The Power of 3
Driving the future further
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SMARTER POWER = GREATER FREEDOM: AMP UP THE RV!

Overview

Travelling somewhere new – and dallying there – is the dream of many, with more and more living that dream. And what better way to do so than in a well-equipped RV?[1]

In Australia right now, over half a million RVs traverse the roads, a number that's expanding at about 25,000 per annum. And it's not just budget-conscious families and baby boomers heading for wide-open spaces; more and more are seniors, or 'grey nomads' – retirees who travel independently, often for extended periods and within their own country, in a caravan, camper van, camper trailer or motor home.

This edition of *The Power of 3* looks at how harnessing solar power, switching from a lead-acid to a lithium battery pack, and sourcing an efficient and reliable battery management system can deliver greater freedom for RV enthusiasts passionate about life on (and off) the road.

> "Aboard and light-hearted, I take to the open road, healthy, free, the world before me ... heading wherever I choose."
>
> ~ *with apologies to Walt Whitman*

Recreational solar

Most modern RVs come with 12- or 24-volt battery systems as standard. Designed to power up while the engine's running, they often incorporate a 240-volt charger that maintains the battery once it's connected to the electricity grid. But accessing 240 volts in more remote locations such as national parks is a rarity, and running a noisy generator or engine is not conducive to relaxation! Indeed, this is now banned in many camping areas and caravan parks.

Today, though, a lot of RVs are rolling off the production line either with a solar system *in situ* or 'solar ready'; that is, the wiring (and perhaps a charge controller) for a solar system have already been installed.

Serenity-seeking owners of more traditionally powered RVs can still opt for rooftop or portable solar panels to lessen distractions for themselves and fellow campers.

Where rooftop solar is being retrofitted to an RV, flexible panels that align with the curvature of the roof are a sensible choice, in that they maximise the useable area.

Portable solar panels are great for smaller vehicles ... and an attractive option (along with a lengthy charging cable) for those who prefer to park in the shade. Installation costs (if any) are minimal, no framing is necessary and there are various sizes to choose from, depending on available storage area. Some even fold up and incorporate a carrying handle. On the road again and with panels stowed, the RV battery can be charged via the towing vehicle's alternator.

Whatever the solar option chosen, daily power needs require careful assessment first. That means checking equipment specifications, layout and any other variables likely to influence those needs. An effective power system should also allow for several days' autonomy, for back up on cloudy days or where long periods off-road prevent charging.

Installing an inverter will bolster the home-away-from-home RV experience by converting the low voltage of the solar system to 240V AC. Unlike a generator an inverter only uses full power when the devices connected to it require it. However, all inverters consume electricity (about 10%) when idle, so biggest is not always best. Safety, too, is very much a consideration and, as with most things in life, adequate research and obtaining professional advice are mandatory.

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Lithium-ion or lead-acid?

Traditionally, lead-acid batteries stored energy and ran appliances in an RV. Recharging the battery meant visiting powered sites and paying to hook into the grid. Now, though, RV owners can augment the autonomy afforded by solar power with better battery technology, gaining greater independence in the process.

Reliance on the grid aside, lead-acid batteries are old school in that they're heavy, toxic and have a relatively short service life (2-5 years). Moreover, the available energy on offer is limited to about 50% of their rated capacity [1].

For many an RV owner, lightweight, super-efficient, space-saving lithium-ion batteries (LIBs) present a real and practical alternative [2]. Weighing half to three-quarters less than their lead-acid counterparts, LIBs are more energy-dense (safely dischargeable to 100% of rated capacity), less toxic, non-corrosive, longer lasting (3000-5000 cycles compared to 300-500 cycles for most lead-acid batteries), maintenance-free and can hold a full charge for more than a year.

Perhaps the greatest advantage of LIBs for the RV owner, though, is their ability to charge rapidly. Any downsides relate to higher cost and perceived 'safety issues' *(see section below)*.

In terms of cost, replacing the lead-acid battery in an RV with a lithium-based battery pack is expensive but, as is often the case with newer technology, prices will ease with time.

With respect to safety, despite the bad press surrounding recent hover-board fires and aircraft accidents, lithium-ferro-phosphate (LFP) batteries are both durable and very safe (the downside being that their specific energy is lower than that of competing cobalt-based LIBs). That makes them ideal for handling high-load currents, since the risk of thermal runaway (i.e. fire!) is low. They can also tolerate overcharging without damage and suit Australian conditions [3].

As always, however, specific requirements must be carefully considered when weighing the pros and cons of particular battery types for a given application.

Battery management systems

Unlike lead-acid batteries, LIBs are quite complex in terms of how they charge and discharge. So, preserving the longevity of a LIB system in an RV, and also ensuring that it remains within safe operating limits, requires a battery management system (BMS), which electronically manages rechargeable batteries or battery packs.

A 'smart' lithium battery pack designed for an RV includes a BMS with an external communication data bus. The pack is charged by a 'smart' battery charger and doesn't heat up during use or charging like lead-acid batteries [4].

Whether inbuilt or not, the primary function of a BMS is to monitor all the cells in a lithium battery pack continuously for faults. As such, it acts as an insurance policy, protecting against misuse and abuse, including over-charging, over-discharging, excessive continuous current and short-circuiting. A good BMS also monitors the temperature of the battery and disconnects the pack long before it over-heats to the point of catching fire. These functions are intrinsic to a BMS, no matter the type of lithium battery pack used, its size or what it powers, be that an electric vehicle, an RV, a hover-board or Boeing's 787 Dreamliner. In all cases, avoiding a conflagration is essential. [5]

The secondary function of a BMS is to correct imbalances within the battery cells themselves. This is achieved passively (with energy wasted in heat) or actively (with energy transferred rather than wasted) – the former is the most common.

Balancing removes the extra charge from the most-charged cells and/or adds charge to the least-charged cells, thereby maximising deliverable power. If the battery pack has been balanced at the factory that built it, maintaining that balance is far easier – all a BMS need do is compensate for variations in self-discharge leakage in the battery cells themselves.

The consensus is, choosing the right BMS can save a bundle. While they generally restrict the discharge rate of a battery pack, some Australian manufactured BMSs permit discharge of an LFP battery pack at 250 amps: enough to power a fridge, a toaster, a microwave, a clothes dryer and a bar fridge (although not all, perhaps, at the same time). It means that, rather than doubling up on appliances, and depending on available space, much or all of the usual home equipment could be packed into the RV before heading out on the open road.

A word of caution however: in the brave new world of advanced battery technology, the exact role of a BMS, and precisely how much user intervention is required, remain open to interpretation. As always, doing adequate research and seeking knowledgeable advice will help to guard against pitfalls ... remembering, again, that big isn't always better!

Which Perth-based company is working to bring the price of lithium down?

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Notes

[1] A recreational vehicle, autonomously powered or towed by another vehicle, that often incorporates many of the comforts of home, including a bathroom, cooking facilities and beds.

[2] Smith, S. 'Battery storage for recreational vehicles – why lithium is the next big thing'. *Proceedings of the Lithium Battery Conference*, May 2016.

[3] http://www.enerdrive.com.au/lithium-all-the-rage/

[4] Chan, S. 'Lithium Ferro Phosphate (LFP) Batteries – the "Safe Lithium"'. *Proceedings of the Lithium Battery Conference*, May 2016.

[5] http://www.lithiumion-batteries.com/lithium-rv-deep-cycle.php

[6] MacDonald, G. Lithium Battery Management Systems (BMS) – Electric Vehicles Vs Recreational Vehicles. *Proceedings of the Lithium Battery Conference*, May 2016.