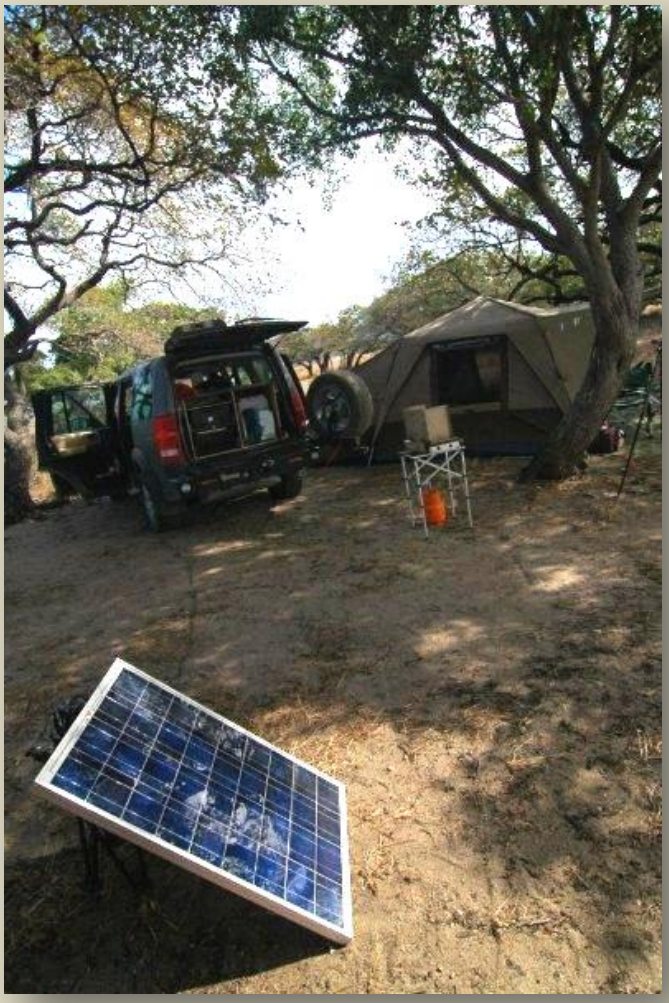
SOLAR CHARGING

These days no-one goes bush without a fridge and lights, so powering them when you're not running your engine is vital for happy camping.



Before the availability of affordable solar panels you had to run your engine for a few hours each day, or power up a generator and risk the ire of other campers. Now, it's possible to have 'free' fridge and lighting power from the sun, by way of solar panels, a regulator and an auxiliary battery.

When you're shopping for a solar battery charging kit you'll notice that there are differently shaped and coloured silicon cells in the panels you're inspecting.
This is not a styling exercise by the makers, but is indicative of the type of cells used in the panels.

All solar cells are not the same.

Some cells are uniformly dark and have silver-coloured, square cut-outs at their junctions to adjacent cells. These are *mono-crystalline* Grade A silicon cells, formed by cutting wafer-thin slices from a cylindrical ingot of single-crystal silicon. A variation of this type is a panel with half-sized mono-crystalline Grade B cells, with triangular cut-outs where they join adjacent cells.

Other cells are paler in colour, have a highly crystalline look about them and are rectangular, with straight silver-coloured joining stirps and no corner cut-outs. These cells are *multi-crystalline* or *poly-crystalline* cells and are sliced from blocks that are formed by carefully cooling molten silicon.

Mono and poly crystalline solar cells are nearly always frame-mounted behind toughened glass, but there are some flexibly mounted examples.

The third common type of solar cell is amorphous silicon, which is a dull-looking, thin-film layer most often seen on flexible plastic solar panels.

There are other types emerging in the market place, including some polymer and nano-technology cells, but the above three are by far the most common used in portable solar panels.

Watt Cell for You


Mono-crystalline panels

Mono-crystalline cells are the most efficient, delivering the highest current flow for a given cell area, followed by poly-crystalline and then amorphous. This means that poly panels are larger than monos and amorphous panels are larger again. The up-side is that polys and amorphous panels are usually cheaper than those made of Grade A mono-crystalline cells.

Another quirk of amorphous cells is the Staebler-Wronski effect that causes an irreversible drop in output when first exposed to sunlight. Amorphous panels are manufactured with a higher rating than they have after stabilising, so it's important that they're initially oversized.

The decision about which panel type you need is not as simple as opting for the greater efficiency of a mono-crystalline one, because offsetting the mono cell's theoretical efficiency is its greater sun-heat absorption, caused by its darker colour. A hot solar panel loses efficiency compared with cool one.

The poly-crystalline panel is lighter in colour and reflects more of the sun's heat, so its ability to remain cooler than a mono panel closes the theoretical efficiency gap.

Amorphous panels are even less efficient, but it's possible to roll up a flexible panel and that may well be more important than panel area.

Buying a Solar Panel Kit

The starting point for solar camping isn't with the purchase of a panel, but with an assessment of your camping electrical power needs. For a start, if you have a three-way fridge (240V, 12V, LPG) don't expect it to run from solar panel power. A three-way fridge uses the inefficient absorption refrigeration principle and is best operated on 240V or gas power. Current draw on 12V operation is typically 7-10 amps, which exceeds the real-world capacity of popular solar panels.

It's important to remember that a solar panel is designed to charge a deep cycle battery that runs your camping appliances. Having the right sized battery is vital, if the panel is to operate effectively, so that's where your calculations should start.

Assuming you have a 12-volt compressor type fridge that is being run in the shade and used to maintain around +4°C (not in freezer mode), it will need 4-6 amps for up to five hours each day. Converting that to battery drain (6A x 12V x 5hr = 360Watt/hours per day). Add to that four hours of two-LED light operation each day (4hr x 0.6A x 12V = 30W/h) and you have a daily auxiliary battery drain of nearly 400W/h, or 34Amp-hours.

Given that you never want to discharge your auxiliary battery below the maker's recommended 70 percent charge level that 34A/h figure needs to be divided by 0.7, resulting in a rounded-out figure of 50A/h. Batteries are only about 90-percent efficient, so that demand figure needs to be increased by 10 percent, lifting minimum battery size to 55A/h.

The typical towing vehicle dual-battery system or small caravan or camper trailer uses a 100A/h auxiliary deep-cycle battery, which provides up to two days of camping electrical power without recharging. Now it's time to consider the solar regulator and panel.

Regulators

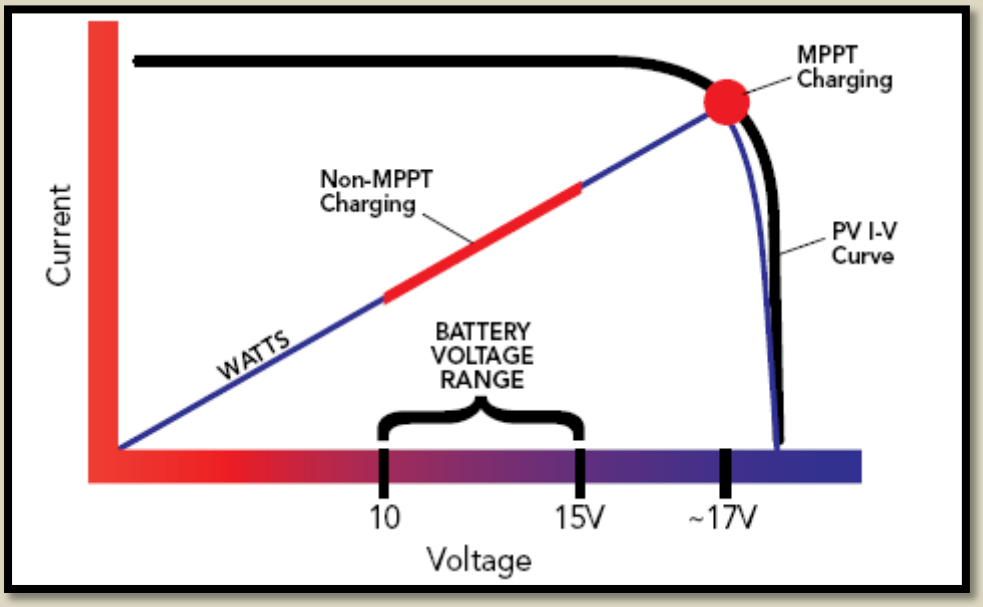
It may seem like putting the cart before the horse, but it's important to choose the type of regulator before you select the panel type and size.

Firstly, small 'maintenance' type solar panels, of the type intended merely to trickle charge batteries of vehicles that are idle for long periods don't require regulation, because the panel voltage and amperage rates are low. However, panels that are rated upwards of 40W need regulation to avoid over-charging deep cycle batteries, because larger-panel voltages exceed recommended battery charge voltages.
A regulator also stops current leakage from the battery when the panel loses sunlight.

The regulator needs to have sufficient capacity to handle not only the panel's rated output, but also the 'spikes' that can occur in circumstances such as a cold panel suddenly being exposed to full sunlight.
Regulators vary in size and price, from a few dollars up to a few hundred. The cheapest ones are simple on-off devices that monitor battery voltage and switch off solar panel current when a pre-set voltage is reached. These controllers can waste some panel power, as the following example shows.

Consider the case of a solar panel, rated at 80W, with a current capacity of 16V/5A. If your battery is partly discharged, at 12V - down from 12.5V - and the panel is connected, your battery won't get 80W and 5A of charging value, because the battery voltage pulls the panel voltage back around 12.5V.
Your 80W panel is now effectively only 12.5V x 5A = 62.5W.

The next step is a two-stage switching regulator that reacts to a full battery charge by selecting a lower voltage switching level, to extend battery life.



This chart shows how MPPT charging differs from conventional charging

A pulse width modulation (PWM) regulator is more efficient than a switching type, because the PWM unit controls panel current while maintaining a constant voltage at the battery terminals. After a pre-set period the PWM regulator reduces charge voltage to a 'float' setting.

The latest development in solar regulators is 'maximum power point tracking' (MPPT), which has nothing to do with moving the panels around! It's *electronic tracking* of the panel *output and battery voltages*, followed by calculation of the best voltage setting that will get maximum amps into the battery.

If we take the same panel and battery example as before, but replace the simple switch controller with an MPPT one we can have a situation where the battery doesn't get the former 5A, but a boosted 6.4A.
Another helpful feature of MPPT trackers is that they can use a solar panel which has a nominal rating of 24V or more to charge a 12V battery. Solar regulators are rated in amps and it's easy to work out how much capacity you need, by dividing panel wattage by charge voltage – typically 15V maximum. MPPT controllers are rated for maximum panel size in watts and maximum input voltage.

Electrical connections are critical components in any solar panel kit, guaranteeing that all the hard earned solar power is going where it needs to go.
The ideal way to connect the regulator to the battery is with heavy duty cable that's directly connected to the battery posts. The next best is via a heavy plug such as an Anderson unit. If you must have a small-plug connection between regulator and battery, Hella plugs are better than cigarette lighter plugs.

Panel Type and Size

You need to decide whether you'll use vehicle-top or portable solar power. The big issue with roof-top units is that at the very time you need solar power – when you're camped and the vehicle engine isn't running – the panels are most likely to be in the shade. Some panels are marketed as 'shade tolerant', but that's misleading, because all solar panels need sunlight. Roof-top panels in deep shade will deliver very little current.

Another misconception is that roof-top panels are needed to help charge your deep cycle battery when you're driving along, but panel output is far less than alternator output – typically at least 10 times less - so you're much better off using the vehicle charging system when mobile.

By far the biggest restriction on roof top panel output is dirt build-up. What's on the roof tends to be forgotten and it doesn't take more than a few days camping for roof panels to be contaminated by dust, tree sap and bird poo. Anything that interrupts sunlight cuts power.
Movable panels can be positioned in direct sunlight, if you're at a campsite, several times during the day. Otherwise, movable panels can be left in a compromise tilted or flat position all day.
Although roof-top panels may be restricted in power delivery they're much more secure against theft than portable panels.

In solar power terms size does matter: an undersized panel may keep your battery alive for a day or two, but it will gradually go downhill and may never fully recover. A panel that replenishes battery power guarantees good fridge performance and long battery life.

How Efficient

Solar panels convert sunlight directly into electricity with an efficiency between seven percent and 18 percent, which isn't very good. Of the bright sun's 1000 watts per square metre of energy, a one-square-metre solar panel can convert this into 70-180 watts of electricity, depending on the type of panel and the angle at which it's disposed to the sun's rays.
Although a solar panel isn't very efficient it provides 'free' power (once you've paid for the panel and controller) and should have a service life of at least 20 years, barring accidental damage.
Early in the morning and late in the afternoon solar panels have a much reduced output, with maximum output near noon. You can expect to average 40 percent of maximum output per 12 hours of sunlight, on clear days.

Light Not Heat is the Key Power Factor

There's some confusion in the public mind about how the power from a solar panel is generated. House roofs can be fitted with solar cells or solar collectors. A solar *panel* is flat, where a solar *collector* has a flat panel, surmounted by a horizontal tank.
Solar cells generate 'free' electricity by converting photons of light energy into electrical energy. Solar collectors produce free hot water by absorbing the heating power of the sun.
A solar cell panel needs sunlight, but not sun-heat, because heat reduces panel efficiency. A solar collector runs on heat input alone.

Typical Solar Panel Kits

There are literally hundreds of outlets supplying solar panel kits around the country. We've chosen a representative sample to show you the most popular sizes and some typical pricing. Note that there are large pricing discrepancies and work to the general rule that you get what you pay for.

We haven't listed panels on their own, because panels are best bought in conjunction with an appropriate regulator. For multi-panel installations you're better off consulting a specialist company, such as Caravan and RV Central or Solar Energy Store in Sydney, Piranha or Projecta in Melbourne and Outback Power Solutions in Adelaide that can size and position the panels and provide the right charger and battery pack. Outback Power Solutions is almost ready to launch its 80W bi-fold, 100W bi-fold and 120Wbi- fold solar panel kits, with mono-crystalline cells and three-stage chargers.

Eco-Camper (by Kimberley Kampers)

The **Eco-Camper** range consists of mono-crystalline hard and flexible panels with chargers.

Eco 80W
The bi-fold, 2x40W panel kit comes with a four-stage charger as standard and an MPPT charger is optional. An Anderson plug, security wire and soft carry bag are provided.
RRP: $895 ($1015 with MPPT charger)

Eco 120W
The tri-fold, 3x40W panel kit comes with a four-stage charger as standard and an MPPT charger is optional. An Anderson plug, security wire and soft carry bag are provided.
RRP: $1195 ($1315 with MPPT charger)

Eco 80W Flexi
The flexible panel kit comes with an MPPT charger, Anderson plug, security wire and soft carry bag.
RRP: $1195

Eco 125 Flexi
The flexible panel kit comes with an MPPT charger, Anderson plug, security wire and soft carry bag.
RRP: $1595

Engel

The legendary fridge maker has two solar charging kits; one with mono-crystalline cells and the other with poly-crystalline cells.

Engel 80W
This bi-fold, 2x40W kit comes with a charger and soft carry bag.
RRP: $1099

Engel 120W
This brand new kit consists of 2x60W poly-crystalline panels, charger and soft carry bag. RRP not available,

EvaKool

EvaKool has one solar charging kit that uses mono-crystalline cells.

EvaKool 100W
The bi-fold, 2x50W panel kit comes with a 10A charger, wiring with battery clips and a soft carry bag.
RRP: $999

Primus

Primus (Piranha)

This specialist solar panel supplier offers custom solar installations and sells one panel charging kit.

Primus 100W

The bi-fold, 2x50W kit is available with a choice of mono- or poly-crystalline hard panels and the kit comes with a smart 8-10A regulator and a soft carry bag.
RRP: $1800 poly-crystalline
RRP: $1250 mono-crystalline

Projecta

Projecta solar panel kits are all poly-crystalline-cell hard panels and are sold as kits or as part of an engineered solar charging installation.

Projecta SPP40K

The one-piece 40W panel comes with an inbuilt controller and soft carry bag.
RRP: $549

Projecta SPP60K

The one-piece 60W panel comes with an inbuilt controller and soft carry bag.
RRP: $688

Projecta SPP80K

The bi-fold, 2x40W kit comes with an inbuilt controller, carry handle and soft carry bag.
RRP: $999

Projecta SPP120K

The brand new, bi-fold, 2x60W kit comes with an inbuilt controller, carry handle and soft carry bag.
RRP: $1399

Solar Energy Store

This company can supply solar charging solutions and also markets a number of panel kits. All panels employ mono-crystalline cells. We couldn't inspect these kits, but we note that they're lighter than most of their competitors. Pricing is way down and we were told that the reason is bulk purchasing power.

SES 80W

The bi-fold 2x40W kit comes with three-stage controller and soft carry bag.
RRP: $335

SES 100W
The bi-fold 2x50W kit comes with three-stage controller and soft carry bag.
RRP: $435

SES 120W
The bi-fold 2x60W kit comes with three-stage controller and soft carry bag.
RRP: $485

SES 180W
The tri-fold 2x40W kit comes with a three-stage controller.
RRP: $950

SES 240W
The bi-fold 2x120W kit comes with a three-stage controller.
RRP: $699