metal, and perhaps labor cost—and then there's the environmental cost of making, moving, recycling, and replacing all that lead.

Batteries have another, less tangible cost, and that's energy waste. At their best, batteries are 90% efficient. That means if you put in 10 kilowatt-hours (kWh), you will get out less than 9 kWh. As they age, their efficiency drops further, and they are also affected by temperature. All this adds up to more energy waste the larger, older, hotter, or colder your battery bank is.

In comparison to grid-tied systems, stand-alone systems have another serious drawback—wasted surplus energy. When a grid-tied renewable electricity system makes more than the homeowners use, the surplus is fed to the utility,

Large battery banks and engine-generators are commonplace components in off-grid systems, and significantly increase the initial and long-term operating costs.



System Cost Comparisons*

Item	1 kW System		3 kW System		5 kW System	
	Batteryless: 2 kW Inverter	Stand-Alone**: 2.5 kW Inverter & 15 kWh Battery	Batteryless: 3 kW Inverter	Stand-Alone**: 4 kW Inverter & 15 kWh Battery	Batteryless: 5 kW Inverter	Stand-Alone**: 2, 2.5 kW Inverters & 40 kWh Battery
PV array & mount	\$5,800	\$5,800	\$17,700	\$17,700	\$28,500	\$28,500
Charge controller	—	700	—	700	—	1,400
Batteries	—	3,100	—	4,800	—	7,000
Inverter	1,900	2,300	2,600	3,200	4,050	4,650
Disconnects, wiring, etc.	750	1,700	1,800	3,200	2,600	3,500
Labor	1,200	2,100	3,600	5,900	5,600	8,900
Low End of Cost Range (-10%)	\$8,685	\$14,130	\$23,130	\$31,950	\$36,675	\$48,555
Total Cost	\$9,650	\$15,700	\$25,700	\$35,500	\$40,750	\$53,950
High End of Cost Range (+10%)	\$10,615	\$17,270	\$28,270	\$39,050	\$44,825	\$59,345

*Real-world figures will vary depending on homeowner and designer preferences.
**With engine-generator backup.

Howard and Carol Pellett paid the extra cost of batteries to enjoy the security provided by their grid-tied battery backup system.

creating an energy credit and allowing the system to always run at full capacity. Nothing is wasted, and the grid is figuratively (not literally) 100% efficient—you get credited for all that you throw their way. When you're off grid, your surplus must be used or it will be wasted. With most off-grid PV systems, the array simply gets turned off by the controller when the batteries are full, so the energy is never generated. With most wind and hydro systems, the excess energy is shunted to a dump load, typically an air- or water-heating element. Savvy off-gridders are aware of their system operation, and change their energy-use habits when there's a surplus—like choosing to do laundry in the middle of the day. But it's not automatic, and it takes some social adjustments to switch from energy sipper to energy gorger depending on the weather.

Most off-grid systems need a backup engine-generator, and this is another big disadvantage of these systems. Generator electricity is expensive when you calculate the cost of purchasing, fueling, and maintaining these dirty, noisy machines. And if you buy a cheap model, you might end up with what veteran off-griddier and RE installer Roy Butler calls an "800-hour throwaway" and have to replace it sooner than you wished.

If living off grid sounds like a bit more trouble than you expected, good! I'd like you to be successful with your renewable energy plans, and being realistic is a good first step. My family moved off grid in 1981, and my wife and I have raised a raft of kids and run several businesses from home, so I know that it's not always a picnic. We've been through multiple generators, and have had hard times when we had to wait for the weather to change before doing the laundry. The social and familial implications of living with a variable energy source shouldn't be underestimated!

Living off-grid can be satisfying, but it's also a big responsibility. It's necessary to be willing to flex your electrical



off grid or on?

activities with the changes in the weather, or be willing to start up a fossil-fueled generator whenever nature is not cooperating with your energy plans. If you're a city dweller who gets impatient when the traffic light takes a while to change, imagine how you'll handle waiting for the sun to come out or for that mechanic to fix your generator.

On-Grid Advantages

Using renewable energy on the grid avoids most, if not all, of the disadvantages of being off grid. The utility is like a big, 100% efficient battery that can absorb all your surplus energy. In addition, you can lean on it as hard as you want to for as much additional electricity as you might need. If you can't afford a renewable-electric system large enough to supply all your needs, you can install whatever portion you can afford. If you're off grid, you have to make it all, one way or another, and if you're strapped for cash when you're putting in your system, you'll end up making a lot of it with fossil fuels. When the grid uses fossil fuels, at least it uses them more efficiently, and with less noise and pollution than a home generator.

With grid-tied renewable energy systems, there is no absolute need to conserve electricity or change your lifestyle. You can choose to live the same way you lived before you installed an RE system. Your system will offset some or all of your usage, and your daily life can continue unchanged.

If you decide on a grid-tied system with battery backup, you can have the best (and some of the worst) of both worlds: You

Grid-tied systems with battery backup allow you to sell surplus renewable electricity to the grid and provide electricity for critical loads during utility outages.



The simplicity of batteryless grid-tied balance-of-system equipment is hard to beat.

can have the independence and backup of a stand-alone system, still be able to use at least some energy during utility outages, and have the ability to sell your excess energy to the grid.

For all these system types, investing in a PV system also means locking in the long-term pricing of your electricity. With a photovoltaic system, you are buying 40 to 50 years of electricity at a fixed price, while maintaining the benefits of being on grid.

On-Grid Disadvantages

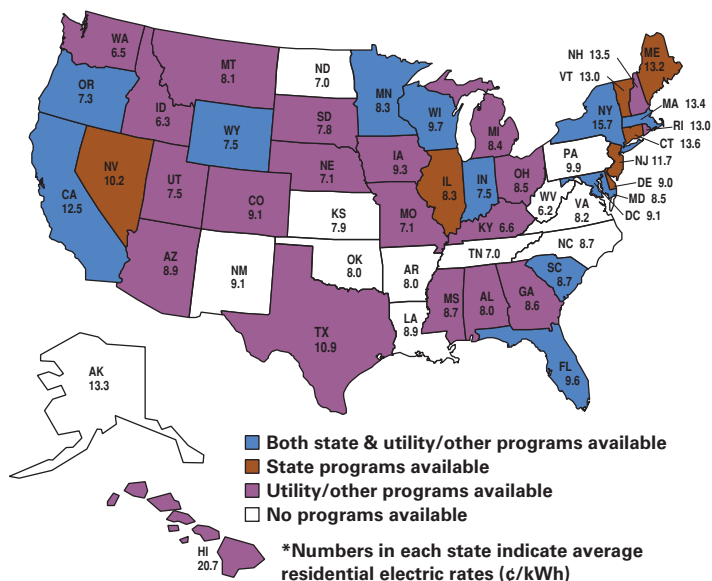
One major disadvantage of having a grid-tied system is that you have less incentive to conserve. That inviting wall receptacle will take whatever you plug into it, and no "depleted battery" warning will sound when you use a lot of electricity. If you can manage to bring an off-grid mind-set to your on-grid home, you'll make the most of your RE investment.

With batteryless systems, you'll have no backup. In most cases, this is not a very serious drawback. The utility grid is quite reliable in most urban places in the United States, with outages occurring only a few times a year for a few minutes to a few hours. But if you have frequent or long outages or critical loads, a batteryless system will frustrate you and maybe even cost you an occasional freezer full of food.

However, battery-based grid-tie systems typically only provide modest backup. To power *all* of your loads during an extended outage when there's no sun would require a very large battery bank, which would be expensive and make for a less efficient renewable energy system.

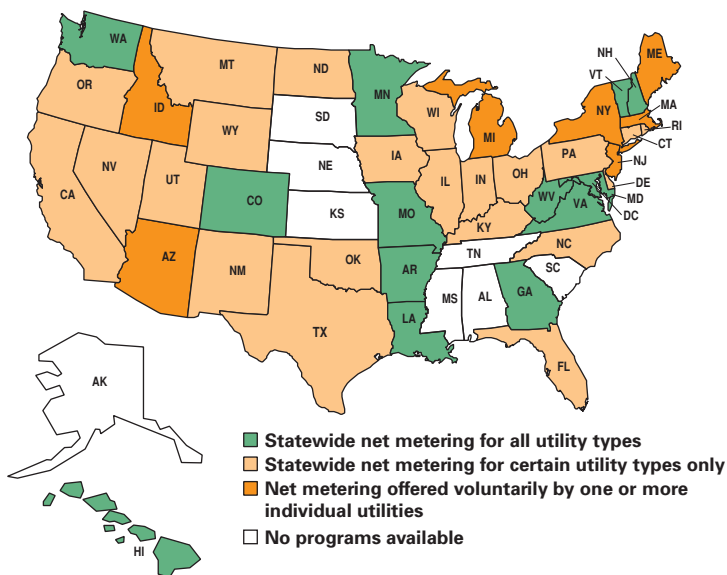
For all grid-tied systems, you also have interconnection red tape. This can range from simple to onerous, depending on the authorities and utility you have to deal with. In places

RE Incentive Programs



Source: Energy Information Administration, 2005. Year-to-Date Average Residential Retail Price of Electricity, revised June 2007

Net Metering Status



Source: DSIRE USA, July 2008

where RE systems are becoming common, there may be a greased path through your inspection agencies and utility, once you know the right people to deal with and the right forms and procedures. If you're pioneering a new path, you might run into a lot of roadblocks, such as public servants or utility personnel who are ignorant of these systems, or burdensome gear or paperwork requirements.

Weighing the Costs

So how do you make the choice between being on grid and off grid? This is a personal decision, based on finances and personal values. First, weigh the costs. A battery-based system generally costs about 30% to 40% more than a batteryless grid-tie system, and maybe as much as 50% more, depending on the battery bank size and other components. The other major consideration is the cost of utility-line extension. This can

The author and his family have lived off grid—courtesy of solar-electric, wind-electric, and solar thermal systems, plus a well-developed energy conscience—for more than two decades.



range from zero for properties close to existing utility lines to hundreds of thousands of dollars for properties that sit a long way from the line. Get quotes from solar contractors and from your utility, and then crunch the numbers.

Values are a bit harder to evaluate objectively. I know people who were faced with \$25,000 line extension costs to get utility electricity to their property. They opted to stay off grid and, in the end, invested more than \$75,000 in their wind- and solar-electric systems. For this, they get satisfaction, independence, and no utility bills. Obviously, the up-front cost was not their highest consideration—they have other values. But they invested a lot of money and time initially, and will have the continued investments in time and money to keep their systems running. Others may decide to spend anywhere from a few thousand to tens of thousands of dollars for the reliability, efficiency, and convenience of having the grid, even if they invest in an RE system that will offset all of their usage and bills.

From the perspective of more than 25 years of off-grid living, my advice is not to unplug from the grid if it's there. Of course, there are exceptions to every bit of advice, and if you live where net metering (selling back to the grid for credit) is not available or monthly base charges are high, you have a different situation. But in general, "greening up" the grid with your renewable electricity will benefit you, the environment, and your community better than cutting the cord.

Access

Ian Woofenden (ian.woofenden@homepower.com) has lived off grid with his family in Washington's San Juan Islands for more than 25 years.

