

## Questions and Answers about low-voltage off-grid living

Moving to an off-grid house or taking an existing house off the grid is a major lifestyle change, especially when using a low voltage system. Here are some common questions and issues.

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### **My husband is not keen on going off the grid, though he sees how much better I do, so he'll probably accept it.**

It is important that the needs of all family members are met, otherwise it will cause tension. Many families have broken up over the stresses from illness and lifestyle changes needed by someone who is environmentally ill.

Going off-grid is a major change. Try to find solutions so the rest of the family can still enjoy life. A common way to do that is to have an outbuilding that is connected to the grid, or has a solar system, so a TV, computer, video game, etc. can be used there. If powered by a solar system, it should be on its own separate system to avoid dirty electricity in the house. If it has an inverter, it may need to be at least a hundred yards (100 meters) from the house.

Another way is to have a room at one end of the house with a 12 volt TV, computer, etc., preferably on its own separate solar system.

### **Can I cook with solar?**

A hot plate uses 750 to 1500 watts, which is too much for a low-voltage system to power. There are low-wattage cooking devices available for 12 volt electricity, such as 100 watt crockpots. These can work well, but are slow to cook with and won't work for larger portions of food. It takes about an hour to heat up a can of soup.

Many 12 volt cooking appliances are made for camping use and are of poor quality with flimsy plastic parts, but there are some that are of better quality.

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Some people with a large solar system and an inverter do cook with electricity, using regular hot plates. This only works on sunny days, unless a generator is used. An inverter is not a good idea for a low-EMF house.

Solar ovens can work in sunny climates, but they have a lot of limitations and cannot be the only source for cooking.

Propane gas is the standard choice for off-grid houses. Sensitive people can cook on a porch, using a camping stove and a bar-be-cue.

### **How much extra work is there when living with such a system?**

If the system is designed well, there is very little extra work. On a normal day, the only task is to glance at the voltmeter (fuel gauge) now and then.

On washing day, you'll need to hang the clothes on a clothesline and probably also start a generator to run the washing machine. If you live in a cold and dark climate, it may not be practical to use a clothesline in the winter, so you'll need to wash elsewhere, use a clothes dryer powered by a generator (best avoided), or hang clothes indoors.

Depending on your system, you may need to adjust the chargepoint and equalize the batteries. This task may take about an hour every three or four weeks.

If you heat with firewood, there is a lot of work with that, but if you set up a propane boiler, there is zero work, if the propane is delivered directly.

If you use a camping stove and bar-be-cue to cook, you'll need to get a portable propane tank filled every three weeks or so – or keep extra tanks and fill more tanks less frequently.

If you move to the country, there may not be trash service, so you'll need to store your trash and haul it yourself every month or two.

If you live in a northern climate, or your system is too small, you may need to run a generator to charge the batteries now and then. I live in sunny Arizona and almost never need to do this, but some people living in northern climates have to do it a few times a week during the winter.

The main impact on people's lives with such a system is learning to live within the limits of the system – to be a stickler for turning off lights that are not needed, and

only wash clothes on days when the weather is nice enough to dry the clothes on a line.

### **What does it cost to buy such a system?**

The cost of purchasing the parts for the solar system can vary between \$500 and perhaps \$20,000 – all depending on your needs. Most single person households will probably need something within \$4,000.

Then there is the cost of the generator and a new refrigerator. Each of these will cost one or two thousand dollars.

Then there are any modifications to the house such as the heating system, hot water system, well, rewiring, etc. The cost will depend on the situation, but can be substantial. And then there is the cost of hiring someone to do the work, if you are not handy yourself.

The cost of fully converting an existing home can be very substantial, so it may be more feasible to only take a part of the home off the grid, and maybe let a garage by on the grid.

If building a new home, the extra cost can be minor. In some cases, it will actually be cheaper than a conventional house, as some utilities charge for installing electrical service to a new house. Land beyond the electrical grid is also much cheaper.

### **Will I save money living off the grid?**

There will be no more bills from the electrical utility, but there will be new costs instead. You'll need to pay for propane gas, occasional maintenance of the generator (oil change, etc.) and the battery bank will need to be replaced about every four years.

The battery bank is the main cost. I use a set of six low-cost golf cart batteries, which last me about four years. Last time that set me back about \$600.

Some people use smaller batteries, some much larger and costlier batteries.

In the end, the annual cost is similar for grid and off-grid houses. However, a poorly managed off-grid house may use up more fuel and have the batteries and generator wear out much sooner.

**A solar installer tells me that thousands of people use inverters with no problem. He also showed me a picture of the sinewave from an inverter and it is totally smooth.**

Millions of people eat wheat products every day with no problems. Some people have wheat allergy and get symptoms from eating wheat. A few people have celiac disease and get very sick if they eat wheat. Dirty electricity and EMF is the same way: most people do fine, some are affected a little, and a few are devastated.

The output from a good sinewave inverter will look nice and smooth on an oscilloscope, but the picture is deceiving. Try to change the resolution on the oscilloscope to around  $1\mu\text{s}/\text{div}$  and  $10\text{ mV}/\text{div}$  or so. If you put in a high-pass filter that dampens the 60 Hz signal, the dirty electricity will be very obvious.

Another way to show the dirty electricity is to use a Stetzer meter (which costs about \$100). This instrument will probably measure off the scale.

The square wave inverters are often worse than sine wave inverters. Both types generate broadband radio-frequency radiation.

**My electrician suggested I use a 12 volt battery charger instead of solar panels.**

This is a common suggestion, apparently. We were contacted by another electrician who had already done this, and his customer was not able to live in the house. He had installed some golf cart batteries in the garage, together with the battery charger. The problem was that the charger put dirty electricity on both the 120 volt system and the 12 volt system. He had tried shielding and capacitors, neither of which worked.

Another electrician has suggested putting the battery charger in an outbuilding, away from the house. This won't work either, as you still have dirty 12 volt electricity coming into the house.

The wires from the charger to the battery can realistically only be about 100 ft (30 meters) long with a 12 volt system. The battery itself must be closer to the house.

Filtering dirty electricity is more difficult with 12 volt than 120 volt, as there is a higher amperage. It is not realistic to filter the dirty 12 volt from the charger.

### **How do I find someone to install a low voltage solar system?**

You can look for a solar installer in your area, though many of them are only familiar with solar systems using inverters and higher voltages. It is unlikely that they will understand the EMF issues, and thus may try to sell you on the type of system they are familiar with and not a low-EMF system.

Try to locate someone with a solar powered house in your area, especially one that has been there a long time. Old-timers are often proud of their system and happy to help out a newbie. Maybe such a person can recommend someone to you, and even give you practical advice.

You may be able to find an open-minded electrician or handyman who is willing to read up on 1990-era solar systems and low-EMF practices, such as on [www.eiwellspring.org/offgrid.html](http://www.eiwellspring.org/offgrid.html).

Be aware that just because someone speaks with great authority doesn't mean he is competent. Ask what personal experience they have. Contact the reference, if possible.

### **Can I hire someone to do the maintenance?**

Solar systems generally require very little maintenance, if they are sized and built properly. You may just need someone to come every three months to check the electrolytes, make sure the battery tops are clean and do an equalization.

If your batteries are not kept at the same temperature year round, the set points on the charge controller may need to be adjusted once every three weeks during spring and fall. Some controllers do this automatically.

You may find a handyman who can do this for you, or you could learn to do it yourself.

### **Do people always do well with a 12 volt DC system?**

I have been visited by many very sensitive people, and none of them have been bothered by my 12 volt system.

I have talked on the phone with some people who believe they do not tolerate 12 volt DC, but I think their problems were caused by dirty electricity, which is a common issue. Dirty electricity is caused when electrical motors, various electronics, fancy charge controllers, inverters and converters are connected to the DC system. Dirty electricity travels on all the wires and may be felt in a room far from the source.

It is likely that those people would not have any problems with a “clean” DC system.

If you want to try yourself, just hold a lit flashlight in your hand. The flashlight must have an incandescent bulb (not LED) and you must be standing in a brightly lit room. This eliminates the possibility that any discomfort is caused by factors that are not related to DC electricity (such as light quality, light contrast and built-in electronics in the flashlight).

### **Do I need to use twisted wires if I use DC electricity?**

Twisted wires dampen the magnetic field around the wires. This magnetic field fluctuates as the current fluctuates in the wire, which can happen both in AC and DC systems. In low voltage DC systems, there are many possible sources, such as:

- DC pumps
- DC refrigerator
- DC swamp cooler
- fan
- battery charger
- computer
- radio
- TV
- internet modem
- electronically controlled LED light
- fluorescent light

The only users of electricity on a typical low voltage DC system that does not generate these fluctuations are

- incandescent light

- halogen light
- LED light (unless electronically controlled)

If you only use such lights, there is no need for twisted wires. For permanently installed wiring, it may be a good idea to use twisted wires, as you may be able to use some electronics in the house at a later date. People often feel better after awhile and then want to use the system for more things.

A low-voltage DC system reduces or even eliminates the fluctuating *electrical field* of an AC system. Twisted wires do not help on the electrical field, only the *magnetic* field.

### **My solar installer says my system will be too big for 12 volts.**

There are limits to how large a 12 volt system can be. The normal solution is then to go with a 24 volt system. This can work well, but there are fewer light bulbs and gadgets available for 24 volts. There are 24-to-12 volt converters available, but they send out a lot of dirty electricity.

Here are some alternatives:

- have two 12 volt systems
- have one 12 volt and one 24 volt system
- use a hybrid 12/24 volt system

You can have two separate systems, perhaps one in each end of the house.

You can have a 24 volt system for the heavy loads (water pump, flood lights, etc.) and a 12 volt system for the electrical outlets, small lights, etc.

A hybrid 12/24 system has a center tap in the battery bank, so there are two 12 volt and one 24 volt feeds. The loads on the two 12 volt sides should be balanced, so the batteries are used equally.

### **We can't use 12 or 24 volt, as we have a deep well that requires a more powerful pump.**

Well pumps often have to be run at a higher voltage. This can be done with a separate system for the well pump. Since well pumps create a lot of dirty electricity, it may be a good idea to run it on a separate electrical system anyway. If possible, the well should not be next to the house.

Another option is to install a water tank and then run the pump from solar panels, a wind generator or an engine generator, with no battery.

### **Do I have to use a propane refrigerator?**

Some models of propane refrigerators are truly zero EMF. Some do have electronics in them, which can be a problem. The fumes from a propane refrigerator are a concern, unless they are vented directly to the outside or placed in an outbuilding.

There are 12 volt/24 volt DC refrigerators, but their electronic controls and the DC motor is a problem, unless the fridge is placed in an outbuilding and preferably on its own solar system.

Thermoelectric coolers have a DC fan, which can be problematic. These coolers are also not as energy-efficient or cold as a refrigerator.

Some folks use ice chests for cold storage.

### **I need to use a swamp cooler, but I am concerned about the DC motor**

All electrical motors generate EMF and dirty electricity, but DC motors are worse. There are 12 volt and 24 volt DC swamp coolers available, which have a powerful DC motor to power the fan. Consider a combination of these measures:

- use a brushless DC motor
- put the swamp cooler where you do not need to be near it
- put the swamp cooler outside the house, with an insulated air duct into the house
- power the cooler with its own separate solar system
- put some large capacitors directly across the plus/minus contacts of the fan

The brushed DC motors emit a lot more EMF and dirty electricity than the brushless kinds. Try to get a swamp cooler with a brushless motor.

If you only need to use the cooler in the daytime, you can run it directly from a separate solar panel. Check the wattage rating of the swamp cooler and make the solar panel at least three times as large. Even better is to ask the manufacturer for recommendations.



You can reduce the dirty electricity on the wires by soldering one or more capacitors directly on the fan motor, or as close to it as possible. The capacitors must be at least 1 microfarad each. The voltage rating should be well above your system voltage.

Be aware that swamp coolers only work with air of low humidity. Also be aware that swamp coolers make the air in the house humid, which can be a problem for sensitive people.

Swamp coolers are wet inside, so mold is an issue. To prevent mold growth, the manufacturers may spray the insides with biocides. The evaporative pad is usually treated with a fungicide. If this is a concern, you may be able to special order a non-treated swamp cooler, and dry it out regularly to prevent mold growth.

### **I would like to add a cabin or little apartment to rent out. How do I supply electricity?**

There are two issues here: sharing a solar system between two households, and bringing power to a second building.

Since the amount of electricity is limited, it is best each household has its own system. I know two sisters who live in adjacent houses and share a large solar system. There is some grumbling about one sister using more than the other. In Europe it used to be common for apartments to share the cost of heating and electricity. When individual meters for heat and electricity were installed on such buildings, the overall consumption generally decreased dramatically.

With renters, you'll have people who are not used to conserving electricity, who do not have the needed habits. It is asking for trouble to have a shared system in that situation.

If separate systems are not practical, consider installing separate breaker boxes for each apartment. This can avoid some conflicts, and make it easier to split the two systems later on. Make sure each apartment has a voltmeter (fuel gauge) on the wall.

As for sharing electricity between two buildings, that can only be done if the buildings are very close together, when using a low-voltage system. Max distance should probably not exceed 50 ft (15 m) between buildings, and from the battery bank to either of the buildings.

Having separate systems is generally the way to go. That is also easier to scale up later, if needed.

**I need a system so I don't need to worry about conserving electricity.**

When you live off the grid with a low-voltage system, it is unavoidable that you have to conserve electricity, especially on cloudy winter days.

Off-grid houses sometimes have a standby generator, which turns on when the battery gets low, but this will probably not work for a low-EMF house. The battery charger sends out EMF and dumps dirty electricity on the household wires.

With low voltages, there is a limit to how big a solar system can be installed, and how much it can carry.

If you use 24 volts, large battery types (not golf cart batteries) and solar panels to match, you can have a lot of power available, but you'll still need to figure out how much electricity you need before you build it. There is no one-size-fits-all system design. The system design depends on family size, lifestyle, climate and other factors.

Realistically, you'll still need to conserve power, at least in the winter.

**I can't tolerate LED lights, so what do I do for porch lights?**

Many environmentally sensitive people do not tolerate LED lights, even at a distance. It appears to be the quality of the light that is the problem.

LED lights are so efficient that they should be used where they are left on for many hours, whether by intent or by accident. This means porch lights.

If you cannot use LEDs, consider whether you really do need outdoor lighting at all. People in off-grid neighborhoods tend not to use any. Some people enjoy being able to see the stars at night, though people moving away from a city may have to get used to the idea.

There is research which shows that burglars are not deterred by outdoor lighting, so the lights do not add any security — perhaps just the sense of it.

Solar powered lights with motion detectors are available. They can be mounted on the side of a building or on a post.

The driveway can be lined with reflectors, so vehicles can find their way without extra lighting. You may also do fine with the small solar path lights.

**I'm just going to use LED lights, so I don't need any of the thicker 12 volt wires, right?**

Yes, 12 gauge wires should work fine for LED lights. The thinner 14 gauge wires should work well too, though using it is against the U.S. National Electric Code (NEC 2011 section 720.4).

If you are installing wiring in walls or ceilings, where they'll be difficult to later upgrade, you may want to use thicker wires anyway. You may not like LED lights and want to go with halogen or incandescent bulbs, or you may use the wiring for more things later. Or the next owner of the house may.

**Do I need any special equipment that my solar installer needs to know about?**

The main thing is to make sure the charge controller does not put out a lot of dirty electricity on the system. This means avoiding chargers using voltage conversion, Maximum Power Point Tracking (MPPT) and Pulse Width Modulation (PWM). The very sensitive should also avoid charge controllers with any digital electronics, displays, etc.

An inverter cannot be used anywhere on the same system, even in another building. DC-DC converters won't work either.

Many solar installers are not used to inverter-less systems, as they are uncommon today. Make sure he can dimension the low voltage wires correctly.

**I can't find a suitable charge controller.**

Take a look at the ASC series from Specialty Concepts. They can do temperature compensation and you can use multiple controllers to build a larger solar system (for a 520 watt solar system, use three 16 amp controllers, each with 140 watts of PV).

The TriStar controller from Morningstar has the ability to turn off the PWM pulses. This controller has temperature compensation, automatic equalization and

other nice features, but it has a built-in microprocessor, so it should be used with caution, and not mounted inside a dwelling. We have not actually tested it.

Another option is the Flexcharge controller. You can also build your own controller, using a voltage-controlled switch (see elsewhere on this website).

**Do I need to put a voltmeter on the wall? It's not very decorative.**

A voltmeter is your zero-EMF fuel gauge. It needs to be in a place where you'll notice it several times a day. This is especially important for the first years you live with the system, so you learn how it handles. Just imagine driving a car with the dashboard placed where you can't see it.

It is common to put it on a wall in the kitchen, but the hallway, living room or even the bathroom could work. Just make sure it is in a place you visit many times a day, and there is an obstructed view to it.

**For more information**

For more information, see the articles on [www.eiwellspring.org/offgrid.html](http://www.eiwellspring.org/offgrid.html).

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