Issue 138

Renew Technology for a sustainable future

SUMMER DIY PROJECTS SPECIAL FEATURE 100% renewables How feasible is it?

Rooftop evolution

Your greenest options

PLUS

Window shading buyers guide Zero-waste on Lord Howe Vertical gardening

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Water wise DIY: wicking beds Creative gardening: reuse materials Earth bricks: make your own Timber finishes: tricks & traps



WIN a home battery storage system from Enphase

*Australian and NZ residents only; details p85

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← Cover image: Photo by Nic Granleese, house and rooftop garden by Nest Architects This issue a lot of our themes come together in our cover image. We take an in-depth look at greener roofing—just what are the important considerations when you're planning the roof over your head? Of course, one option is literally a green roof, like this lovely one from a house design by Nest Architects. Roofing article starts page 52. The solar roofs on the cover also tie in nicely with our special feature on the feasibility of 100% renewables in Australia. Energy experts at the ATA (*ReNew*'s publisher) look at answers to the oft-cited challenges of intermittency and grid stability in a transition to renewables. It's a must-read that helps correct misconceptions and suggests a planned transition is both possible and necessary. We also look at several islands where a transition to renewables is already well underway.

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Products

In this section we share info about products that sound interesting, sustainable and useful. Product listings are not an endorsement by *ReNew* or the ATA of any particular product—they are for reader information only. They are not product reviews and we have not tested the products.



01

MPPT charge controller with Bluetooth

If you are setting up a DC-coupled batterybased solar energy system, then it makes sense to get as much energy from the panels into the battery bank as you can. Maximum power point tracking (MPPT) charge controllers can harvest more energy from the solar array than can a series charge controller.

The SmartSolar MPPT charge controller range from Victron Energy (a more advanced version of their BlueSolar range that we looked at in *ReNew 135*) includes models with maximum array input voltages of 150 V (the 150/85 and 150/100 models) and 250 V (the 250/85 and 250/100 models), with battery charge currents of 85 and 100 A. This allows for array powers of up to a huge 5800 W with battery voltage selectable from 12, 24, 36 and 48 V.

The units come with inbuilt Bluetooth connectivity, remote control capability, a configurable output relay, an optional plug-in LCD, fully programmable charge algorithm with eight pre-programmed algorithms, full electronic protections, and the ability to adjust the MPPT voltage setpoint to cater for partial array shading.

The regulators are available with either screw terminals or MC4 terminals for the solar array connections.

RRP: POA. For more information, contact Victron Energy, mleeftink@victronenergy.com, www.victronenergy.com

02

Beautiful inside, hardy outside

Well-sealed double- or triple-glazed windows can considerably improve the thermal performance of a home. Timber windows look nice, but they can be a high-maintenance item when the timber is used outside.

Paarhammer has addressed this issue with their Wood-Alu range of windows and doors, which feature the warmth of timber on the inside and low-maintenance powder-coated aluminium on the outside. This eliminates the need for exterior painting and will extend the life of the window frames compared to all-wood frames.

The Wood-Alu range is available with double or triple glazing and a variety of glass options and timbers, including FSC-certified wood. Frames are custom-made for each installation with the aluminium component available in a range of colours. The internal timber can be factory spray-painted in a variety of stains or solid colours to suit your design.

The range provides U-values from a low 0.9 (R1.1, excellent for a window of any type), no draughts and low air infiltration from 0.05. Noise reduction values of up to 42 dB are possible. The Wood-Alu range includes tilt-and-turn windows, fixed windows, hinged doors, French doors and sliding doors (with bifold doors coming soon).

RRP: POA. For more information contact Paarhammer Windows, ph: (03) 5368 1999, mail@paarhammer.com.au, www.paarhammer.com.au



03 Go with LEDs outdoors too

While most indoor lighting is changing to LEDs, the range of LED outdoor lights has been a bit more limited, mostly cheap Chinese import fittings of variable quality.

Philips has released a range of LED floodlights designed to replace halogen floodlights in the 100 to 1000 W range. The floods come in 30, 50 and 70 W units with 2600, 4300 and 6000 lumen outputs respectively (so around 86 lumens per watt), with a nice 4000 K neutral white light output. Beam angles are 30° vertical and 80° horizontal, so they direct the light in a flat plane to optimise brightness levels on the ground.

The lights are designed to keep the LEDs running cool, even in high ambient temperatures, and the fittings are IP65-rated, making them water- and dust-proof. They are also 4kV surge protection-rated, making them resistant to failures from mains voltage spikes.

Dimensions are 193 x 143 x 38 mm, 270 x 202 x 43 mm and 316 x 234 x 45 mm, and the units weigh 0.6, 1.2 and 2.0 kg respectively. The lights have a 30,000-hour rated lifespan (to 70% of original light output), which is around 20 years if used for four hours a day, every day.

RRP: POA. For more information and to buy, contact Reduction Revolution, ph: 1800 611 322, www.reductionrevolution.com.au



100% renewable grid Just how feasible is it?



With ongoing discussion by government and media about the effect of renewables on the grid, the ATA's Andrew Reddaway and Damien Moyse consider the feasibility of 100% renewables for Australia.

THE ATA (*ReNew*'s publisher) supports a transition from fossil fuels to renewable generation in Australia's electricity grid. As well as being important to meet our international commitments to fight climate change, this brings other benefits such as improved local health outcomes, greater energy security and more jobs.

However, as this transition progresses we must ensure the grid remains reliable and avoid economic hardship. How can this be achieved as we approach 100% renewables? This article considers the challenges of relying on intermittent generation, ways to address those challenges and a plan for moving forward.

The challenge of intermittent generation

OUR AGEING COAL-FIRED GENERATORS The average age of a coal-fired power station in Australia is nearly 30 years, and some are operating beyond their design life. For example, Hazelwood started up in 1964. In the absence of renewables, substantial investment would be required to rebuild or renovate these old assets.

Coal electricity's current low wholesale price (about 4 to 5c/kWh) is possible because these power stations were paid off decades ago. Energy from a newly-built coal generator would cost more. The best estimates for future costs are in the Australian Power Generation Technology Report (www.bit. ly/2fPnLdt), which estimates that the average cost of electricity over a new coal plant's lifespan (excluding decommissioning) is about 8c/kWh. Allowing for profit margins, the price would be even higher. This report



↑ The Anglesea coal mine and power station has recently closed, with Hazelwood to follow soon. In the absence of renewables, substantial investment would be required to rebuild or renovate these old assets.

also found that new power stations fuelled by natural gas will have a similar cost, assuming they are of the most efficient type.

WIND AND SOLAR: THE FRONT-RUNNERS Wind and solar farms are the cheapest renewable options, generating electricity at around 10c/kWh and 14c/kWh respectively, averaged over their lifespan. Those costs are for 2015, and they're dropping fast, expected to reach around 7c/kWh and 8c/kWh respectively by 2030 (see Figure 1). Operating costs are very low (the fuel is free!), so the dominant factor is capital costs, calculated assuming an 8% cost of debt. Money can currently be borrowed more cheaply than this, assisting new renewable generators to commit to sell electricity below 8c/kWh in Australia and below US5c/kWh overseas.

(With such prices for electricity generation, you may be wondering why you're paying 25 to 35c/kWh for electricity from the grid. The bulk of your bill pays for other factors such as poles and wires, retail billing costs, profit margins etc.)

The main drawback of wind and solar is that they operate intermittently, depending on weather conditions. However, their generation is very predictable using shortterm weather forecasting and cloud tracking techniques. Some people worry about the energy required in construction, but modern turbines and panels recoup this very rapidly. For more information, see 'How green is my solar' in *ReNew 135*.

Tidal and wave power are also intermittent renewable energy sources, but their development lags far behind wind and solar.

Island of energy Community-owned and renewable



Denmark's Samso Island went from complete reliance on imported oil and coal to 100% renewable electricity in just a decade. Jayitri Smiles and Nicky Ison explore the community and government partnerships that made it happen.

DURING the global oil crisis in 1973, Denmark began to think creatively about how to supply cheap energy to their population. As they built their first wind turbine, they were unknowingly establishing themselves as future world leaders in renewable energy.

Today, Denmark aims to have renewable energy powering 100% of their country by 2050 and to eliminate coal usage by 2030. These targets build on a track record of success: since the 1990s Denmark has witnessed the quadrupling of renewable energy consumption.

The creation of the world's first fully renewable energy powered island, Samso, is an exemplar of Denmark's leadership. Not only has Samso become a carbon-negative region, but it has accomplished this worldfirst using community investment.

The road to renewables

In 1997, Denmark's Minister for Environment Svend Auken was inspired at the Kyoto climate talks. He returned home with a passion to harness the collective efforts of local Danish communities in a way that promoted self-sufficiency in renewable energy. Auken held a competition, which encouraged Danish islands to consider how their clean energy potential could be achieved with government funding and matching local investment.

The most compelling application came from Samso, a small island west of Copenhagen with a population of 4100. This island of 22 villages, at the time run purely on imported oil and coal, was suddenly thrust into the global spotlight and, through a combination of local tenacity, investment and



↑ More than 500 local residents own or have shares in the local wind turbines and benefit from exporting the energy to other households and regions. Twelve out of 21 onshore turbines are owned outright by local farmers.

government funding, transitioned to 100% renewable power in just a decade.

At the heart of this energy revolution sit Samso's community-owned wind turbines. Onshore turbines with a generation capacity of 11MW offset 100% of the island's electricity consumption. Another 23MW of generation capacity from ten offshore turbines offsets Samso's transport emissions. Most (75%) of the houses on the island use straw-burning boilers via district heating systems to heat water and homes, and the remainder use heat pumps and solar hot water systems.

The extraordinary result is a carbonnegative island and community. The island now has a carbon footprint of negative 12 tonnes per person per year, a reduction of 140% since the 1990s (compare this to Australia's footprint of 16.3 tonnes per person in 2013 and Denmark's overall footprint of 6.8). Not only is the island energy selfsufficient, they now export renewable energy to other regions of Denmark, which provides US\$8 million in annual revenue to local investors.

And Samso is not slowing down. Highly motivated, knowledgeable and passionate locals are aiming for the island to be completely fossil-fuel free by 2030. They plan to convert their ferry to biogas and, despite already offsetting their vehicle emissions via renewable energy generation, residents of

Other islands going renewable

The idea of moving to renewable energy generation is proving attractive to many smaller communities, particularly islandbased communities. Other islands planning a move to renewables include:

Kangaroo Island: Currently powered by a 15 km undersea cable from mainland SA which is nearing the end of its design life, one option, moving the island to renewable energy generation, has been examined by UTS Institute For Sustainable Futures. The outcome of the study was that the cost of replacing the undersea cable would come in at \$77m whereas a local wind/solar/diesel hybrid system was estimated at around \$87m. However, once ongoing costs such as network charges are factored in, costs for the new cable option rise to \$169m, compared to \$159m for local supply. The system would likely include doubling the existing 8MW diesel generation capacity, installing between four and eight wind turbines, adding five hectares of solar farm and around 800 solar rooftops. The end result would be 86% renewable and 14% diesel generation. www.bit.ly/KangUTS100

Isle of Eigg, Scotland: In 2008, the island's electrification project was switched on, providing 24-hour power for the entire island. Previously, electricity had been provided by individual households using their own generators, resulting in excessive noise, pollution and high maintenance burdens on individuals. The project included laying of 11km of cable and installation of three hydroelectric generators–100kW at Laig on the west side of the island, with two smaller 5 to 6kW hydros on the east side. Four small 6kW wind turbines below An Sgurr and a 50kW photovoltaic array round out the system. There are also backup generators for periods of low renewable input. To prevent overloading of the grid, each house has a maximum power draw of 5 kW, and 10 kW for businesses. When excess renewable energy is being generated, the electricity is used to heat community buildings. www.islandsgoinggreen.org

Bruny Island: As looked at in *ReNew 136*, the CONSORT Bruny Island Battery Trial is an ARENA-funded project to install up to 40 battery systems on the island, with the view to stabilising the grid and reducing the use of diesel generation during the peak season. Households that participate in the trial will be provided with a large subsidy to install solar power and a smart battery storage system. They will also be able to sell their stored energy into the electricity market via Reposit Power. So far, the first round of participants have been selected. www. brunybatterytrial.org

Rottnest Island: The Rottnest Island Water and Renewable Energy Nexus project involves the construction of a 600kW solar farm to complement the existing 600kW wind turbine, which was installed in 2005 and already produces around 30% of the island's electricity needs, saving more than 300,000 litres of diesel a year. The solar farm is expected to push the renewables portion to 45%, further reducing the need for diesel fuel. Funding for the project will be jointly provided by the Rottnest Island Authority (\$2m) and ARENA, which will provide \$4m. www.bit.ly/RottnestSust

King Island: The King Island Renewable Energy Integration Project (KIREIP) aims to increase the island's renewable energy generation to around 65%, and up to 100% at times, while reducing the reliance on diesel fuel. By adding energy storage and energy flow control, the system allows greater contribution of power from renewable sources. Integration of smart grid technology provides the ability to control customer demand to match the available renewable energy supplies. The storage system, the largest electrochemical battery ever installed in Australia, is capable of producing 3MW of power and storing 1.6MWh of usable energy. www.kingislandrenewableenergy.com.au

Island of Ta'u: The island of Ta'u in American Samoa lies around 6400 km off the west coast of the USA. Until recently it was entirely diesel-powered, with diesel being delivered by ship. Disruptions to deliveries had at times resulted in severe electricity restrictions-not great when you rely on electric pumps for basic water requirements. Ta'u now has a solar power and battery microgrid that can supply nearly 100% of the island's electricity requirements from renewable energy. The new microgrid has all but eliminated power outages and greatly reduced the cost of providing electricity to Ta'u's almost 600 residents. The system consists of a healthy 1.4 MW of solar generation capacity from SolarCity, which feeds into 6MWh of grid-grade storage from Tesla (Tesla recently aquired SolarCity) consisting of 60 Tesla Powerpacks. The project was funded by the American Samoa Economic Development Authority, the US Environmental Protection Agency, and the US Department of Interior. It is expected to offset more than 400,000 litres of diesel per year. blog.solarcity.com/islandin-the-sun

The island of Ta'u has a new 1.4 MW solar array coupled to a 6 MWh Tesla battery storage system.





Howe it's done Waste not, want not



Don Batson and Sophie Liu's dream holiday on Lord Howe Island included a tour of the waste management facility—that's a *ReNew* kind of holiday! They describe the amazing work done to reduce waste on this pristine island.



Meticulous sorting and compacting reduces the volume of waste that needs to be shipped back to the mainland. A life cycle assessment of everything brought onto the island happens "almost unconsciously" and reduces unnecessary waste.

WHEN you live on a crescent-shaped island 11km long and only 2km across at its widest, you need to be mindful about limited resources—and as we found out, that can lead to innovative sustainable solutions for all sorts of things, including how you think about and manage waste.

Recently we were lucky enough to have a holiday on Lord Howe Island, a tiny speck in the Pacific, 600km east of Port Macquarie, with a population of 360 plus a maximum of 400 tourists at one time. It's an island with UNESCO world heritage status and we were drawn there to experience this pristine environment with its unique plants and animals. The last thing we expected to be excited about was the waste management setup! Yet somehow, on our third day there, we found ourselves having a three-hour tour with John, the manager of the island's waste management facility.

Towards zero waste

From speaking with locals, we got the sense that a life cycle assessment of everything brought onto the island happened almost unconsciously, by necessity. The high cost of bringing in a product and shipping out any waste requires a less 'disposable' approach to purchasing. For example, to bring a new car onto the island, you must first arrange to have the old car removed. "Some locals told us that they'd saved money and reduced trips to the centre by giving their food scraps to a neighbour with chickens—and they were receiving eggs in exchange for their contribution!"

The island also has a wonderful food cooperative— a great community and social enterprise. It offers bulk foods for sale in recycled and reusable containers, so there's less packaging to be disposed of. This was 'zero-waste' heaven, with all sorts of nuts, dried fruit, grains, flours, cereals and even spices sold in bulk. They also had dairy items bought in bulk then portioned up for sale, homemade dips and locally made cakes and biscuits. We were in awe of the simple, effective system set up so customers can return empty jars and containers, which are then washed and reused. As visitors, we were actively encouraged to participate.

Recycling for tourists too

Our curiosity about the recycling systems began at our accommodation. The kitchen had three bins: one for non-recyclable rubbish, one for recyclables such as glass, cardboard and plastics, and a small bin for food waste (with pictures noting that meat scraps and fish bones could be added). Intrigued, we asked one of the staff there about the food waste: did they compost all this on site? Melissa explained that it went off for processing at the waste management facility on the island. And, she added, if we were interested we could get in touch with the manager, John, and perhaps arrange to see it.

The next day, planning our week's activities at the information centre, we asked the

Driving change One EV owner's insights



From what it's like to drive an electric vehicle (EV) to where to charge at home and abroad, happy Tesla owner Jeff Challis answers some frequently asked questions about owning an EV.

Why did you choose an EV?

Our impetus to buy an electric vehicle (EV) came after we installed our home solar panels in 2007. I started thinking of other ways that we could use the solar-generated electricity to reduce our impact on the environment. If households could adopt solar and reduce the need for high carbon usage power stations, then surely EVs would reduce the need for oil. This led me to research a now well-known US company that had created its first EV, a twodoor sports car, in 2008, with grand ambitions to expand and mass produce four-door EVs too. This company is of course Tesla and I have been following their progress intently for the last eight years.

In June this year (2016), the delivery was imminent. I filled up my internal combustion engine (ICE) car with petrol for the very last time and a week later we became the proud owners of a Tesla Model S70D hatch.

What is it like to drive a Tesla?

We feel the Tesla must be one of the simplest cars to use and drive. There are no remotes or keys needed to unlock the car. You just walk up to the car with the fob in your pocket and the door handles come out to greet you! Hop into the car, put your foot on the brake and push the lever on the steering column down to select forward, or up for reverse. There are many driver-assist features, such as auto-steer for freeway driving, auto headlights and autopark when needed.

What features do you enjoy?

Owning a Tesla is a not a compromise. Not only does our car have the same features, handling, performance and range as a traditional vehicle,



 Public charging provides extended range for EVs. Note the use of an adaptor lead so that the Tesla can charge using a standard J1772 outlet.

it also offers benefits beyond those of a normal car. An EV has instant torque from zero and is typically much faster to accelerate when compared to the ICE equivalent. The Tesla can also download software updates, allowing the car to be made safer and smarter over time. And of course, they are extremely quiet with zero tailpipe emissions.

Does the range affect your trips?

In the few months we've owned the Tesla, we have not been constrained by range at all. We've completed trips from Melbourne to Mt Hotham (385 km), Euroa (175 km), Apollo Bay (190 km), Creswick (120 km), Christmas Hills (75 km), Yarra Junction (90 km) and the Mornington Peninsula (110 km). Many of these trips included other side trips and a return on the same day. I often didn't even need to do a full charge beforehand, if the available range (indicated on the console) was enough to cover the distance.

Are people interested in your car?

Yes! Quite often when I'm getting in or out of the car, I'll get asked questions about it and I often end up taking people on a mini tour of the car. I open the hatch and they almost always comment on how much room there is. I also open the 'froot' (front boot) where

Straight up Vertical garden lessons

S

The last thing you want is to spend a lot of money on a vertical garden system and then have it fail. Jenny and Bevan Bates provide advice and inspiration from their own living walls—five years old and growing strong!

THE inspiration to garden vertically is not new. The Hanging Gardens of Babylon, if they are more than legend, may have been an early precursor, built to bring luscious greenery to the ancient city's terraced buildings. Your grandma's hanging pots are a more down-toearth example, as are vines on a trellis.

More recently, the idea of living walls has become a popular trend, in part in response to higher density living and homes with small gardens. For Jenny and Bevan Bates, their move to a new house with a small courtyard and a stark black brick wall facing their living area windows—was the reason they started experimenting with gardening on a wall.

"You have to be prepared to experiment," says Jenny. In fact, their first vertical garden was a failure. "We tried a \$100 system, but the pots were too small and it dried out too quickly; it was hard to keep anything alive in it," she says.

However, they persevered and they now have five vertical gardens providing cooling, colour and herbs, which adds interest to their home. The black brick wall in fact sets off one of the vertical gardens nicely—the colour they didn't like turned out to be complementary to the planting!

That particular garden was their first success, says Jenny. It's now five years old and thriving (see photo above). It's on a southfacing wall overlooked by the north-facing living area windows—a lovely sight.

They created the garden using Woolly Pockets, a product which at the time they needed to get delivered from the USA (though there are now retailers in Australia).

The pockets are composed of long troughs of recycled polyethylene (PET, from milk bottles for example). That recycled aspect was



↑ Instead of a black brick wall, this is now the view from Jenny and Bevan's living room. Plants in this vertical garden include begonias, fuchsias, nandina, dianella, clivea and various bromeliads and ferns. The pots in front can be moved to bring a ladder in for maintenance.

important to them; "You need to think about the full life cycle; for systems made from virgin plastic, there can be a lot to dispose of at end of life," says Jenny.

Which plants they use has evolved over time; some plants grew bigger than expected, shaded other plants or didn't like the position.

Seeds of success

Jenny and Bevan note that the critical things to consider for success are: aspect, dictating how much sun the plants will get and when; a good growing medium; containers of sufficient size so they don't dry out too quickly; an automated watering system as hand watering can be tricky with so many pots; and appropriate plant selection.

Jenny suggests that using a west-facing wall with its harsh sun will be difficult—a vine grown in the ground rather than many small pots would likely work better. But on other walls, the array of plants can add more interest and diversity than a single vine.

Their south-facing vertical garden looks lush, but there have been challenges along the way. The plants at the top get a lot of sun in the morning and afternoon during summer, so they need to be hardy. They lost several plants in the top row in the first year, so they now shade it in summer with an overhead blind made of white shadecloth.

The vertical garden on their north-facing

A roof over your head Choosing the right roofing materials



There are many different roofing materials to choose from, but what are the advantages and disadvantages of each, and how sustainable are they? Lance Turner surveys the market.

IN *ReNew 132* we looked at options available for walls when building a home or extension. But of course there's more to a home than just the walls—roofing is equally important as it not only protects the rest of the building, but also has to withstand the most intense levels of solar radiation of any part of the home, as well as considerable forces from wind, rain and hail.

The roof must also be able to support added structures such as solar panels and solar hot water systems, satellite dishes, ventilation and air conditioning systems, as well as the weight of people walking on it while installing and maintaining such systems. Plus it's used to collect rainwater for your home and garden.

There are many different roofing materials available, including corrugated iron and Colorbond steel, concrete, ceramic, metal and composite tiles, slate, shingles and even load-bearing panels such as SIPs (structural insulated panels). Each option has its advantages and disadvantages, each has its own particular look, and each comes in a range of options for that particular material.

Which roofing you go for will depend in part on the materials and the general look of the rest of the home, as well as your personal preference, which may be determined by a number of factors including appearance, the eco-credentials of the material, the range of colours and styles available, the building method (some roofing materials need more structural support than others), the level of maintenance you are willing to give to the roof, the fire resistance level required, and, of course, the location and hence surrounding environment of the home, including heritage or aesthetic requirements of your local council. Let's look at each material in turn.



↑ Colorbond sheet is a very popular roofing material as it is light, durable and comes in a wide range of colours. This roof, in Annerly, QLD, was replaced after hail damaged the previous roof. Note how the edges of the roof capping are cut to match the corrugations in the sheet. This reduces weather ingress and keeps out pests.

Sheet materials

GALVANISED IRON/COLORBOND STEEL These materials are made from thin steel sheet (typically less than 1 mm thick) and are coated in either zinc (galvanised iron), an aluminium/zinc/magnesium alloy (Zincalume) or paint over zinc alloy (Colorbond) coating. There's also a stainless steel-based version of Colorbond for extreme coastal environments.

Steel sheet materials come in a wide range of profiles (the shape, corrugated or otherwise, when viewed end-on), including the common corrugated iron, the mini version (such as Lysaght Mini Orb, which is usually used on walls but can be used as a roofing material), as well as profiles more commonly used for commercial roofing although also suitable for some domestic projects, such as Trimdek, Klip-Lok and numerous others. See www.steelselect.com for information on the sorts of profiles available.

Sheet steel products are all used in a similar manner: they are either screwed (or sometimes nailed) to wood or steel battens, or they are clipped onto concealed brackets which are screwed to the battens. Both methods have the edges of the sheets overlapping to prevent water ingress, but concealed fixing systems eliminate piercing of the sheets associated with screw or nail fastening and provide a more reliable weather

Revealing work A brief guide to timber finishes



Choose right, prepare well and work with the timber's properties: Peter Smyth delves into the issues to consider when selecting and using timber finishes.



WHAT are we talking about when we say we are finishing timber rather than painting it? Perhaps the most fundamental and obvious difference is that we care what the underlying timber looks like. We have gone from regarding the timber purely as a functional substrate to using it for its aesthetic properties.

This has a number of consequences. The first is that how we prepare the timber for the finish is of much greater importance; this includes obvious points such as not filling holes with an undesirable colour, to more subtle concerns such as how we sand the timber. Second, we are often using the finish not just to preserve the timber but also to enhance its look, so the timber and finish must work in a kind of symbiosis. This relationship is at the heart of what we are trying to do when we finish timber and there are a multitude of ways it has been approached over the years.

Timber selection

Not all timber is created equal and through all of what follows it is worth bearing in mind the importance of appropriate timber selection. This is particularly important in outdoor applications, with some species being more susceptible than others to weathering, termites and other forms of ageing and decay. A wealth of information exists in this area; see links at end. When timber finishing doesn't go as planned: uneven application followed by too long between maintenance reapplication means that achieving even weathering or an even level of finish will be very difficult without completely stripping the finish from this building and starting again. Where maintenance access is difficult (such as here on Swanston Street in Melbourne), it can be better to choose a timber and finish combination that requires less frequent renewal.

Penetrative vs surface finishes

Timber finishes fit on a spectrum between those that are penetrative, such as traditional oil finishes which soak into the timber, and those that are film or surface finishes which sit as a layer on top of the timber, as seen with the plastic-like resin finishes. In practice most finishes both penetrate the timber and leave a surface film: it is just a question of the degree to which they do each.

In using penetrative treatments we are seeking to protect and preserve the timber through the finish curing and hardening within the outer surface of the timber. Such finishes do not necessarily protect the timber from impact or staining as effectively as some of the more superficial treatments, but done well they can be both attractive and protective, and are generally easy to use, renew and repair.

Surface treatments are often harder for non-professionals to apply than penetrative treatments and are more likely to be based on (less desirable) high-VOC solvents, although improvements have been made in both these areas in recent years. They are often more impact-resistant than penetrative finishes and many of them can nearly completely prevent water and other liquids affecting the underlying timber. They can be hard to repair, particularly if they are not maintained properly.

Landscaping with impact Reuse in the garden



Permaculture gardener and teacher Drew Barr has loads of experience with reusing materials in the garden—even getting high school students involved in creating quirky but useful structures.

BUILDING materials can be expensive, and many have high embodied energy and other environmental burdens attached to them. Sadly, old building materials can end up in landfill as they may not be suitable for use in new builds. But there are many other uses for them, particularly in the garden. Here are some options for masonry, metals and other materials—and some examples of how I've been using them alongside students to build a permaculture garden at Templestowe College in Melbourne's north.

Masonry

BRICKS

Bricks are useful objects. Durable and cheap, their regular shape means they can be stacked or laid in patterns. Almost all bricks have the same dimensions, although older handmade bricks may be slightly smaller. The size and shape are designed for easy one-handed handling by an adult.

Bricks are energy-intensive to manufacture and transport, but will last hundreds of years, and can be used over and over again.

When reusing bricks, you'll need to clean them to remove the mortar. This is dirty and laborious work and seems very slow to begin with, but once you have mastered the knack you will be surprised how fast you can clean bricks. The best tool for this is a scutch hammer, which has replaceable toothed blades called combs. Chip at the mortar where it meets the brick and it will come off in big chunks. Wear gloves and a face shield though as flying mortar chips really hurt.

BROKEN CONCRETE SLABS Concrete is also a very energy-intensive



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↑ The gates to the Templestowe garden set the scene: this is a garden dedicated to making an impact with less.

Permaculture Canden

material to manufacture, and similarly highly durable and strong, and ideal to reuse.

Concrete slabs, sometimes referred to as 'urbanite', can be reused to make crazy paving, or stacked without mortar to form low retaining walls. When sourcing slabs make sure you get only non-reinforced slabs such as from council footpaths or old driveways. Reinforcing steel in the concrete is very difficult to cut, and as it rusts it will swell up and split the slab.

Councils often replace footpaths and must dump the slabs of concrete they remove, and they will usually be happy to dump it at your place for free.

Concrete can be sawn with a concrete cutting saw to give a smooth sawn edge, but the saws are expensive, noisy and dangerous. For crazy paving, breaking the slabs with a sledge hammer yields interesting odd-shaped pieces; resist the temptation to break them too small, as they are more difficult to get level and stable when laying. For retaining walls more regular shapes are better and the best way to cut them is with an electric jack hammer.

PRE-MADE CONCRETE PAVING SLABS

These are usually square in shape, and about 40 mm to 50 mm thick, with sizes ranging from 200 mm to 600 mm square. They are often pulled up and thrown out so they are readily available. They can be laid hard together or with a space between and sown with a herb lawn. Or they can be grouted with mortar and decorated with broken crockery and tiles.

They are also useful around fruit trees to

Keep your cool External shading buyers guide

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With summers getting hotter in many parts of Australia, keeping the sun off your windows and out of your home is becoming even more important. Anna Cumming looks at the options for external shading, for both new builds and retrofits.

THERE'S been quite a shift from preindustrial times when glass was an artisancrafted luxury item, and homeowners were taxed according to the number of panes they had. These days, our houses are getting bigger and so are our windows—often to the point of comprising entire walls. Windows and glazed doors frame views, admit natural light and breezes, and allow a connection with the outdoors. In a well-designed house, they also admit the sun's warmth in winter to assist passive thermal performance.

However, from a thermal efficiency point of view, windows are the weak link in a home's building envelope: *Your Home* notes that up to 40% of a home's heating energy can be lost and up to 87% of its heat gained through windows. Efficient double-glazed windows with thermally broken frames (preventing heat conduction through the frame) perform considerably better—advanced glazing solutions can exclude up to 60% of heat compared to plain single glazing—but will still allow more heat to enter in summer and escape in winter than the adjacent wall.

Internal thermal blinds or curtains can help a lot in preventing heat loss through windows in winter, but to tackle unwanted radiant heat gain in the hotter months, it's far more efficient to stop the sun hitting the glass in the first place with appropriate external shading.

Location and orientation

There is a huge variety of options for keeping the sun at bay, from carefully chosen deciduous plantings and simple solutions like a piece of shadecloth on a frame, to awnings, shutters, blinds, and even pergolas with sensor-operated louvre roofs. To choose the



↑ A relative newcomer to the external shading market, the folding arm awning has "taken the market in Australia by storm" according to Joe Turner, president of the Blind Manufacturers' Association. These awnings can be up to 7 m wide and can extend out up to 4 m, without support poles.

best solution, firstly it's important to consider your location and the orientation of your windows.

In most of Australia, shading is needed on windows on the north, and also the east (to prevent summer sun heating the house from early in the morning) and west (to block hot late afternoon sun). North of the Tropic of Capricorn, thought should also be given to shading windows on the south side of your house, as the sun's steeply angled path in summer means these windows will also receive direct sun. Helpfully, the Geoscience Australia website (www.ga.gov.au) allows you to find your latitude and calculate the sun angle at any time of the day, on any day of the year.

Even at the same latitude, different

local climates will mean different shading priorities. Perth-based architect Sid Thoo points out the importance of protecting east and west windows in his part of the country: "Summer morning and afternoon sun can be very harsh in WA." However, a house at a similar latitude in alpine NSW might instead prioritise maximising solar gain for winter.

Because of the angle of the sun through the day, one size does not fit all when it comes to shading for all of the windows in your house. For windows within 20°W and 30°E of solar north, it's easy to exclude summer and admit winter sun using simple horizontal devices, including eaves and awnings. This also applies to south-facing windows in the tropics. It's reasonably straightforward to calculate the optimal width and height of

DIFFICULTY RATING: ★★★★☆

Pressed into service DIY earth bricks

Creating pressed earth bricks isn't hard when you have a machine and willing helpers. John Hermans describes the process and advantages of this low embodied energy approach to construction.



↑ A decorative use of the pressed bricks in the display home at the ecovillage at Cape Paterson.

THIS article aims to inspire owner-builders to minimise the carbon footprint of their new sustainable dwellings by using pressed earth bricks. By explaining the many virtues of this building material, I hope to spark interest in my offer to share the amazing machine that I use to make them.

I started making and using pressed earth bricks in 1988, shortly after commencing excavation for our house site. I had seen a hydraulic brick press working very effectively around this time and, with the intent of making a copy, I took several photographs of it in operation. I then found four aspiring owner-builder friends who were willing to become 'shareholders' and finance the brick press fabrication; my input was to build it.

The machine I built back then is still going strong today. To date, this press has made in excess of 70,000 bricks and has been responsible for some very creative, costefficient and low embodied energy housing.

What's in a pressed earth brick?

A pressed earth brick is simply a brick made by compacting soil that has a high percentage of clay. The machine compacts the soil by 50% using the power of a hydraulic press. The result is an attractive and easy-to-use brick that needs no firing and can often be made from subsoil excavated from the house site and thus has much lower embodied energy than the average house brick.

My machine makes bricks that are 300 mm long by 220 mm wide by approximately 130 mm high, so quite a bit larger than the average house brick (dimensions 230 x 110 x 76 mm). The height of the brick depends on the amount of clay mix put into the press, but averages around 130 mm. At that size, the brick ends up weighing around 15 kg.

It is important to seal the bricks to prevent surface erosion. There are many earth brick sealing products available now (e.g. *Your Home* suggests linseed oil and turpentine; or you can use one of the Bondall products).

Quality bricks are achieved by using a claybased subsoil that will bind well and dry hard. This is often an excavation waste product, with little commercial value. Using a press to make several test bricks is a sensible idea.

An addition of 5% to 10% cement will form a brick that will handle days of total water submergence, although this is a condition rarely encountered! No cement is needed in the mix if the bricks are used indoors. If used in exterior walls that are likely to be impacted by rain, then the use of cement is recommended.

The pressing process

In preparing to make these bricks, there are a few additional items that are essential to ensure a smooth operation;

- a medium-sized 5HP rotary hoe
- at least a dozen 15L plastic buckets
- two shovels
- water
- a team of four enthusiastic and fit workers
- several old wooden pallets.

The first step is to break up the clumps of earth using the rotary hoe to create a smaller

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