Resilient portable power systems

Watch this short video to see these basics explained

When the mains power fails, so does much of our modern life. The most critical parts of that; lights and communications, can be kept running with very modest solar power solutions. Keeping the fridges, washing machines, etc. going isn't part of this pamphlet, as that requires a much bigger system.

First thing is to be familiar with the low-power settings on your phone. This can make the difference between running it flat every day, and lasting for a week on one charge. It may not keep up with your social media, but that's not likely available anyway.

Vehicle

If you don't already have an in-car charging adaptor, get one. Those with a USB-C outlet will charge many modern laptops too, and are much faster anyway. Look for one with a voltage display (1). This will show how full/empty your car battery is, so you are less likely to end up stranded. Contrary to popular opinion, it's really not necessary to run your 60,000 watt engine to charge your 10 watt phone! Just keep an eye on the voltage, and stop charging when the voltage goes below 12 until you've got a reason to drive somewhere. If the car system is in good health, it should show ~14.2 volts while engine is running.

A good-sized USB battery should be the next part of the kit, at least 10 AmpHours (AH) ('10,000mAh'), to be able to recharge your phone a few times, and to keep a small USB desk lamp running for a few hours. The earlier USB-A type are all 5 volts, while the newer USB-C type can provide a range of voltages and higher power. We prefer the larger 20-30AH sizes for $40-$80. Those that can also start a car in an emergency cost approx double, but one is well worth having in your kit (2).

Solar

A phone charger typically requires 5 to 10 watts, so the smallest practical solar charging panels are a few 10's of watts. These can be bought for under a hundred dollars on eBay and from camping shops. Some have USB sockets built in, so can charge your phone or USB battery directly. Anything less will barely keep up with your phone's power usage (3).

Solar panels require full sun to deliver their rated power. Even on those days the sun shines, you can expect no more than 6 hours maximum output from a solar panel. Expect only 5-10% on overcast days and ration your use accordingly. Even a small patch of shade will dramatically reduce the output. Measure it with your multimeter, don't believe those who claim otherwise.

Ideally you want your panel to be able to fill your battery in no more than a day of sun. To fill a 20 AH battery in 6 hours, you'll need to be putting in 3.3 Amps into it. (20AH/6A). Next we need to know that the panel can actually deliver that to the battery. Many older USB sockets only give 0.5 to 1 Amp out, so that's not going to be enough to fully use the power of the panel. That's where the USB-C comes in. It can charge much faster than the earlier USB-A.

The next size up - Less portable, more capable

Now we're looking at panels of a few hundred watts, either folding, rigid or flexible. The output of these typically goes via a regulator, into a car battery or similar.

Panels

Folding or portable - Camping shops sell folding panels for >$1/watt. These often come with a built-in regulator and wiring suitable for 12 volt car-type batteries. Buy no less than 100 watts.

Flexible panels are very attractive, but are easily damaged. They're intended for limited and infrequent flexing only. If

you are confident that you can keep them from rough handling, they can be a lightweight option. (4)

Rigid 'grid-connect' panels sell new for ~50c/watt, and are very suitable for this scale of power system. Secondhand home roof type panels can be had for the asking when systems are 'upgraded'. The old ones are generally fine, and are often smashed if there's no-one there to take them home. Testing is straightforward (5).

These require a particular type of regulator (MPPT) to match their voltage to that needed by the battery (6).

Regardless of the type of panel used, they are all prone to damage if allowed to fall. Many panels have been ruined when, propped up on a stick, or against a fence or tree, the wind has picked them up so they fall and break. Make them secure, if only by a rope though the holes at the back.

Regulators

Most combinations of solar panels and batteries will require a regulator to be connected to avoid damage from overcharging. The MPPT types are more expensive, but they make much better use of the power coming from the panels than do the older PWM types. Working out the size you need is simple arithmetic (6).

Batteries

Most systems of this size will start out with an old car battery. Better to retire your existing car battery at 2 years rather than letting it fail at 3, it will last many years as a light-duty reserve – if you keep it charged! A new 'RV' battery for ~$200 is a next step up. The 'wet cell' types with refill caps are more robust than the newer sealed types, but are becoming less available. Any size battery is better than none, but ~90AmpHour as used in utes is probably the practical minimum, as you'll want it to last through a few days of little charging because of cloud, rain, smoke, etc.

If there's a bit more money available, it's probably time to spend $400-$1000 on a new Lithium battery. Most modern campers are fitting these now. They are much more tolerant of deep discharge than the Lead-Acid type of batteries, and you can actually use the full capacity without damaging the battery, but they do have specific charging requirements. Be sure that the regulator is suitable for the Lithium battery, not all of the cheaper regulators have that setting available (7)

Any battery should have a suitable fuse installed, to avert the risk of fire in the event of short circuit elsewhere. Tape a spare fuse or two on. A 'resettable fuse' is also a good option. (8).

Charging your house battery when you drive

Many utes and camping vehicles already have an Anderson connector. It must be properly fitted, with a fuse. This can charge a second battery while driving, much faster than any charger you are likely to have around the home.

Wiring

Using plugs and sockets that ensure things can't be connected the wrong way round is the single most important thing here. Vital equipment is often destroyed by improper connection in an emergency. Don't be tempted to use any ordinary 3 pin plugs and sockets in your system, lest there be dangerous confusion.

The rigid panels typically come with the 'MC4' connector, a waterproof, latching plug and socket. To use these, you will need a matching pair of cables to connect to the regulator, preferably long enough to bring the solar electricity to the regulator and battery inside your shelter. These cables are likely available from the same source as your secondhand panels. You don't want to have to disconnect these frequently as they're tricky. (9)

The camping panels generally have the 'Anderson' connector used in many caravans and camper trailers. These are good, but not weatherproof, so need to be sheltered, and preferably treated with a lanolin spray to avoid corrosion by electrolysis. Most regulators are not weatherproof either, so should also be sheltered. Fixing them to the

underside of the solar panel with silicone sealant is not such a bad way of doing it. Fewer loose wires too. (10)

A vehicle-type battery may have screw connectors, or tapered 'battery posts'. If the latter, get brass connectors that give screwed wing nuts to which the regulator cable can be attached. Fitting lugs on the cable make for a more reliable setup (11).

Distributing the electricity should be done neatly, so others can easily see and understand the layout. Simplest are cigarette lighter sockets from the regulator ('load' - output +ve & -ve), so you can plug in the USB adaptor, and your (labelled) 12 volt leads for charging your torch, radios, etc. A camper outlet panel with a range of sockets is also a neat solution (12).

A means to keep your torch, phone, AM/FM receiver and two-way radios charged

Direct from the battery is preferable to using a small inverter to turn the 12 volts DC into 240 volts AC, only to then use plug pack adaptors to transform it back down into 12, 9, 5 volts DC, etc. Just running the inverter doing nothing else typically uses more than charging your phone. Many things use 12 volts DC as the intermediate anyway, if so, you can just snip off the lead and connect it to your regulator output (be sure to get the +ve and -ve the right way round, else you'll let the smoke out). For the USB-charged devices, get a charger that plugs in a cigarette lighter socket, preferably USB-C or QuickCharge A desk lamp is the next priority. Pick one that uses a 12 volt adaptor, so you can connect it directly also, or there's a very nice desk lamp at Bunnings that runs off your USB battery (13)

Generators (petrol & diesel)

Days of overcast weather producing little solar power, and the need to keep things running, it's all but inevitable that you'll need a generator at times, but you don't want to be running a ~3,000 watt engine just to keep a 50 watt satellite terminal going, or to charge even a dozen 10 watt phones. If you can, get a good-sized battery charger (a few 10's of amps) so that you can be charging your battery at the same time, to make better use of the generator fuel.

Storage of generators and fuel

Petrol, and to a lesser extent, diesel fuel, goes stale in storage. Try to 'rotate' your spare fuel stocks through your vehicle or mower, etc. Any that must be stored for more than a few months should have a preservative added (14). When the generator goes into storage, fuel should be removed, otherwise it will become gummy. Keep the required tools and a copy of the instructions tied on, and become familiar with removal and cleaning of the spark plug and carburettor bowl.

Notes & links

1) USB in-car charging adaptor - https://www.ebay.com.au/itm/313102981186 or https://www.amazon.com/Charger-Baseus-Adapter-Digital-Display/dp/B08F25BP4X?th=1

2) Search eBay for 'power bank' or 'jump starter'.

3) Small solar panel with USB outlets https://www.ebay.com.au/itm/264743493834

4) Camping-type solar panels https://www.4wdsupacentre.com.au/adventure-kings-200w-solar-blanket-with-mppt-10m-lead-for-solar-panel-extension.html

5) Testing secondhand panels - A $10~$20 multimeter from Jaycar or eBay is all you need. Read the label on the panel, note specifically Voc (Voltage open circuit) and Isc (Amps short circuit, 'intensité du courant'). Prop the panel facing the sun, set the meter to 200 VoltsDC and poke the probes into the wires from the panel. It should read close to the Voc. Now shift the red lead of the meter over to the 10A socket, turn the meter switch to 10 AmpsDC and connect the leads again. Check that the reading is close to the Isc. Don't forget to change the red lead back to where it was. The 10A position is only for the purpose of in-circuit Amp measurements and grief will result if you leave it there! Done.

6) MPPT - 'Maximum Power Point Tracking'. Two reliable brands are Victron Blue & Renogy. We have used these $50

regulators recently https://www.ebay.com.au/itm/233566955373 Others may work, but beware, eBay is full of false claims for this type of thing. PWM - A simple regulator that merely switches the solar power on and off, rather than transforming it to better match the needs of the battery as do the MPPT types. The arithmetic to sizing the regulator to the system is straightforward, once you have the concept Volts x Amps = Watts, so Watts/Volts=Amps. You might have a 200 watt solar panel. At 12 volts, that can produce 200/12=16.7 Amps. So a 20 Amp regulator will do fine.

7) Lithium batteries – The Voltax and similar brands have been around for a couple of years, these cost ~$700 for 100AmpHours. Recently a new crop has appeared for much lower cost. We don't have long experience with them, but are testing them now. For example, $400 for 150Ah https://www.ebay.com.au/itm/154487700589

8) Resettable fuse in battery lead - https://www.supercheapauto.com.au/p/sca-sca-circuit-breaker-auto-reset---30-amp/528969.html Cable tie the leads so they can't cross over and touch.

9) MC4 – Try to get the leftover wires from the solar refit. Otherwise, eBay will sell them, but they'll need crimping or soldering.

10) Anderson connector – Your camping panel will probably have all you need, if not, eBay, but crimping or soldering needed.

11) Battery terminals - https://www.supercheapauto.com.au/p/calibre-calibre-battery-terminal-wing-nut-universal---2-pack/13087.html

12) Example wiring - TBD

13) Example appliances and leads – TBD

14) Fuel stabilizer - https://penriteoil.com.au/products/petrol-fuel-stabiliser

15) Watch this short video to see the basic information in this information sheet explained – it helps to see how things are connected.