Using solar power when living in a van or pickup truck

We describe how to use low-EMF solar for long-term camping in a van, pickup truck or other vehicle. We cover the options from the simplest low-cost system to the biggest that will fit on a vehicle. And also what you can realistically expect. Throughout, we consider the special needs of people with chemical sensitivities (MCS) and electrical sensitivities who sometimes are forced to live in vans and other vehicles.

Keywords: *12 volt solar, solar power, solar electricity, van, cargo van, truck, MCS, chemical sensitivity, electrical sensitivity, environmental illness*

What kind of vehicle do you have?

In the following we assume you have a regular van (passenger or cargo van), or a pickup truck with a cab over the bed.

If you have a station wagon, travel trailer or a camper van some of this information still applies.

If you have an all-electric or hybrid vehicle this article is not for you.

What to expect

A little electricity can go a long way to make living in a van or truck more comfortable. The most common uses are to power or charge portable electronics (phone, book reader, laptop computer) and a light or two. Some people want to do a little more, such as powering a refrigerator, fan or other small devices.

There are strict physical limits on how much electricity is available. There is not room for a lot of solar panels and batteries, so some things are simply not realistic:

- electric hot plate
- air conditioning
- electric space heater

Any one of these things takes so much electricity it would require a solar system at least ten times as large as would fit a van or truck. And even then it would be a stretch.

If you try to do too much with your system, you are going to have problems with power outages and batteries that don't live very long. These systems are not like credit cards and government debt where you can seemingly live beyond your limits.

Start small

You can start with a small system and then grow it over time as you get more experience.

There are several options, which we'll cover here. We start with the simplest and gradually cover more sophisticated systems. Along the way we teach you what you need to know, so it may not be a good idea to skip around.

Using the vehicle's existing electrical system

Your vehicle has a built-in 12 volt DC electrical system with a battery. The battery is mainly used to start the engine. When the engine runs the alternator charges the battery and powers everything else.

There should be a 12 volt electrical outlet (cigarette lighter) somewhere around the dash board and also some interior lights.

This system is not intended to be used much when the engine is off. The battery is a "starter battery" and is not designed to power anything except for a short time (minutes). If you keep using it to power something for a longer time, the battery will have a short life. It is not designed for what is called "deep cycling."

Several people living in their vehicles just use their existing system. They charge their portable electronics from the 12 volt outlet when they drive, so the engine provides the power. When the engine is off, they use battery lanterns and the batteries inside their portable electronics.

Solar charging of portable electronics

Some people charge their portable electronics using tiny solar panels. They are designed to plug directly into mobile phones to charge their batteries.

Charging a mobile phone using tiny foldable solar panels.

Some portable radios have small built-in solar panels to charge their battery. They are often marketed as "emergency radios" for use during power outages.

There are some battery lanterns with built-in solar panels, or they can use disposable batteries. Portable solar battery chargers are also available for small size batteries (AAA to D).

Upgrading the vehicle's battery

It is possible to upgrade the vehicle's starter battery so it can both start the engine and also power a few things when the engine is off. We've seen people use such a system to run one light at night while powering their laptop computer (even watching a DVD movie on it).

When the engine is running it will charge the battery again. This upgrade can work well if you drive the vehicle on a daily basis, or every other day.

The type of battery that can do this is called "dual purpose" (i.e. both "starting" and "deep-cycling"). You might not find this type of battery in your average auto supply store, but they can probably special order one.

A dual-purpose starting and deep-cycling battery can be installed instead of the regular starting battery.
The one shown is an AGM Yellowtop from Optima.

There are very few brands available that are truly dual-purpose. The one we are familiar with is the Yellowtop made by Optima. It uses AGM (Absorbent Glass Mat) technology, though not all AGM batteries are truly dual-purpose. (We do NOT recommend trying to start the engine with a regular deep cycle battery.) The Optima battery may be a different size than your regular battery. You might have to install slightly longer battery cables or need an adapter to hold the battery securely in place.

If you discharge the battery too much, you won't be able to start the engine. That could leave you stranded – unless you had a solar panel to charge the battery, which is the next step up.

Adding a moveable solar panel

The next step forward is to add one or two moveable solar panels that can charge the battery when the sun shines.

This is easy to install and can work well if the vehicle isn't moved a lot. When the van is moving, the panels will have to be stowed inside and won't charge the battery, but then the engine will charge it instead.

A moveable solar panel is simple and works well if the van isn't moved every day. Here is a framed type panel of 60 watts.

There are three major types of solar panels suitable for this:

- Framed solar panels
- Flexible solar panels
- Foldable solar panels

All three types have their benefits and drawbacks.

The **framed solar panels** are the most commonly produced, so their cost is the lowest. They weigh enough that they can simply be placed on the ground where only high winds may move them. If it is blown around by wind, the glass front may break. If you accidentally step on the panel, the glass will break. They are typically about 1 1/4 inch (3 cm) thick, so they take up more room than the other types.

The **flexible solar panels** are very thin and lightweight, which may make them the best choice for a moveable panel. The drawback is that the wind can easily grab them if they are not held in place by straps or pegs. But there is no glass front and it is not likely to break if taken by the wind.

A flexible solar panel is thin and lightweight, but may need to be staked into the ground.

The **foldable solar panels,** are the most expensive types. They cost several times what a framed panel cost. They are encased in some sort of plastic fabric that is

heavy enough to hold the panels down in moderate winds, and if they do get blown away they are virtually unbreakable. They take up more room than the flexible panels and the plastic may be a problem for people with MCS.

Connecting the solar panel to the battery

If you are a little handy you can connect a solar panel to the van's battery yourself. Otherwise, see the section about hiring someone later on.

For a moveable solar panel, we suggest you put it on a cord that is 20 ft (7 meters) long. This allows you to move the solar panel around, while keeping the van in the shade. The solar panel needs direct sunlight, with the solar panel facing into the sun. For optimal power, you should move it two or three times a day.

Don't make the cable longer as you'll lose electricity (line loss).

With a single panel you can use a heavy-duty extension cord like contractors use on work sites (usually colored orange). Cut off the regular electrical plugs and replace them with what fits your solar panel (such as MC4 connectors or directly into screw terminals). Or you can use any other rugged and UV-protected cable. A thickness around AWG #12 should work great.

In the other end of the cable you need a charge controller, which turns off the flow of electricity when the battery is full. It will be covered in the next section.

Another cord of similar type then goes from the charge controller to the battery. You want this cord to be rather short for the charge controller to work well (probably no longer than 10 feet/ 3 meters).

The connection to the battery can be as simple as a set of battery clips you attach to the battery each time you set up the solar panel. For long term use something more permanent is better. Some people have installed a charging port on the front grille or other convenient places. You may also be able to backfeed through a 12 volt outlet inside the van, if it works with the ignition off.

Charge controller

The charge controller is the only piece of electronics a solar system really needs. It monitors the voltage of the battery and when the battery is full the charger turns off the flow of electrons. Without a charge controller, the battery will be overcharged and eventually damaged.

A simple solar charge controller of the brand ASC.
It emits virtually no EMF, unlike models with more features.

Most modern charge controllers have additional features, such as digital displays and more efficient pulsed charging (MPPT, PWM). If you are electrosensitive you'll probably want to avoid such features and use a basic on/off controller. (We've used ASC controllers for nearly twenty years, but there are a few others.)

The controller must be able to handle the current from the solar panels. They are rated in amps.

Controller rating amps	**Solar panel watts**
7	84
10	120
12	144
16	192

You can use a separate controller for each solar panel to get higher wattages.

If you are charging a sealed battery, make sure the charger can't raise the voltage above 14.4 volts (14.2 volt for some batteries). Otherwise the battery will not last long.

If you put in a fuse or breaker for the solar panel make sure to put it between the panel and the charge controller. NOT between the controller and the battery. If the charge controller gets electricity from the solar panel, but is not connected to a battery (or other power sink) it gets confused. It then very rapidly turns on and off. This generates radio waves that are easily picked up with an AM radio. We found this problem on all three brands we tested. If you have electrical sensitivities, you'd want to avoid this.

Since the charge controller operates by monitoring the battery voltage, it is important to keep the wire to the battery rather short (minimize voltage drop). Perhaps no longer than ten feet (3 meters) or so.

Mounting solar panels on the vehicle

It is more convenient to have the solar panels mounted on the vehicle, especially if there is more than one panel.

We have seen up to three hundred-watt panels mounted on the roof of a van (see picture on first page).

We have seen single panels mounted on the side of truck cabs with hinges so they are vertical when the vehicle is moving. When parked, the panel is tilted out to better catch the sun.

Mounting the panel on the vehicle produces less electricity than a moveable panel, since the panel is usually mounted flat on the roof. A panel that directly faces the sun will produce more electricity. But it charges even when you are driving down the road.

When panels are mounted on the vehicle, it cannot be parked in the shade. A shaded solar panel may produce as little as just 10 percent as when in full direct sunlight.

A simple way to mount on the roof is to buy flexible panels and then caulk them in place. The downside is that once mounted the panels cannot really be removed again.

Pickup truck with solar panel hinged on the side.

Mounting regular framed solar panels is more complicated and the added wind resistance will cost more in fuel. The simplest way is to bolt the panels flat onto a roof rack intended for a kayak or skis. More complex setups include hinges so the panels can be raised to face the sun and produce more electricity.

Use two wires to carry the electricity all the way to the charge controller and on to the battery. Do not let the negative run through the chassis (this causes unbalanced circuits or "net current" which can be a problem for sensitive people).

You may need a specialist to mount the panels. You don’t want them to tear off while you drive on the freeway. Also, the wire penetrations into the vehicle must be caulked so rain doesn't leak inside and create mold (though a wire can be brought in through a door).

Separate battery

If you need more power when the sun isn't shining, you can use a separate battery for the solar system instead of upgrading the vehicle battery.

The simplest way of doing that is to buy an all-in-one setup available from some RV-camping outlets. In one box the size of a small cooler, there is typically a battery, charge controller, inverter and outlets for 12 volt DC, USB 5 volt, 110 volt AC (or 230 volt AC). All you need to do is plug in a solar panel.

These systems are very slick and convenient. However, they have several drawbacks. They cost a lot more than a do-it-yourself project. Some must be thrown out when the battery wears out, while some allow the battery to be replaced. Some tend to lock you into using their high-priced solar panels.

If you are electrically sensitive, these systems may not work for you with their built-in inverter (for AC outlet), DC-DC converter (for 5 volt outlet), and pulsing charge controller.

A low-cost low-EMF alternative is to build one yourself that is 12 volt DC only with a similar setup as described earlier when using the van's battery. The only difference is that it is not connected to the van's 12 volt system. You'll still need a battery, a charge controller and a solar panel.

You can keep the battery and charge controller in a plastic box inside the van. Auto supply stores sell such boxes. Also add a small automotive type fuse or fuse box to protect against electrical shorts.

For an inside battery, you'd want a sealed type so there are no acid fumes and no possibility of acid leaks.

If you are electrically sensitive, avoid any kind of lithium battery, as they all require a pulsing charge controller (without one they can catch fire). The pulsing controllers send out EMF and dirty electricity.

For electrically sensitive people we recommend some sort of deep-cycle AGM (Absorbed Glass Mat) battery. You don't need a "dual purpose" battery here.

If you need more battery capacity, you can have additional batteries, but realistically, you shouldn’t use more than about three. Make sure the batteries are of the same type and brand, otherwise they will “fight” each other and not live long.

Charging batteries with alternator

You can charge your battery bank with the alternator when the engine is on. But you must do it separately from the van’s starter battery (otherwise they’ll fight each other). You can have a battery selector switch installed to do this. But going solar is probably better.

How many panels are needed?

The number and size of solar panels depends on your need and the climate. If it is a cloudy climate you may need twice as much rated power as in a sunny climate. If you are camping in the winter you will also need more panels.

If a solar panel is rated for 60 watts, that means it produces that under optimal conditions, such as direct sun from a clear blue sky. If it is hazy or the sun is at an angle, the power output is less. If it is heavily overcast, a 60 watt panel may only produce 6 watts.

A 60 watt panel that is mounted flat on the roof will never fully face the sun, unless you live in the tropics. It may just produce 40 or 50 watts around noon on a clear summer day. It will be even less late and early in the day.

If you will be running a laptop computer for a few hours each day, charge a cellphone and have a couple of lights at night, you should get along with one 60 watt solar panel.

If you want to run a mini-fridge, you'll need to add at least 120 watts of panels. This is extra, just for the fridge.

If you are in a northern or cloudy climate, you may need to even double the number of panels.

These are just some very round numbers. A competent solar installer can make a better estimate based on your specific needs and location.

You can start small and as you get more experience with the system you can add more if needed.

The outer edge of what you can fit on a van is 300 to 400 watts on the roof and 200 watts as moveable panels on the ground. We haven't seen anyone actually having that much.

Vehicles with 24 volt systems

Large pickup trucks and other vehicles with large engines may have a 24 volt system, using two 12 volt starter batteries. They should still have a 12 volt cigarette outlet up front.

If you want to use this system, you'll need to upgrade both batteries. They must at all times be the exact same type and age battery, or they will "fight" each other.

To get 12 volt service you could tap into just one of the two batteries, but for serious use that causes imbalance and shortened lifespan. Better is to install a 24-to-12 volt DC-DC converter and use both batteries.

However, DC-DC converters create EMF and dirty electricity and may not be acceptable to people with electrical sensitivity. At least put it on a switch so it is turned fully off when not needed.

Monitoring the system

The standard mistake newbies make is not to monitor their system. That is like driving a car without ever looking at the speedometer or the fuel gauge.

We've seen people who repeatedly killed their battery every three or four months. If you do it right, you should get at least three years out of your battery, if you use the system every day.

A voltmeter that plugs into a 12 volt socket is an easy way to monitor the battery.

A voltmeter is a simple way to monitor the system. There are many types available, including some that plug directly into a 12 volt socket.

The measurements are most accurate when no electricity goes in or out of the battery, i.e. when it is at rest, such as at dawn and dusk, with everything turned off.

The battery is full if the voltage is 12.75 volts or higher (and not being charged).

It is 55% full when the voltage is 12.30 volts (also while at rest).

The battery is empty when the voltage is 12.0 volts or lower. Don't go there, it is harmful to the battery to fully discharge it.

During the daytime, the voltage will rise as the battery slowly fills up. It will have to go well above 14 volts before it is full (exact voltage depends on battery type and temperature).

The day-night cycle

Solar systems have a daily cycle. At night the battery powers everything. In the morning, the solar panel starts charging the battery back up again. If it's a sunny day, the battery may get filled by mid-morning. If it's a cloudy winter day, it may take all day – or it may not get full at all.

It is important that the battery gets filled completely almost every day, as it otherwise will have to be replaced sooner.

It is also important not to discharge the battery too much every night. It will last a lot longer if no more than 50% of its capacity is used at night. Keep an eye on the voltmeter, and try to keep the voltage above 12.3 volts. Never let it go below 12.0 volts.

Once the battery is full, it is "use it or lose it" for the power still available from the solar panel. That is the time to fire up appliances that there normally isn't enough electricity to use, such as a small electric pot. But watch out, if clouds roll in the power feast can quickly turn into a power famine. It is essential to keep an eye on the voltmeter when really pushing the system like that. Wait until you have a lot of experience.

Seasonal performance

The solar system will perform much better in the summer than in the winter. In the winter there are fewer hours of daylight to generate electricity, and the sun is weaker. The sun is also lower in the sky, so solar panels that are flat on the roof of a van will generate a lot less electricity, as they do not face the sun.

At the same time, your need for electricity will be different. It may be higher if you want to use a heating pad at night. Or it may be lower if you don't need to run an electric cooler in the cool weather.

Appliances

Like we said up front, it is not realistic to run a lot of appliances that people with unlimited grid power take for granted. These include electric space heaters, airconditioners, and electric hotplates. They simply use too much electricity.

There are special 12 volt cooking devices. They use about 100 to 150 watts. That is puny compared to an electric hotplate which uses about 1000 watts, so it takes a long time to heat anything. And yet, 130 watts is a lot for these small solar systems, especially if you use it when the sun isn't shining.

The only realistic time you can use such a cooking device is in the middle of a sunny day, with a full battery and **at least** 150 watts of solar panels directly facing a bright sun. But you'll be disappointed how it performs.

Thermoelectric coolers are able to keep their insides about 18 C (34 F) cooler than the outside. If sitting in a 38 C (100 F) hot van, the cooler should be 20 C (68 F) inside. For this meager cooling capacity it uses 50 to 60 watts continuously. Under optimum conditions you'd need 200 watts of solar panels and a deep cycle battery both dedicated to keep it running. In practice you may need more.

Mini refrigerators that run on 12 volts are better than the thermoelectric coolers. According to a vendor, their 50 quart (48 liter) model uses an average of 28 watts when inside a hot van and cooling to around 4 C (40 F). It will use less if inside a cool van.

Most people living in vans use a simple ice chest instead. It is a lot cheaper and there is no EMF from electric motors. But you'll need to get ice every two or three days in the summer.

We have seen a 12 volt electric heating pad to use in bed. It uses 50 watts, which is not realistic to run all night. Wide-mouth screw-top steel bottles with hot water are a non-electric alternative.

There are many other 12 volt appliances available from online stores catering to campers and truckers. They include 12 volt televisions, hair dryers and much else. Just be aware that many of them are designed for occasional use, they are not sturdy enough for daily use.

Solar systems and EMF

Virtually all modern solar systems radiate EMF. This can be eliminated by good design, but very few solar installers are familiar with this issue.

Modern solar systems use inverters, optimizers, pulsing charge controllers and DC-DC converters, which all radiate EMF. Every type of inverter is problematic (sine, square or modified wave form).

You can have an EMF-free solar system, but not with these modern extras. With the size limitations for a van solar system, 12 volts is enough for anything you realistically could use it for. The only electronics you really need is a charge controller and non-EMF versions are available (see earlier in this article).

Avoid placing any sort of fuse, breaker or switch on the cable between the charge controller and the battery. If that connection is severed, the charge controller gets confused and is likely to switch on and off at a high frequency and generate EMF (very loud in an AM radio).

The wiring does not need to be shielded if your system is designed to be low EMF. If you hold an AM radio up to the wires and it squawks, eliminate the source instead of trying to shield the wires.

It's a common myth that "grounding" solves such problems. We've seen a van where a solar installer added several grounding straps between the solar panels and the chassis. It actually made things worse.

Use two wires to carry electricity wherever possible, and run the wires along each other. Avoid sending the negative through the chassis, as that can cause radiation problems ("net current").

Many electrical gadgets produce EMF on their own, and may also put dirty electricity on the wiring in the van. This includes most battery chargers, and any kind of electrical motor, such as for fans, refrigerator compressors and thermoelectric cooler fans. But when you unplug them, it becomes electrically "quiet" again.

It is a fool’s errand to try to "fix" or "shield" the newer solar systems with lithium batteries, inverters, etc., that are now sold in some trailers. There are too many big problems (described throughout this article).

Generators

A generator will take up a lot of room and is a hazard to have inside a van. Most generators run on gasoline and also have an oil reservoir. Any spill inside your safe van would be a disaster. Also, they tend to stink after a while.

Propane generators are better, but still have the oil reservoir.

The noise from generators is also a nuisance to other people when camping in a quiet place.

All generators emit EMF and dirty electricity.

Hiring someone to install your system

You may need to hire someone to do the installation, especially if you want a larger system. A shop that specializes in RV/caravan solar systems may be a good choice, or even a backyard mechanic willing to do something like this. These systems are not difficult to do.

But if you are electrically sensitive, you have to be really careful. These installers do not understand low-EMF solar systems. And giving them a copy of this article may not help much.

They will try to sell you the equipment they are used to and are comfortable with. This will likely include inverters, converters and pulsing (MPPT, PWM) charge controllers. It will be new to them that these things can be a health problem, so it will be difficult for them to accept it. Some may give you some assurances and then do whatever they've always done.

It may be helpful to bring a portable AM radio and hold it up against their equipment to demonstrate the problem.

In any case you will have to be vigilant and verify. The AM radio is a good tool here. A well-designed solar system does not cause static on an AM radio.

A cautionary story

We know one person who bought a van to live in year-round. She went to a solar installer who promised her that he could build her a solar system that would allow her to cook with electricity and use an electric space heater to heat the van in winter. He promised her the moon.

The system he installed was as big as could fit on her van. There were 300 watts of solar panels bolted to the roof and three large batteries in a compartment. There was also a pulsing charge controller and inverter.

The system kept shutting down when she cooked and the inverter caused sleep problems at night. She wasn't even using the electric space heater yet. The first set of batteries died after a few months, the next set didn't last long either.

She would need a system twenty times as big for what she expected it to do.

When she finally complained to the installer, he told her he had just declared bankruptcy (which may or may not be true). She was stuck with what she had.

Is solar for you?

Living with a solar system is definitely not for everyone. If you are used to push-button convenience and anything slightly technical is a mystery, this is probably not for you. In order to live comfortably with a solar system you need to have a basic understanding of how it works and be willing to daily monitor how it is doing and live within its limits. If not, it will be as if you have a dog you refuse to care for. A cared-for solar system will be your loyal friend.

About the author

The author is a retired engineer who has privately tinkered with solar systems since 1994 and lived completely off the grid since 2008.

More information

More articles about solar systems at www.eiwellspring.org/offgrid.html.

More articles about living in vans, cars and trailers at www.eiwellspring.org/temporaryhousing.html.

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