ReNew

Technology for a sustainable future

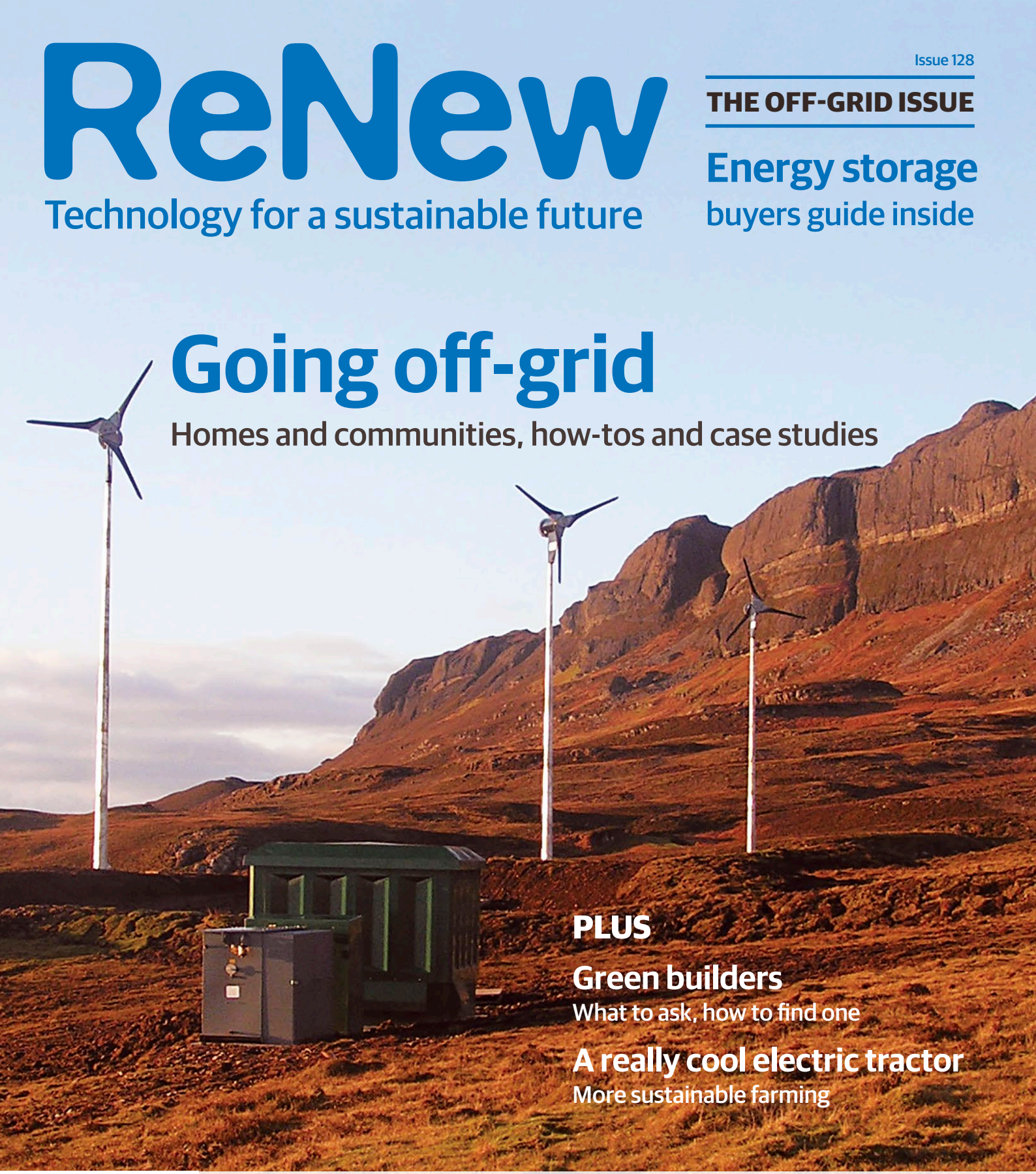
Issue 128

THE OFF-GRID ISSUE

Energy storage
buyers guide inside

Going off-grid

Homes and communities, how-tos and case studies



PLUS

Green builders
What to ask, how to find one

A really cool electric tractor
More sustainable farming

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Low PV prices: a winning formula
Oversizing PV: how much is enough?
DIY: integrated hot water and hydronics

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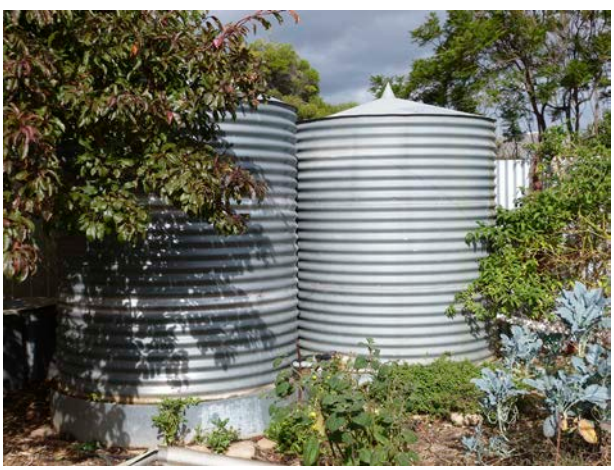
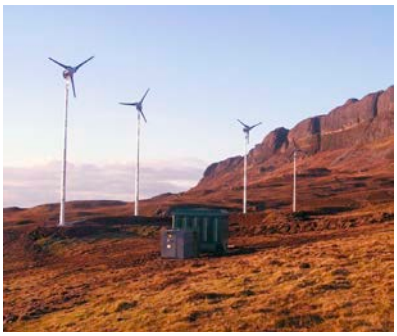
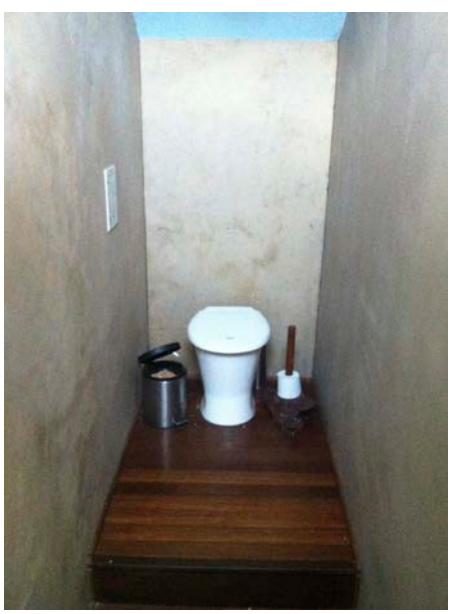


↑ Our off-grid special covers everything from an independent household water supply, page 54, through to battery systems in our off-grid basics article on page 45.



← **Cover image courtesy Wind & Sun Ltd (www.windandsun.co.uk).** These wind turbines are part of the Scottish Isle of Eigg's microgrid, pictured on page 38. The island had been heavily reliant on diesel generators until Eigg residents came up with an ambitious plan to establish their own renewable energy company, called Eigg Electric. Eigg Electric runs three hydroelectric generators, four small wind turbines, pictured, and photovoltaic cells at various locations to supply the island with clean green energy. The output of all the renewable energy generators is brought together and distributed to homes and businesses via an 11 km island-wide high-voltage grid.



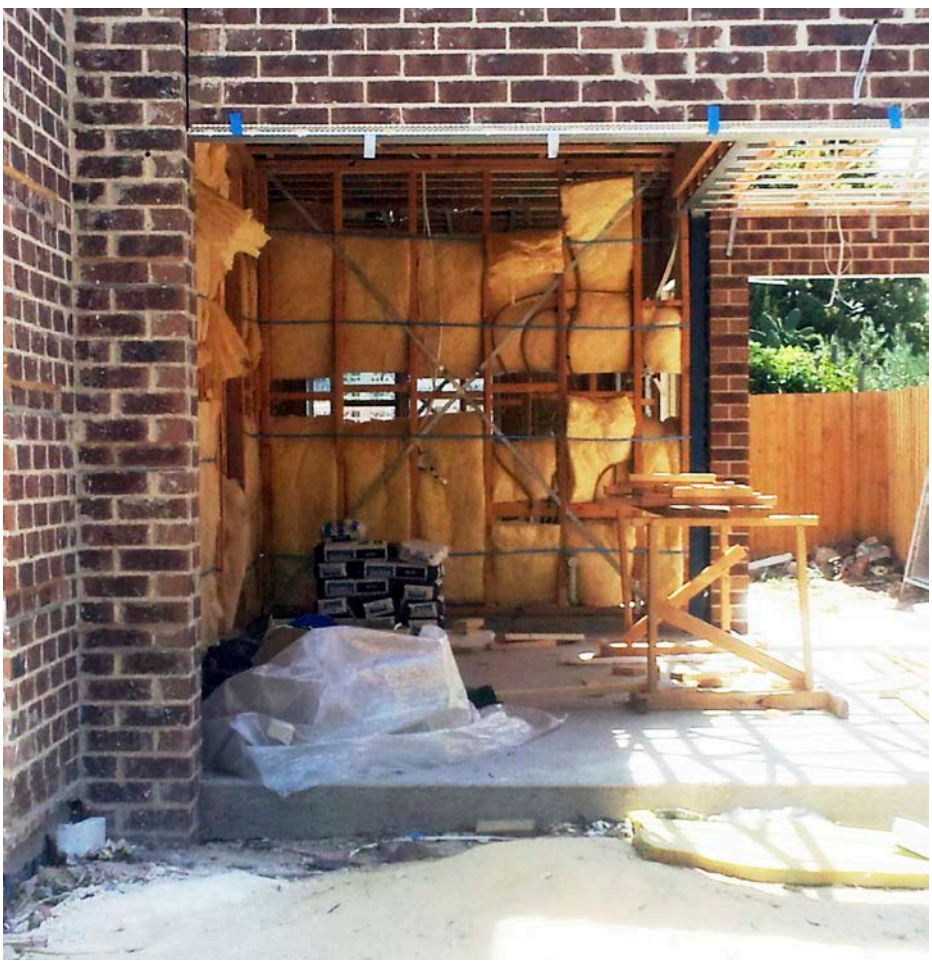
↑ A composting loo in an urban area. Page 56.

Regulars

Shades of green
Sourcing a green builder

By Elizabeth Wheeler.

"While it might feel daunting (or even rude) to ask challenging questions of a prospective contractor, remember that a lot is at stake. What's more, if it doesn't feel right asking questions of a builder in the contracting process, how will you ever raise thorny issues when they inevitably arise?"



↑ The plasterers were already at work on site when this photo was taken. Insulation as installed here would have been a complete waste of money; luckily, it was detected and the plasterers were called off until the insulation could be rectified. The problem is, who checked to see if the job was done any better the second time around?

ONE of the things I hear most when I speak with people about their builder is, "He said he was open to incorporating our ideas about green building." Sadly, the context for our conversations is almost always their disappointment, frustration and even anger at how their home was ultimately constructed. And quite frequently these people say that, upon reflection, they didn't enquire deeply enough about the builder's knowledge, values and experience.

I suspect that fear is often what stops people asking 'too many' questions of prospective builders. It is common for people to worry that the builder won't want to quote on their job and/or that the builder will apply a premium to the contract for a client they perceive to be pushy or 'hard work'. Sometimes time pressures are also in play—for example, wanting to be in by Christmas or before the baby comes. Almost always, clients seem to feel that it is the builder, not them, who is in a position of power.

Yet for most people the cost of a house or major renovation is the most significant one-off bill they will ever pay. And in ecological terms, what happens in construction is critical—a well-designed house will still perform badly if the builder hasn't done their job properly. What's more, given that working drawings rarely specify products and brands for the building fabric, issues such as VOCs, embodied energy and ethically sourced timber are usually the domain of the builder.

From both a personal and environmental perspective, it's critical for people to work through their fears and expectations and contract a builder who can deliver a quality, environmentally sensitive home.

From chug to whir
Farming, renewably, without diesel

On a recent trip to Tasmania, ATA's branch manager Doug Rolfe found something even more rewarding than the 'EV grin'.

I'VE been lucky enough to be involved in an ATA branch in Geelong working on converting petrol cars to electric drive. This has been very educational and exciting, but being exposed to electric transport forms something of an addiction—you start to look for possibilities for electric transport everywhere. Living on a small farm, the potential for electrification of farm machinery is an obvious candidate.

So, when I visited Ronald Winckel's organic farm in Barrington, Tasmania, I found something even more rewarding than the 'EV grin'—my first drive of an electric tractor.

As I'm used to larger 50-60 hp diesel tractors, the diminutive Allis Chalmers 'G' looked cute, but not particularly capable. However, its application to Ronald's need for an organic method of weed control was perfect. It quietly moved along the rows of healthy herbs with only a few squeaks and a gentle whir. Quite a contrast to my tractor which requires wearing hearing protection and chug-chugs along like any diesel motor of its age. Ronald's tractor accelerates quickly, but smoothly, and without any suggestion of being underpowered. Okay—I'm convinced!

Ronald's EV tractor forms a part of a broader holistic plan for his farm. From solar thermal herb drying to solar water pumping and the large PV array supplying the property's electricity needs (including the tractor's), Ronald is working towards a form of agriculture that finally brings the industrial revolution onto a sensible and sustainable path.

It struck me that the use of renewable energy technology in farming is the perfect extension to primary production itself. All farm production is based on the biological capture of solar energy!

Conventional farming practices in Australia have strayed far from a fundamental appreciation of that fact, relying instead on huge inputs of fossil-fuel derived pesticides, herbicides and fertilisers. The production of GMO 'terminator' seed technology is perhaps the final indication that we are losing the desire to farm based on solar-driven self-renewing cycles.

Ronald's conversion

A few years ago while researching community supported agriculture, I came across an amusing YouTube video from the folks at the Flying Beet Farm which featured an electric Allis Chalmers 'G' tractor (www.youtube.com/watch?v=vJUtTvZQGpM).

Ronald had also seen this video and purchased a kit from the Electric Vehicle Association of America to enable him to convert his beloved 'G', which he'd brought with him to Australia.

↑ The electric tractor—a conversion of an Allis Chalmers 'G'—is used for seeding and cultivating.

The underrated pet
Backyard chickens

Keeping chickens in your backyard can have many advantages, and not just for you, as Justin Brasier explains.

I ONCE heard about a man who recovered from serious depression after acquiring a small backyard flock of chooks. Observing the complex, often hilarious social hierarchy of his chooks as they foraged and explored his backyard gave the man a focus, helped him wrestle with his own inner demons and reminded him of the simple pleasures of life. His story is proof that eggs aren't the only benefit of backyard chook-keeping.

Chickens are indeed beautiful, giving creatures and while they may not have the same apparent therapeutic impact on you as they did the above-mentioned man, I promise they will change your life for the good and, in the process, transform your backyard in a productive and positive way!

As most backyard chook-keepers already know, chooks really do have their own personalities. We grow to appreciate this in our daily routine of feeding and egg collecting, or when we take a moment to observe them as they entertain us with their antics. One of the greatest motivations to start up your own flock of chooks is that they encourage you to actually venture into your backyard and experience your immediate outdoor environment.

Chickens are the ideal backyard companions and are truly giving pets. For a start they feed you—one to three hens will usually provide the average family with more than enough eggs. They are relatively easy to keep, although some thought and preparation is required for their overnight housing (more on that later). And chooks are not particularly needy. Unlike dogs, they don't have to be exercised daily nor like cats do they need to be constantly stroked and fussed over.

↑ Rosie and Daisy were both ex-battery chooks and made fantastic pets.

Sustainable 'pets'

Many of you who are reading *ReNew* are already trying to make a difference at home with your environmental footprint. Some will have water tanks, others solar panels; worm farms and compost heaps are also popular. Well, chooks can help complete the picture. In fact, chooks are also champion composters. Since I got chooks I have had next to no food rubbish. With the exception of citrus and potato and some vegetable peel and coffee grounds, all kitchen scraps are decimated.

Chook-keeping is becoming trendy. Normally, I'm not interested in the latest fads but I don't mind being on board this bandwagon. Maybe you've had a similar epiphany—well, you're not alone. There's a groundswell rejecting the multinationals who are dictating our food choices, and much of this movement is occurring in the suburbs. We seem to be returning to the ways of previous generations when keeping chooks was commonplace.

Keeping chickens in your backyard is more than a hobby; it's a more sustainable way of life! I would also like to believe there is a repulsion towards the way we 'manufacture' chicken meat for profit, and that people are reacting to the cruelty of the poultry industry. I was horrified when I learnt that the average hormone-boosted table chook lived only 8–10 weeks in a small cage, not once feeling the rays of the sun on their feathers. And in the egg industry, 'spent' hens and male chicks are routinely killed. How did we get to the stage where we devalue other animal life so much?

What happens when we unplug?
The economics of going off-grid

Recent ATA research explores Australia's 'unplugged' potential. Just how financially viable is it to go off-grid? And if it's not financially viable now, when will it be? Mischa Vickas explains the study's modelling and results.

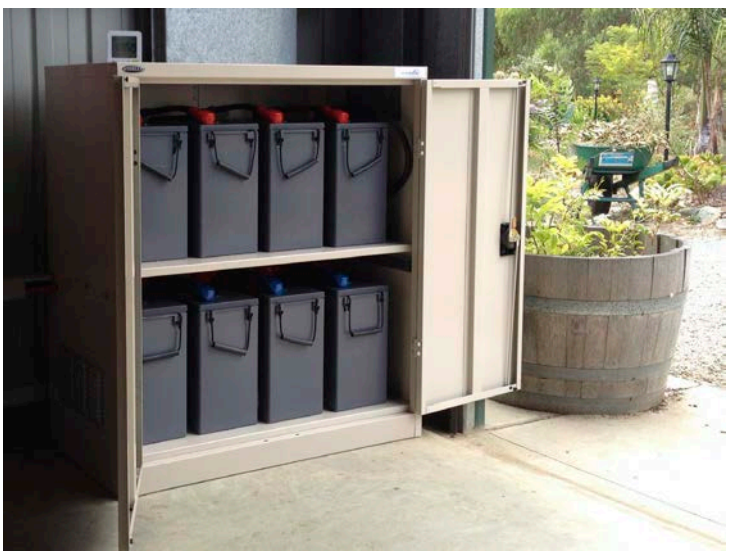


Image: Off-Grid Energy Australia

← The research found that going off-grid is likely to be economically viable by 2020 for individual homes in regional areas (in certain cases)—and can be viable now for 500-home community projects.

WHILE rising energy prices are leading some to unplug their appliances, others are considering unplugging their homes and entire communities. In a new report, *What Happens When We Unplug?*, researchers at Energy For The People and the Alternative Technology Association have examined when it will become economically viable for households and communities to free themselves from electricity and gas networks using off-grid solar photovoltaic (PV) and battery storage systems—often called stand-alone power systems (SAPS).

Their report highlights the strong economic case for some regional and outer-suburban communities to unplug today, while noting that unplugging could be cost-effective for others by the end of this decade.

The story of solar PV should be all too familiar to readers of *ReNew*: prices have fallen by around 90% since 2009, and there is now over 3.2 GW of installed capacity across Australia[1] (equivalent to nearly 6% of total electricity generation capacity[2]), including solar panels on the roofs of 1 in 8 Australian homes[3]. Combine this with lithium-ion battery storage—the price of which is expected to fall 40% by 2020[4]—and you have the ideal ingredients to develop SAPS for single households or entire communities.

Why go off-grid? A key motivation is the increasing risk of the 'utility death spiral': as demand for electricity continues to fall, for reasons including behaviour change, energy efficiency and solar PV, distributors may be forced to increase prices in order to remain viable. The flow-on in higher retail energy prices drives consumers to use even less electricity. The end result is that centralised electricity generators (power plants) and distribution infrastructure (poles and wires) are increasingly becoming stranded assets, with the costs of keeping them alive passed on to consumers. And so the death spiral continues.

Modelling an energy transformation

In modelling Australia's unplugged potential (see box), the researchers used scenarios of typical Victorian housing types found in the inner-Melbourne suburb of Preston, the outer-Melbourne greenfield suburb of Werribee and the regional town of Bendigo. Victoria was chosen as a 'worst-case scenario' region—in most of the remainder of the country, due to better solar insolation and often higher grid prices for energy, the value proposition for SAPS would be more attractive.

SAPS were modelled for both single houses and 500-home community projects in scenarios with and without access to mains natural gas. The cost of these scenarios was then compared with the 'business as usual' cost of sticking with centralised electricity and gas networks, including the expected energy price rises and potential upgrades that go with them. Scenarios considered economically viable were those where homeowners break even or make a profit within the 10 or 25 year periods modelled.

Economically viable today

There is good news for those in regional and outer-suburban areas of Victoria: going off-grid today via a 500-home community project can be cost-effective in the long-term. This applies for the regional scenarios with and without mains gas as well as outer-suburban scenarios with mains gas. Such projects could involve communities collectively purchasing local electricity network infrastructure and re-purposing it for a solar microgrid with the help of an energy services company.

In developing projects outside the metropolitan area, for example, each household could be over $9000 better off (in net present terms) after 25 years being off-grid

Local energy is reliable energy
The resilience of microgrids

The need for reliable energy is driving microgrid development in the USA, and paving the way for smarter, cleaner, community-based energy here in Australia. Kristian Handberg shares his latest microgrids research.

Photo: Kevin Deamandel

↑ A power outage in Lower Manhattan, New York, following Hurricane Sandy in 2012.

HOW would you feel if you lost power for days or even weeks, when your electricity provider knew it was likely to happen but did very little to avoid it?

For many in the USA, this is exactly what happened in 2012 after Hurricane Sandy. In response to this and other natural disasters, many communities and businesses in the USA are pursuing local energy solutions. Microgrids—as described elsewhere in this edition of *ReNew*—are being promoted by US policymakers and adopted by end-users as a means of improving energy system resilience.

These efforts are focused on hardening the grid and reducing the impacts of events such as extreme weather[1]. By way of an example, power outages caused by Hurricane Sandy in October 2012 cost an estimated US$14–26 billion and resulted in 50 deaths[2].

Microgrids can be used to strategically fortify critical infrastructure such as hospitals, police stations, public shelters and emergency response facilities, giving them the ability to disconnect from the main grid in times of widespread outages.

Investments to promote system resilience are also aligning with cleaner, smarter energy objectives. Projects are increasingly incorporating renewable energy, as a result of both sustainability concerns and reductions in technology costs. Such decisions reflect the ability to tailor microgrid design and operation to specific customer needs, in contrast to the 'one size fits all' approach in the traditional grid.

For corporations, resiliency translates to business continuity. With the cost of unplanned outages necessitating uninterruptable or backup power sources, the wider benefits and decreasing costs of microgrids are increasing their appeal[3].

In addition, the peak demand charges that apply to large electricity users provide an incentive for increasing levels of self-sufficiency, boosting the financial argument for commercial microgrids. Data centres—large energy users that may access cost savings by switching to direct current (DC) power systems—have been identified as an early market application for microgrids.

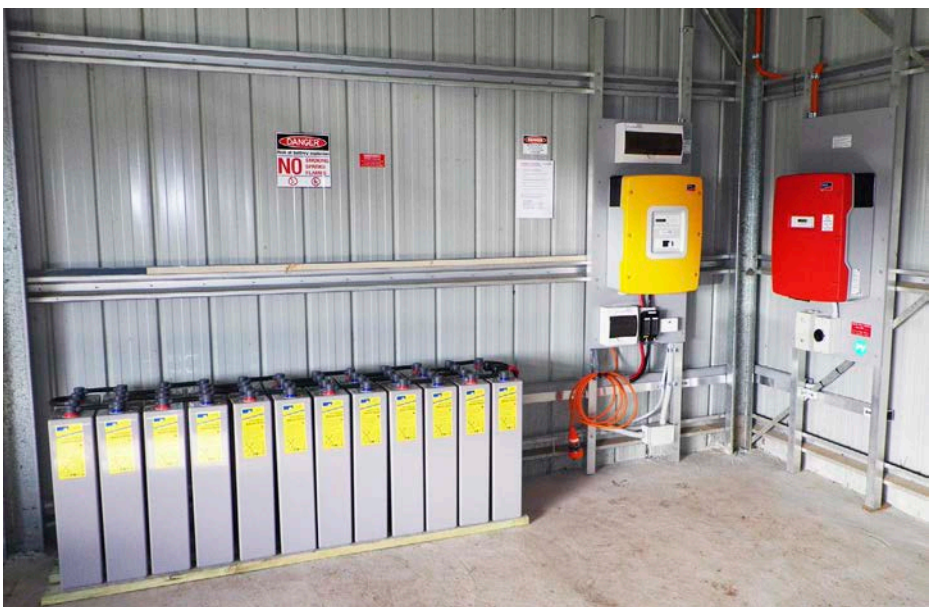
Know your renewables
Off-grid basics

With reducing grid reliability and steadily increasing electricity prices there's been renewed interest in giving energy companies the flick. Lance Turner takes a look at the how and why of going off-grid.

MOST people never think about their electricity supply until it isn't there. Most blackouts are short-lived events caused by car crashes or fallen tree limbs and are, at most, an annoyance. But what if your electrical supply disappeared for days, even weeks?

Anyone who has experienced a natural disaster knows that an extended power outage can have serious consequences. For instance, you might be dependent on a bore pump for your water supply or for pumps in a bushfire, or you might be in the depths of a cold winter and find yourself without heat.

Even if you are an optimist and believe that such an event won't happen to you, there are still other reasons to get off the grid.



↑ A typical AC coupled off-grid system. The battery bank is on the left, the yellow box is the inverter/charger and the red box is the grid-interactive inverter.

Energy independence

It's not just the thought of days without electricity that makes people think about becoming their own energy generators. Another incentive is the variability of energy prices and the steady transfer of costs towards the fixed component of energy bills—so even energy-conscious people are receiving high bills.

Being responsible for your own energy also means that you are more aware of your energy use. Additionally, the sense of being independent for your energy needs and generating energy from renewable sources such as solar panels instead of using grid power from dirty generation sources can be enormously satisfying. One comment I have heard repeatedly over the years is just how good it feels to be independent of the big generators and retailers.

And, of course, for many remote properties the cost of connecting to the grid may be higher than installing even a large independent energy system. In those cases, there's simply no reason to connect to the grid.

There are some disadvantages to being off-grid. The most obvious is that you can only use the energy available from your generation system. Use too much and your system will run down and simply shut down from low battery voltage. If you have a backup source of energy such as a petrol, diesel or even steam-powered generator (yes, they do exist, such as those from Strath Steam, www.strathsteam.com/page6.html), then you are truly independent.

There is also the system maintenance required, such as battery electrolyte level checking, although with sealed batteries this chore has disappeared. Modern systems can have very low maintenance requirements until the components reach end of life.

One point to note is that you can legally disconnect your mains-connected house from the grid without having to pay any further service fees. You just call your electrical retailer and ask for a disconnection, although you may need to give a reason, such as renovating or moving out, to avoid them arguing the point.

Economics

While we should also look at the economics of going off-grid compared to staying grid-connected, comparisons are difficult as the cost of renewable energy equipment is steadily decreasing, while grid power prices

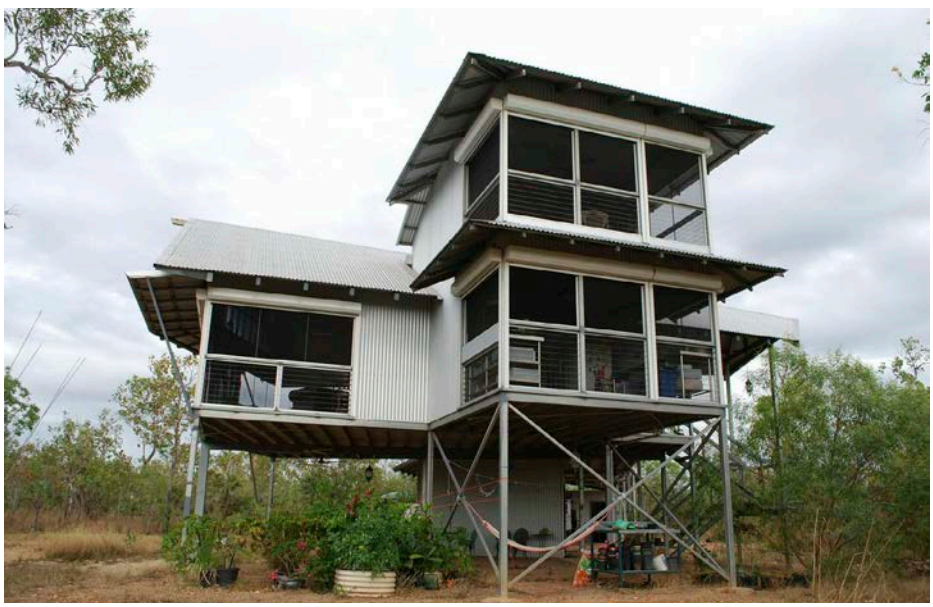
Off-grid in the tropics
Cool conservation

Designed for the tropics, Andrew Spiers's tropical off-grid home exists to look after this conservation block. By Robyn Deed.

WHEN I call to speak to Andrew Spiers about his off-grid home near Darwin, he's out 'chasing weeds' on the property. It's a conservation block, which Andrew and Helen Spiers bought in 2002 while living in Darwin. They had planned to retire to the block down the track, but it proved difficult managing the land conservation on weekends only. So they decided to build a house and move there before retiring. Thus, Andrew describes the house they built as "existing to look after the block".

An ex-ranger and current educator in sustainability, Andrew's trying to stop the native savannah woodlands from all becoming grasslands. It's a greater risk to the tropical environment than cane toads, he says.

The weeds he's fighting are mainly African grasses, introduced for pastoralists as they're preferred by grazing animals. Australian grasses, he says, have "spent their lives making themselves unpalatable to kangaroos". Kangaroos prefer the African grasses too. That's how Andrew can track down the invasive grasses: they're the chewed patches in between the native grasses.



Images: Robyn McLean

↑ The house design is based on a Beni Burnett design and centres around air flow. Windows are taken right to the corners and thus can pick up breezes from any angle around the home.

Living lightly in the tropics

Within the savannah woodland environment that he's protecting sits a completely off-grid and passively cooled home. The home's design was initiated by Andrew—he has a background in planning and was interested in demonstrating just what's possible, in terms of living comfortably and lightly in the tropics.

He'd started thinking about the design in 2002 when they first bought the block. Over several years, Andrew and his partner Helen went along to what were then called Solar House Open Days (now Sustainable House Days), talking to owners, and going back several times to some houses.

A modern Burnett design

Even more importantly, he says, he also studied the heritage houses designed by Beni Burnett in the 1940s in Darwin.

Burnett was a government architect of Scottish extraction who grew up in South-East Asia. He understood tropical design, but also was able to come up with a compromise to suit the mainly British immigrants. In addition, he was dealing with a town without electricity or running water, so his house designs provided comfort in the tropics without even the cooling effect of electric fans.

A Burnett design centres around air flow, critical to a passively cooled house in the tropics. Andrew's house is skewed from an east-west orientation to pick up breezes which come from the southeast in the dry season and the northwest in the wet. This is something that's been lost in so many Darwin developments, says Andrew. There's no room between the houses for breezes, and orientation just doesn't seem to play a part.

The two-bedroom house is also just one room wide. Andrew says, "In a Burnett house, and in my house, the verandah becomes the house." Any internal walls that block breezes are louvred to allow the breeze through when it's needed.

Not flushed away
Water independence

Flush good quality rainwater down the toilet? Not in this Adelaide house, where flushing rainwater is only done in times of plenty. By Melissa Crawford.

WHEN we bought our 1950s classic fibro shack in Port Noarlunga, on Adelaide's southern beaches, the backyard contained two trees, some overgrown hedges and a lot of dry, dusty soil. We planted lemon and fig trees to start our food garden while we planned the house changes.

Minimising our impact on Adelaide's already stretched water supplies (from the Murray River), making use of the intermittent local rainfall (450 mm in a good year) and acknowledging our limited rainwater catchment were key for us. Our renovation included all the wet areas, so it was an ideal opportunity to re-plumb. We decided on a mains-connected system that would allow us to be off the town water supply during times of plenty, but still have backup during the long dry summers. This approach meant we didn't need a huge tank on our small suburban block but we could make use of the rain that falls on our site all winter. We were also able to minimise our stormwater pollution to the nearby sea and recharge the local soil water supplies.

To make the most of our rainwater we created usage zones. As the rainfall becomes more intermittent in September, we gradually cut off each zone to preserve the rainwater for higher priorities.

Of course the priorities will be different for everyone, but we like to use our rainwater in the following order (from most to least important): drinking water; watering the vegie garden; the hot water service, including showering; clothes washing and toilet flushing; the rest of the house.

We needed a plumbing solution to achieve this and luckily my partner had experience with plumbing and a great problem-solving brain! He soon came up with a simple (a key emphasis in everything we do) system of manual valves which allow us to prioritise rainwater to different areas depending on availability and circumstances.

↑ Three secondhand (ex Housing SA) 4500 L galvanised iron tanks are linked to provide water for the house and garden. Rainwater for drinking is provided by a separate 1000 L tank.

Tank for drinking water

We first needed to guarantee our drinking water would never run out, so we installed a 1000 litre rectangular tank that gravity feeds a tap in the kitchen. This tank is fed from the front third of the house roof and is independent from both the mains and the rest of the rainwater system. The minimal head on this tank means the tap runs very slowly, but we soon became used to this. Since being installed six years ago we have never run out of drinking water!

The overflow from this drinking water tank goes into a recycled plastic drum acting as a surge vessel in times of plenty. Dripper irrigation pipe is connected permanently to the drum, automatically distributing water to a native garden area in our front yard whenever the drum fills, thereby recharging the local soil water and again ensuring stormwater does not escape us.

Our house and garden water circuits

Diagram 1 shows the house and garden water circuits we installed.

We installed two water circuits in the house: one supplies the hot water system and

Composting toilets
In an urban setting

Jeff Knowles had reservations about putting in a 'long drop' in his urban home, but was pleasantly surprised.

IN 2001, my partner Chrissy and I engaged Strine Design to assist in the design of our new sustainable home in Queanbeyan. Under the leadership of architect and builder Ric Butt, Strine had been responsible for numerous buildings of a deeply sustainable nature in the Canberra area. Many of these included sustainable elements that were not available through other builders/architects at that time—composting toilets being a case in point.

Initially, it must be said, I had reservations (mostly to do with smell and a reputation for being difficult to maintain) about putting in a 'long drop', but several visits to see Clivus Multrum units already installed around the district convinced me that the idea was worth proper consideration. Chrissy was especially keen, due to the water saving and general ecological advantages.

Deciding to incorporate the unit into our home design and actually getting that design through the local council turned out to be two quite separate things. Fortunately for us, our architect Ric Butt had a lot of experience in this area. He'd pioneered the use of the units with forward-thinking councils, even in water catchment areas such as the Googong Dam where it was absolutely crucial for them to work well. He also had ready access to evidence from other composting toilet owners of the minimal maintenance required.

The eventual approval only took two weeks. With written agreement on our part to maintain and service the unit, our council agreed to pass the 'radical design'—which, in fact, represented a return to many concepts that had previously been commonplace in Australian houses in the bush.

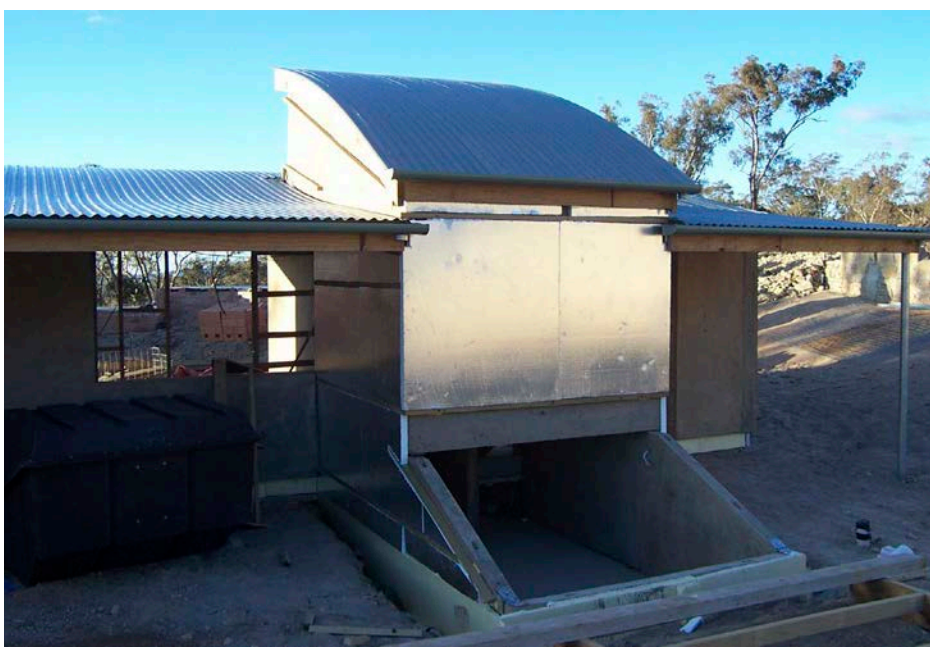
The house was duly built and the toilets (one CM10 unit with two separate toilets) were installed. We had them installed partly raised inside and partly submerged outside with a service hatch. This is one way of installing them—it means a couple of steps inside, but not as far to descend to do the maintenance outside.

We obtained wood shavings from the local sawmill and our learning began. Ric's flippant suggestion was to start the composting process by just throwing in a dead possum. Not surprisingly, I couldn't find said deceased possum lying anywhere around, so we finished up using a product from the supermarket called Actizyme.

Actizyme is designed and marketed as a natural drain cleaner but is also an excellent compost starter. It took me a while to understand that the active microbes in standard food composting systems are the same as the ones in the Clivus Multrum.

That established, we settled in to using the loos—and fielding the inevitable questions from visitors such as "Where is the button?", "Why don't they smell?", "How much water do you really save in a year?"

"Our council agreed to pass the 'radical design'—which, in fact, represented a return to many concepts that had previously been commonplace in Australian houses in the bush."



↑ The composting toilet under construction, with insulation around the edge of the service pit.

A novel design
Taking advantage of low PV prices

This battery-based solar system is cleverly designed to reliably provide daily energy needs, even on an overcast day, with a smaller battery size than normal. John Inglis from Positronic Solar in Brisbane explains.

WE recently installed a system for a customer who had experienced blackouts of four days due to storms, despite being situated in a well-serviced northern Brisbane suburb. The home office employs four bookkeepers using computers, printers, faxes and phones. The house is an all-electric two-storey suburban house, typical of the brick veneer, tin roof houses built in Australian suburbs since the 1980s. The daily energy use from the electricity bill averaged 13 kWh.

The project design brief was to provide a UPS (uninterruptible power supply) for the home-based business.

↑ The 12 kW array was split into two separate 6 kW arrays, each connected to its own inverter.

Design response

The design takes advantage of low PV panel prices, high storage density of $LiFePO_4$ batteries and advanced energy management.

In the past, battery storage systems have been sized with five days of storage and one day of generation. This made sense when panels cost $10 per watt. At $1 per watt the economics are different.

In Brisbane, a 3 kW_p PV system averages 13 kWh per day. On a fully overcast day, PV produces about 25% of the average, so to provide 13 kWh in overcast weather requires a 12 kW_p array. A 12 kW array will provide surplus power in sunny to poor weather, which can be used for discretionary loads—described below.

We design our $LiFePO_4$ batteries with a 45% SOC floor. Cycling the batteries to 45% allows 4000 cycles—say, a ten-year life if cycled daily. Since overcast weather is covered by the oversized PV array we only need to provide one day's storage.

The customer's 13 kWh per day usage means we aimed for 16 kWh of usable storage capacity, and so needed a 29 kWh battery. We used Schneider XW inverters which run at 48 V, so that indicated a 600 Ah battery.

Our quote to the customer specified 12 kW of ET Solar 200 W mono PV panels, two Trannergy PVI5400TL 4.6 kW grid-tie inverters and a Positronic BI48600XE energy storage system, for a total cost of around $36,000 after STCs. Backup power is provided by the off-peak Tariff 33 power from the grid.

Installation

The system was installed in October 2013. The PV array is arranged as two standard 6 kW grid-tie systems, wired to the energy storage system (ESS).

The ESS uses AC coupling and the battery management system (BMS) regulates the output of the Trannergy inverters relative to the battery state of charge (SOC).

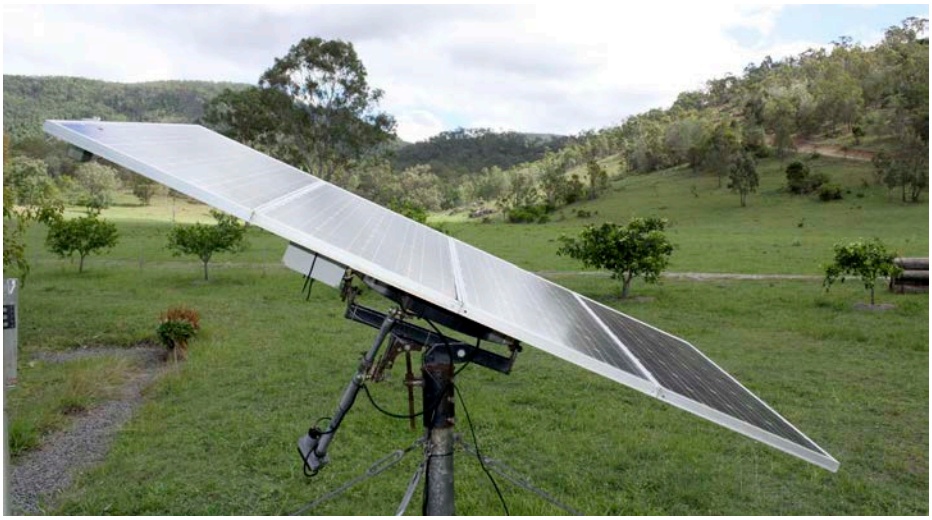
The hot water system was removed from Tariff 33 and connected to the ESS 'dump load' circuit, which is enabled when the battery is fully charged; this uses excess PV generation which would otherwise be wasted as, in Queensland, battery systems are not able to export to the grid.

Tariff 33 was connected to the ESS 'generator' input which is enabled when the battery SOC drops to 40%. The generator

No wires
And too much power!

Kevin White describes his off-grid home in Queensland as a renewable energy 'power station', with more energy than they can use!

'Noddy' did his duty, day in and day out. We were always delighted when guests asked, "Did your solar panels just move?"



↑ 'Noddy' with four 80 W panels tracking the sun.

IT all began with eighty-three acres in southeast Queensland, an almost clean slate, up for sale by a good friend who'd fallen in love and was emigrating. Suddenly we had acquired a property with a bit of everything—dairy pastures running out to steeply treed hills, peaking at a ridge before descending into remnant rainforest; a 300-foot hill rising from the flats completes the picture.

Buying the property was the easy bit; deciding what to do with it was more evolution than plan. The flats had been used for grazing so we decided to continue that. In went cattle yards and a reasonably large shed—your shed can never be big enough! We decided to build a studio within the shed as temporary accommodation while we planned our build.

As ex-yachties who'd swallowed the anchor for the country life, we knew we wanted to maintain our independence. The 'reasonably large shed' had plenty of roof area to supply a water tank and there was plenty of fallen timber nearby for heating.

We wired the studio for both 12 and 240 volt power. We had no idea where on the property we wanted to build so we didn't consider getting a quote for grid power at the time. However, we did get a telephone connection put into the shed.

At that time (just a few years ago!), solar panels were a rather costly item, so for our interim system we decided to mount four 80 W panels on a frame and have them track the sun for peak efficiency, along with using an MPPT charge controller and 400 Ah of Trojan T105 batteries.

Being an ex-electronics tech I built the tracking system—from an old C-band satellite dish mount, coupled to a homemade tracking controller. 'Noddy' did his duty, day in and day out. We were always delighted when guests asked, "Did your solar panels just move?"

With 12 volt LED lighting, a modest 12 volt fridge/freezer, 12 volt entertainment devices, a laptop and a pot belly stove (with a year's worth of cut timber), my tolerant wife Gudrun spent over a year living in our temporary home while I went to work in Antarctica for a year.

During this time there was only one 'lifestyle' failure in the system—the 12 volt pressure pump switch failed but a kind neighbour had this running again within the day. We can honestly say during this time, and after, we never lacked for convenience living with such a minimalist setup. I guess the only thing we had to forgo was ironing clothes. Pity really!

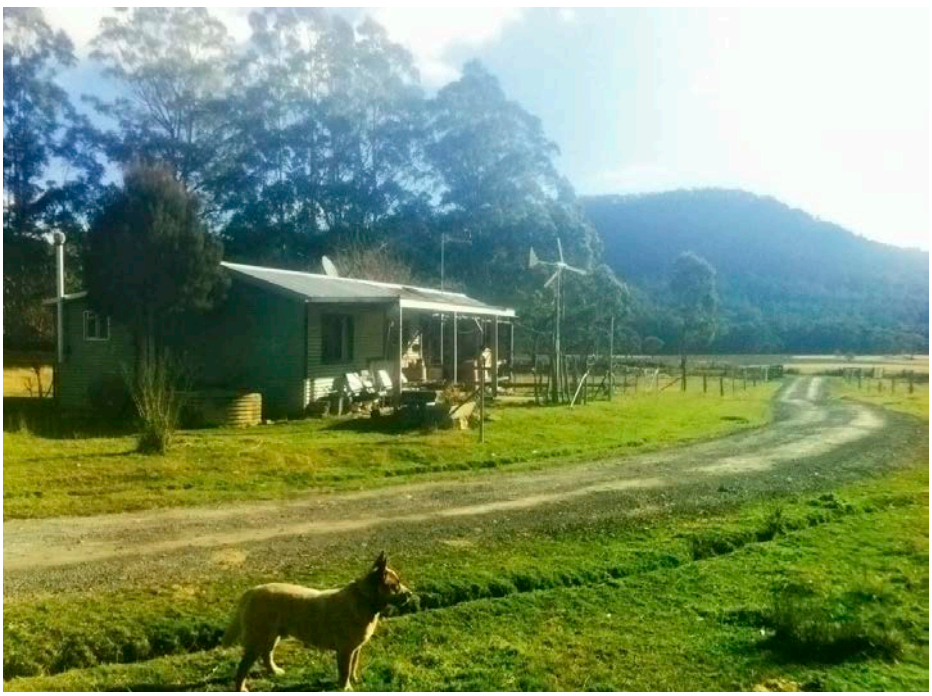
Building location is often not just a matter of power and water needs. These days access to communications can be just as important. We were some 15 km from the telephone exchange so ADSL was out of the question, and there was no mobile coverage on the flats where the shed was built.

Well, if the mountain won't come to... We placed a 3G router and antenna on the top of our hill, pointing at a mobile tower some 30 km away. This could then beam wifi internet access down to the studio meaning Gudrun could continue her university studies in my absence.

Over the next year of long-distance dreaming and thinking we came up with the closest thing to a plan that we'd ever had. We'd owner-build at the top of our hill where the views were fabulous, there was always a gentle breeze—and we could get internet!

Off-grid round-up
The power of many

Here are just a few more stories of people going off-grid around Australia, highlighting some of the pros and cons. Compiled by Robyn Deed.



Off-grid community

IN JACKEY'S Marsh, Tasmania, there's a whole community of 35+ households all living off-grid. There's no electricity transmission at all into this remote mountain valley.

The valley reflects the evolution of off-grid. Many people came here for an alternative lifestyle in the 80s and embraced the lack of grid power. When they were offered a grid connection in the 90s, no one wanted it; besides, they were already set up off-grid.

Rosemary Norwood and her husband Sean run off-grid eco accommodation here, powered by micro-hydro and solar. Rosemary says, "Over time, people's power systems have become more sophisticated, particularly as solar panel prices have dropped." Most households use solar, plus there are about six micro-hydro systems (Pelton wheels or larger Platypus Power engineered systems), and three or four households using wind turbines.

Many of the systems started out using old tractor batteries or recycled lead-acid batteries from Telstra.

Max Herron, Rosemary's neighbour, says the recycled Telstra batteries used to be easy and cheap to get hold of, but they're harder to get now. He says, "It's a bloody shame if they're just being discarded. They fail Telstra's stringent tests, but they're still good for household use." He has three banks of 500 Ah batteries that he's been using for 10 years. He's had two cell failures in that time.

Mind you, he says he struggles with generation and needs to use the petrol generator to keep the batteries charged during cloudy periods. He runs it three or four nights a week in autumn and winter. He has solar panels as well as two 200 watt wind turbines from Jaycar that he bought as an experiment.

He says, "Wind could be good if you had wind! The wind speed just isn't enough here in the valley." (For good wind generation, it also usually pays for the turbine to be at least 20 metres high, and at least 10 metres above any obstacle within 150 metres. For more info on wind turbine siting, see *ReNew 122*, 'Doing Small Wind Right'—*Ed.*)

The biggest drain on Max's system is his fridge/freezer, but the upside is that it doesn't draw as much in winter. His energy use per day averages around 10% of the battery capacity.

Most households get their heating and hot water using wood-fired systems. There are a couple of solar hot water systems, and some gas heaters. Cooking is generally via wood or bottled gas. Max says, "We don't run elements."

Rosemary's Forest Walks Lodge has been running off-grid for five years. They need to use their generator around 5% of the time in autumn, when the creek is dry after summer so the micro-hydro system can't run, and the days are wet and overcast, so the solar panels aren't generating much. However, once the creek is flowing again by late autumn, they can generally run without the generator until the next autumn. They are conservative with their energy usage when the micro-hydro system isn't running. And they never allow guests to use hairdryers! Their heating needs are small when it's sunny, given the passive solar design of the lodge. When I call it's a chilly but sunny 9 °C day and inside it's around 24 °C, without heating.

You can read more about Forest Walks Lodge's micro-hydro system in *ReNew 120*.

Keeping the water flowing
Remote pumping buyers guide

Moving water is a requirement on nearly every remote and rural property. We take a look at the different types of pumping systems and what pumps are available.

ON MANY rural properties, pumping water is critical, whether it be for watering stock, irrigating crops or providing potable water for household use. Mains power may not be available on the property or the pump may be far removed from the house, so these pumps often require an alternative energy source, such as solar panels or wind power.

For both rural and non-rural off-grid properties, off-grid pumps are also often used for circulating water, for example in a remote-coupled solar hot water system.

These pumping requirements may also be critical to the operation of a farm business. Such off-grid pumps thus need to be reliable, easy to maintain, long-lived and cost-effective.

So what are some of the features of pumps that need to be considered? Firstly, different tasks require different pumps: for example, the pump for drawing water from a well or bore will be different from a pump to circulate water through a hot water system. Secondly, the amount of water and the height it needs to be pumped to (the 'head') also vary from site to site, and the pump needs to cater for these requirements.

To meet these variations in pumping requirements, there are many different types of pump on the market. These include the well-known windmill-powered bore pumps, solar bore pumps, reticulation pumps and pressure pumps. There are also numerous types in each of these categories, adding to the confusion in choosing a pump.

This guide looks at pumps designed to be powered from renewable energy sources—solar, wind and water. It includes DC electric pumps as well as pumps directly driven by wind or water power.

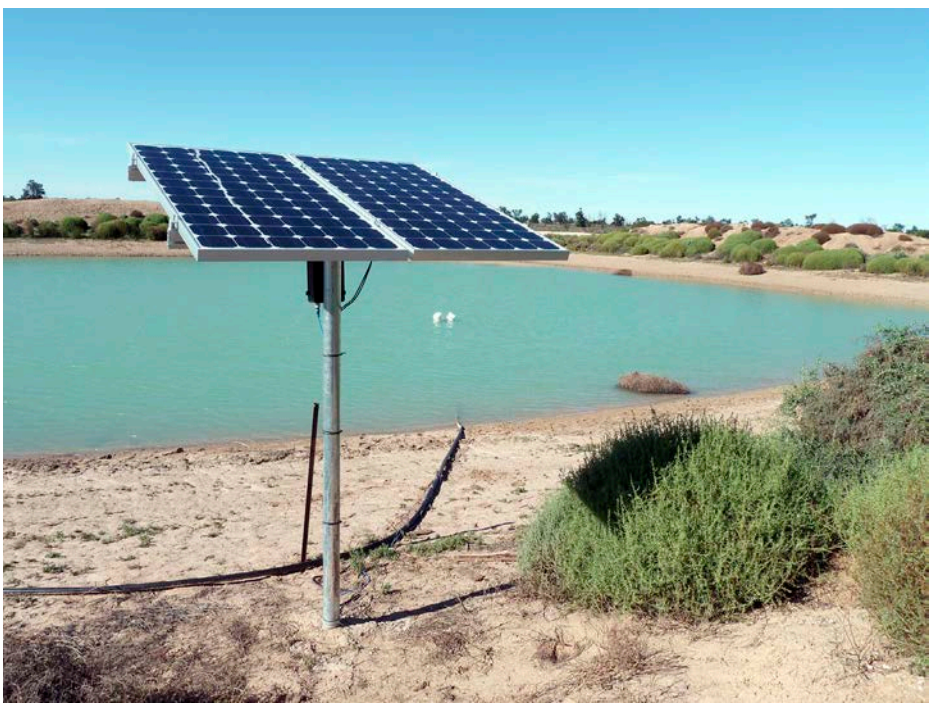


Photo: Carbon Management Solutions

↑ A typical solar pumping setup. This one is using a submersible pump to draw water from a dam.

Although 240 volt pumps may at first appear an obvious choice due to low cost and the wide range available, they require AC power to operate, necessitating the use of batteries and inverters or expensive solar pump controllers. These increase system cost and complexity, an unsuitable characteristic for remote pumping. In addition, there are so many shapes and sizes of 240 volt pumps on the market that it would be impossible to cover them all in our table.

Pumping terms you need to know

Before beginning your search there are a few terms you should understand: head, lift and flow rate.

Head, also called **pumping head**, is how high the pump can push water above itself. It is not the total distance up a hill, only the vertical height component. In a bore pump it also includes the depth from the pump inside the bore to the surface.

The total pumping head also includes a component for the frictional loss due to viscous effects produced by the internal surface of the pipe. A smaller diameter or longer pipe will have greater frictional losses, which will reduce the maximum possible pumping head for a given flow rate. The smaller the pipe, the greater the frictional loss and the lower the pumping head for that

DIFFICULTY RATING: ★★★☆☆

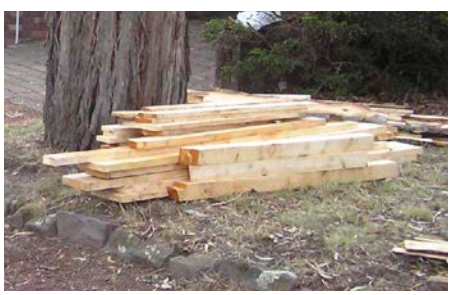
Home-grown shelving
Making the most from a drought-struck tree

Victoria's recent drought had a devastating effect on trees in many Ballarat gardens, but John Petheram found a silver (or amber-coloured) lining.

THE first trees to die in our garden in the recent drought were introduced species such as the silver birch and other shallow-rooted species accustomed to moist soil conditions. Although we prefer native species and hadn't personally planted these exotics, it was sad to see 30-year-old trees just curl up their leaves and die, despite our efforts to keep them alive with greywater.

Three alder trees were the next to go. In cutting the first two for firewood, I was impressed by their amber-coloured timber. The third alder to die had a straight trunk, three metres long with a diameter of about 40 cm so I asked a forester friend, Mark Stewart, to cut this into planks on his portable saw. I was amazed at the skill Mark used to get the very best out of this rough old log that had never been pruned for timber use.

We cut most planks about 30 mm thick and as wide and long as the log allowed, plus some 10 x 10 cm square pieces for table legs and smaller planks 20 mm thick for lighter furniture.



The remaining timber was cut into 30 x 15 mm strips to use as spacers in the drying stack.

We carefully built up the drying stack on a level surface, with spacer strips between each layer of planks. We used heavy planks, bricks and stones to weigh down the final 40 cm deep stack. After four years drying under our house, the planks reached 13% moisture (measured using a borrowed meter)—dry enough to use.

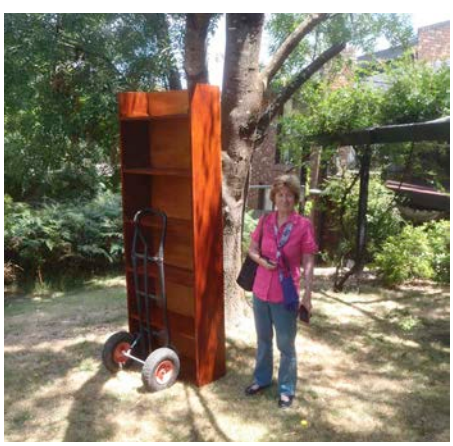
Although I had cut the planks with the aim of making a table, when the planks were ready for use my office bookshelves were bowing badly, so I decided to make a simple bookcase instead. The 25 mm thick shelves were perfect to take the weight of all my office work. I had the timber dressed at a small joinery for $75 and put the bookcase together with the help of Horace, my 95-year-old ex-carpenter neighbour, using simple hand tools.

The final product is a bit rough in places because of branches and knots, but the stain came up well and it looks okay from a distance! It's very satisfying to use furniture that came from our garden and labour.

At least this 100 kg of carbon will remain well sequestered in my house while I'm around. ✷

John Petheram is a Ballarat resident and member of BREAZE (Ballarat Renewable Energy and Zero Emissions).

The dead alder trees in the garden (top left), the sawn logs (left), and the finished bookshelf in the trees' place in the garden, with John's wife, Nicky (below).



Making heat while the sun shines
Integrated hot water and heating

Chris Ogilvie explains how he has integrated his solar hot water and hydronic heating systems, even taking advantage of the excess heat in summer.

OUR solar hot water system looks like most other split systems, with the collectors on the roof and the tank at ground level. But its design has a number of differences to a typical system—and it also feeds into our hydronic heating system, integrates with a wood-fired boiler and stores excess heat in the rock base beneath our house. It's all integrated, simple and efficient!

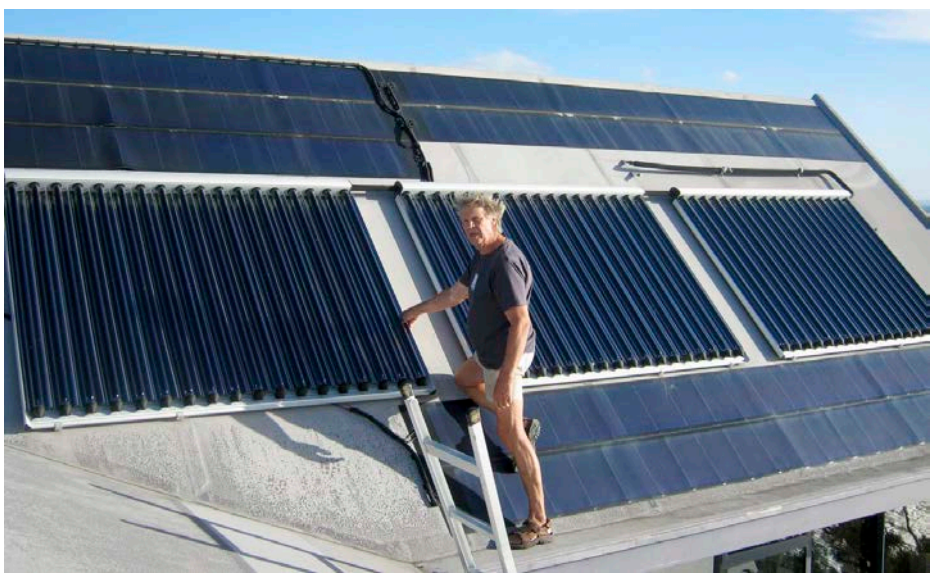
Non-pressurised tank with mains pressure water

The first thing to note is that our system uses a non-pressurised hot water tank, yet still provides mains pressure water. We don't actually use the fluid that circulates through the tank and evacuated tube collectors on the roof—that fluid is instead used to heat mains pressure water via a heat exchange coil when a hot water tap is turned on.

The tank is connected to the solar collectors with an inlet at the top and exit at the bottom. The fluid (water with a non-toxic anti-corrosion agent added) is pumped from the bottom of the tank up to the collectors and, once it is very hot (currently 90 °C), it is pumped back down to the top of the tank.

The heat exchange coil is a 45 m long 20 mm diameter copper pipe coil fitted internally near the top of the tank.

This design means even when the collectors are only producing small quantities of high temperature fluid (e.g. during patchy sunshine), there's still sufficient hot fluid stratified at the top of the tank, ready for use in heat exchange. I've never had to use the electric booster—although we do have twice the recommended area of collectors for the size of our tank!



↑ Chris's house, located near Coromandel Town in New Zealand, has 9 m² of hot water collectors mounted between UniSolar PV panels. These are 'U-tube' type tubes, with the circulating water contained within small copper tubes inside the vacuum tubes.

Advantages of this system

An advantage of my system is that it gives an 'easy life' to both the solar collectors and the tank. They're not subjected to changing pressures or to fresh mains water, instead using the recirculating system fluid. For the tank in particular, I see no reason why it shouldn't last indefinitely.

Both cold and hot water taps in the house run at the same mains supply pressure, thus reducing a number of problems, e.g. the shower temperature doesn't fluctuate.

Legionnaires disease is also not an issue, as the household water is fresh mains water, not stored in the hot water cylinder. There is no need to heat the tank to 60 °C periodically as in other systems.

Integrated with hydronic heater and a wood-fired burner

The tank is also connected to the hydronic heating pipes in our floors. A standard manifold and pump setup draws hot water into the pipes from a quarter of the way up the hot water tank and returns it to the bottom of the tank. It is set so that when the temperature at the base of the tank rises to 40 °C the system turns on and remains running until the sensor a quarter of the way up comes down to 40 °C.

It is ideal for running my hydronic floor heating—it supplies water at the right temperature and pressure, on call.

A wood-fired burner is also integrated to heat the water in the tank with an inlet in the bottom of the tank.