ReNew

Technology for a sustainable future

Issue 132

BUILDING MATERIALS SPECIAL

WIN a $5000 managed fund from Australian Ethical!

*Australian and NZ residents only

Innovative sustainable materials

PLUS

Thermal mass in action

Design that lasts

Farming renewably & more

Issue 132 July-September 2015
AU $8.95 NZ $9.90
www.renew.org.au

ISSN 1327-1938

Local, clean, green: the new generation

Building with SIPs: quick and easy

Go with the flow: micro-hydro guide

Go hybrid: solar + storage

Contents

Issue 132, July – September 2015

Read more articles at renew.org.au
Follow us on Twitter: twitter.com/ReNewMagazine
Like us on Facebook: facebook.com/ReNewMag

Building blocks

Materials, mass and more

↑ The Hamilton's 60-acre property in south-west WA is a model of sustainable farming. Page 28.

↑ The Green Swing share their journey of collaboration in the building process. Page 34.

↑ Community energy projects are making a real difference. Learn more on page 38.

↑ Studio Nimbus: built to last in one of Australia's most beautiful, and challenging, regions. Page 54.

← **Cover image courtesy EPFL – SwissTech Convention Center**
The SwissTech Convention Center, Lausanne, Switzerland, features the first solar photovoltaic glass facade of its type on a public building. The Grätzel facade, built by Hevron in Courtételle, consists of 300 m² of Grätzel dye-sensitised solar cells from Solaronix in Aubonne. These cells imitate photosynthesis in plants to produce electricity while reducing solar heat entering the building. They are integrated into the west face of the centre with a beautiful stained glass appearance and are expected to generate up to 8000 kWh of energy per year. Artist Catherine Bolle, in conjunction with the Grätzel laboratory and Richter Dahl Rocha & Associés, designed the facade to make best use of this technology. Page 69.

↑ Beautiful, strong, sustainable bamboo. Not for everyone, but one of the many materials emerging in the building market. Page 69.

↑ Explore the design principles that give buildings a longer lease on life. Page 64.

Guides

Micro-hydro buyers guide

DIY

Regulars

Editorial

Sustainable building: Not just another brick in the wall

WE'VE gone a little bit *Sanctuary* (our sister magazine which showcases modern green homes) this issue! Or, at least, our theme of building blocks sees us concentrating a bit more on sustainable building materials and systems, and a bit less on technologies such as solar and batteries.

But we haven't completely forgotten solar, with an article by the ATA's energy guru Andrew Reddaway on ways to add batteries to an existing grid-interactive system, to create a hybrid system. He suggests that for many in our cities this will be a more cost-effective and sustainable approach than going off-grid, with the recently announced Tesla Powerwall setting a lower-cost and longer-warrantied battery system benchmark that we're hoping many other providers will follow.

We also look at solar panels as a building material in our article on emerging materials. Building integrated PV promises a way of reducing construction materials, replacing roofing or even windows with solar panels, and we're pleased to see some roofing companies taking up the challenge.

As part of our building theme, we decided to cast a *ReNew* eye over the many possible approaches to building walls. The array of choices can be confusing, so we've created a quick guide that looks at how each wall construction system works and considers sustainability across a range of criteria.

In terms of building guides, we also feature Mullum Creek, an innovative residential development in Melbourne's east, which is providing guidelines for purchasers on both sustainable design and building materials. For example, their clay products guide lists local products and suppliers that have lower impacts than typical brick products. Each listing comes with a comment as to why it's been included, a helpful pointer on the issues to consider in selecting materials.

We also consider longevity and sustainable design. As architect Ande Bunbury asks, shouldn't we be designing buildings to outlast us? Getting the basics right, flexibility and durability are all important for longevity.

There's much more besides, including a sustainable farm conversion that's going from strength to strength, a discussion of the advantages of collaboration in building design, an update on the ever-expanding world of community energy, the results of our cooking challenge, a DIY roof heat capture system and a micro-hydro buyers guide. Alan Pears features several times: with an in-depth look at where/when thermal mass is effective, a book review and his column on the bizarre world of Australian climate policy.

We'd also love to get your views on *ReNew* in our reader survey, running until 31 July. It really helps us to hear what you'd like to see more (and less) of in *ReNew*. It only takes 10 minutes and there's a prize of organic wine or olive oil on offer. Find it at renew.org.au/readersurvey.

Robyn Deed
ReNew Editor

In *ReNew 133*, out late September

Reuse and recycling, LED lighting buyers guide, phase change materials + more.

OUR mission at the Alternative Technology Association (ATA) is to enable, represent and inspire people to live sustainably in their homes and communities. We've been doing this for 35 years, providing independent advice and sharing stories of practical sustainability from across Australia.

We're very excited to announce a major step forward in our work, as co-organiser of Sustainable House Day in 2015 with the EnviroShop. The ATA has been a long-time supporter of Sustainable House Day, with many ATA members opening their homes on the day, allowing the general public to see good sustainable design, ask questions and receive unbiased advice.

Sustainable House Day joins a range of events the ATA conducts each year to provide face-to-face advice on practical green living. This year we've already held Speed Date a Sustainability Expert events in Sydney, Melbourne and Perth and there are more coming up in Brisbane, Sydney and Melbourne's western suburbs.

Without the support of our members, with many actively involved in their communities sharing information on sustainable living, none of our work would be possible.

As we come to the end of the financial year you can support the ATA's work by making a tax-deductible donation. As well as supporting Sustainable House Day, your donation will enable us to continue development of the on-grid battery component of the Sunulator solar system feasibility tool and to advocate for consumer protection and carbon reductions in a changing energy landscape.

You can make a donation online (www.ata.org.au) or by calling 03 9639 1500. With your support we can continue to enable practical action on climate change free of commercial influence.

Donna Luckman
CEO, ATA

Going hybrid
Adding batteries to grid-connected solar

Going off-grid may not be for everyone; a better route may be to 'go hybrid', by adding batteries to grid-connected solar. Andrew Reddaway explores the options.

Image: Bosch Power Tec

↑ Storage systems, such as the Bosch Power Tec BPT-S5 Hybrid, look more like appliances than battery systems.

THE solar battery industry is on the verge of disruptive change. Traditionally, large batteries were only seen in houses at off-grid locations such as Moora Moora (see box on the solar hybrid training course held there, which I attended earlier this year and which provided input to this article).

For off-grid systems, reliability is crucial; failure prompts an emergency call to the solar installer, so such systems have been designed conservatively using proven lead-acid batteries.

Meanwhile, in towns and cities, grid-connected solar systems have gone mainstream. As feed-in tariffs for solar export have dropped far below the rates paid for grid electricity, householders are looking for ways to cut bills by making better use of their excess solar generation. One answer is to add batteries to create a hybrid system: a grid-connected solar system with batteries either for backup or load-shifting.

This article gives an overview of current hybrid technology and the options available for adding batteries to an existing grid-connected solar system.

Different batteries for hybrid

A hybrid solar system is tough on batteries. Unlike an off-grid system that may store enough energy to last multiple days, a hybrid system's entire usable capacity will be charged and discharged daily. This requires a battery that can handle fast discharge rates at high levels of efficiency. Lithium batteries fit the bill, and have already become dominant in consumer electronics, power tools and electric cars. Compared to lead-acid, they are also smaller, lighter, don't require monthly maintenance and don't emit hydrogen gas. The only things holding them back in the solar market are unfamiliarity and price.

The recently announced lithium Powerwall battery from Tesla is priced well below previous products and has a 10-year warranty. Traditional lead-acid batteries cannot compete with this new benchmark, so it's expected that systems will start to move away from them. Hybrid systems are now expected to become viable on pure economics in a few years or less. Early adopters are already installing lithium hybrid systems, as are some who value maintaining power during a blackout.

Option 1: Solar buffer battery

So how can a battery be added to an existing grid-connected system? The simplest concept is to connect it between the panels and the grid-interactive solar inverter, most likely wall-mounted next to the inverter. From a string of panels, current flows at, say, 400 VDC into the battery during the day. The voltage is regulated to the internal battery voltage, say 500 V. At night, DC current flows from the battery to the inverter and then to the house switchboard at 230 VAC. The inverter doesn't even know that a battery is present—as far as it's concerned the solar panels are still generating!

To work as a proper solar buffer, a sensor at the switchboard is also required. When the house is starting to import electricity

Farming renewably
Reaping the benefits

One person/farm can make a difference: David Hamilton describes how his farm's sustainable conversion cut carbon, benefited the landscape and turned a profit.

↑ Much-improved pasture and happy Wiltipoll sheep.

I'VE READ many inspiring articles in *ReNew* from individuals trying to live more sustainably and lessen their impact on the planet. This article takes a slightly different approach—a rural perspective—to demonstrate that it can be commercially viable to run a farming enterprise using systems that are truly renewable, whether that's for water, electricity, housing, food, livestock, pasture or wildlife.

Our journey to sustainable farming began in 1993, when my wife Roberta and I purchased a 60-acre property in the south-west of WA with the twin objectives of restoring the degraded land and becoming as self-reliant as possible. The land included pasture that was totally lifeless and neglected, along with a dam, two winter streams, old gravel pits and two areas of magnificent remnant native forest. We wanted to be independent for water, electricity and as much of our food as was practical. With fewer bills to pay, we could work fewer hours off the farm—which was very appealing.

As a registered nurse with no farming experience, I was on a vertical learning curve. Luckily, Roberta has a dairy farming background and, with her accounting experience, is a wizard at making a dollar go a long way.

When we began, we were both working full-time. We spent the first two years establishing a gravity-fed water supply, preparing house and shed sites, and fencing the property, including to protect remnant bush from planned livestock. We also planted over a thousand native trees and shrubs, plus a few 'feral' trees for their air conditioning and fire-retardant properties.

Next we built our workshop and shed, complete with bathroom, with fittings sourced from the salvage yard. We set up our bacterial biofilter sewerage system, with the resulting treated water directed as a deep root supply for our planned fruit trees. With these in place, we were then able to move onsite as caravan dwellers. Cooking and refrigeration were from bottled gas, a wood-fired heater provided hot water, and a 500 watt generator provided all our electrical needs.

A healthy soil

Our attention then turned to researching suitable livestock and pasture improvement methods. We already believed that the traditional superphosphate and chemical farming methods were not sustainable, as they are energy hungry, non renewable and destructive of soil microbiology. The idea of working with nature, rather than against it, sat most comfortably with us. This included nurturing the soil back to a healthy state without using chemicals.

In a healthy forest or grassland, the soil is rarely disturbed. Leaves, branches and trees fall and this organic litter accumulates,

Many hands make light work
Collaboration in building

Can a collaborative approach to building design lead to even better sustainability outcomes? Eugenie Stockmann describes a different type of development via The Green Swing.

WHEN setting up The Green Swing in 2010 to develop a plot of land in inner-urban Perth, we wanted to create a distinctly different type of housing development—one that would be sustainable, affordable and with a great community feel. After all, we were planning to live in it ourselves!

The Green Swing is what we called our development company, a partnership of myself, my partner Helmuth and another couple, Alana and Mark Dowley. That first project, Genesis, was completed in 2012 and is now home to the four of us, alongside two other apartment homes. Pleasingly, it went on to win several industry awards.

We learnt a lot along the way; perhaps most importantly, we realised we didn't want to let all that knowledge and experience just fade away. So it wasn't long before we commenced our second project, The Siding, due for completion in early 2016.

Image: Ethan Dowley

↑ The Green Swing crew looking at plans and materials on-site at The Siding with their architect and builder. From left to right: Alana Dowley, Mark Dowley, Sid Thoo (architect), Eugenie Stockmann, Gary Wright (Right Homes, builder), Helmuth Stockmann.

Oversights and inconveniences

We also learnt that there's always room for improvement. One area we were particularly keen to improve was the process of collaboration.

You might think that all buildings are designed and constructed via collaboration. After all, it's very hard for one person to design and build a house completely by themselves. Even the early stages of a project involve a number of people—the client, architect or building designer, draftsperson, engineer, planner and building surveyor, just to name a few.

Yet, the experience of our first project highlighted that effective and meaningful collaboration doesn't always come easy. With so many people involved, it perhaps comes as no surprise that problems, inconveniences and oversights often occur, resulting in head-scratching exclamations such as, "Why did they do that?" or "If only they'd asked before they did..." and "This could have been easily avoided if..."—you get the picture.

To add to the issues, people's idea of and commitment to sustainable building design and construction can vary. The Australian Public Service (2007) described sustainability as a complex, 'wicked' issue, in that no-one knows what it looks like, nor how to get there. Somewhat ironically, their conclusion was that a collaborative approach is best for dealing with wicked problems!

For us, it was experience that taught us the most about what real collaboration means: the importance of open and honest communication to make sure you're all 'on the same page'; that it is not necessarily what you know, but who you know, along with being able to admit what you don't know; that to reach your shared goal, you will need to be able to make compromises. We'd like to share a bit of our journey with you.

Bricks, blocks and panels
What's in a wall?

There are many different approaches used for building the walls of a home, but which one is ideal for your build? Lance Turner takes us on a quick tour of the different systems, materials and their sustainability credentials.

FOR those embarking on a sustainable building project, there can be almost too much information available, making it hard to quickly compare the possible building approaches. One important decision is the wall-building system to use in your build.

To help in that evaluation process, this article provides a quick guide to the different wall-building systems and materials available. For each system, we consider how the walls are constructed, their thermal performance and sustainability. A table at the end of the article summarises each approach in terms of a range of sustainability criteria. It's intended as a quick guide; you'll need more information before you start your build, but we hope to give you a head start on the different systems available.

So, what is in a wall? There are many different methods of wall building, but they all fall into four broad categories—stud frame with cladding, bricks/blocks, cast/poured materials and pre-fabricated panels.

Photo: Copyright Brett and Sue Coulstock of Red Moon Sanctuary.

↑ Strawbale walls can have a wooden frame, or can be load bearing. The bales are fitted and rendered to seal them from moisture and vermin.

Stud frame with cladding

Probably the most common wall system used in Australia is a structural timber frame with cladding, in either a single or double timber stud system.

Single stud walls have one layer of framing—the internal cladding (such as plasterboard) is attached to the inside of the frame and the external cladding (such as weatherboard, fibre-cement or brick, as used in brick veneer, see later) is attached to the outside. Bulk insulation is fitted into the spaces between the studs of the frame, and foil insulation can be added as an additional layer around the outside of the frame, allowing for R-values up to almost R4 with the right material combination.

For example, according to the TasTimber document *R-values for timber framed building elements —walls* (www.bit.ly/1B4K0T2), a 90mm stud wall with R1.5 batts, reflective foil layer and AAC external cladding can achieve an R-value of 3.9.

To enable even more insulation, a double stud wall can be used. Double stud walls are just like two single stud frames, built one beside the other with a small gap in between. The resulting walls can be 200mm or more in depth, so a great deal of bulk insulation can be installed. Of course, a double stud wall costs more than a single stud wall, but its advantages may well offset the extra cost if you live in an alpine area or area with low average temperatures, such as north-west Tasmania.

For a truly thermally efficient home, thermal breaks (thin layers of insulation material) between the studs and external wall cladding should be considered, although the extra expense may not be justifiable in moderate climates where low levels of heating and cooling are required.

Pest damage must also be considered, and the requirements will vary from location to location. In most areas except Tasmania, some form of termite barrier will be required. In cold, damp climates cavity wall ventilation may also be necessary to prevent moisture buildup.

BRICK VENEER

We are all familiar with brick veneer, it being the mainstay of the Australian building industry for many decades, but, as traditionally built, these houses were not very energy-efficient.

Mullum Creek
Guiding residential development

Eva Matthews explores the Mullum Creek project and the building materials guides that are helping owners meet important environmental design criteria.

Image courtesy Danny Mathews

↑ Artist's impression of a home design from Mullum Creek's 'Living Design Principles'.

IN 1958, Bob and Rivkah Mathews—ordinary people with a passion for nature and social justice—bought a property and built a family home on 20 acres of open paddocks and natural bushland in Donvale, a suburb 20 kilometres east of Melbourne. Over time, they bought adjacent parcels of land, growing the property to some 20 hectares.

When the land was re-zoned from rural to residential in 1972, Bob and Rivkah had ambitious hopes to coordinate the development of neighbouring properties so as to preserve the natural landscape as much as possible. Many of the neighbours, however, had other ideas!

In the late 90s, the three Mathews children—Steven, Danny and Sue—reignited the vision with a commitment to conservation, good design and social responsibility. Embarking on a lengthy and complex planning process, they finally saw that dream approved by council in 2012 for the environmentally sustainable residential development that is Mullum Creek.

The property has been subdivided into 56 lots, with each being oriented to maximise access to sunlight (for solar PV and passive design purposes) and views of the creek and bushland. A cycling/pedestrian track will link with the Yarra Trail, enabling an easy fossil-fuel-free commute into Melbourne and the development has 45% dedicated open space.

To ensure the successful implementation of the Mullum Creek vision—beautiful, sustainable homes with a minimum 7.5 Star energy rating—land purchasers are guided by comprehensive design criteria, developed by an expert collective of building and landscape architects, urban planners and ESD consultants, that have been on board since the project's early days. These criteria seek to uphold environmental principles including by using construction methods and materials that minimise their carbon footprint and impact on the environment.

To this end, owners are supported through financial incentives to access architects and design professionals who are familiar with the site and prescribed design principles. The project consultants have also put together a number of materials guides designed to help owners understand the environmental pros and cons of various products and also to make it easier for them to choose those that will achieve their sustainable design ambitions.

Just 18 months since launching the development, nearly all lots have been sold, showing that there is a healthy desire for people to live in harmony with their environment. Let's hope that the blueprint that has been so thoughtfully developed to minimise the residential footprint for this project is mirrored in similar urban and regional developments—and individual projects—into the future. ✱

Building materials guides

The following guides (with entries chosen for their low impact in production, use and/or eventual disposal) are available on the Mullum Creek website.

While they, and several other useful resources, have been developed primarily for the future residents of Mullum Creek, they can be (and the Mathews family hope they will be) accessed by anyone embarking on a sustainable building project.

TIMBER

Includes information about products, species used, recommended applications (e.g. framing, joinery, cladding), manufacturers and retailers.

CLAY

Includes brands, suppliers, reasons for recommendation (e.g. embodied energy, thermal mass properties, sound attentuation, whether recycled/recyclable).

CONCRETE

Includes brands, suppliers, reasons for recommendation (e.g. insulating properties, recycled content, embodied energy, whether locally sourced/produced, meeting environmental/quality standards).

STEEL

Includes brands, suppliers, reasons for recommendation (e.g. prefabrication, efficient processing, meeting quality standards, efficiency of use, strength grade).

View guides at: www.mullumcreek.com.au

Images: www.all-free-download.com; timber—Petr Kratochvil; clay—Teodoro S Gruhl; concrete—tuku; steel—Peter Griffin

SIPs in the tropics
Habitat in the clouds

With thoughtful design, it is possible to live sustainably and comfortably in the rainforest. Paul Michna describes what his family has dubbed their 'trapezoidal mountain habitat', built using SIPs.

THERE are many challenges, but similarly many rewards, when building a home in the tropics. Humidity and condensation, cyclones, rain, site access, land clearing and cooling in a tropical climate all pose questions to be answered.

Our journey to living in the 'jungle' began back in 2002. We purchased this site, surrounded by World Heritage rainforest in far north Queensland, with plans to develop a home. The area was too wet for camping while building (with about 4500 mm of rain a year) so we brought in an on-site caravan for our initial weekend planning visits. In 2005 we constructed our first home, a shipping container retreat (see *ReNew 95*). Surviving cyclones Larry (2006) and Yasi (2010) taught us valuable lessons for construction and design in a cyclone-prone area (see *ReNew 118*).

This knowledge fed into the design of our trapezoidal habitat in the clouds, Studio Nimbus.

Built using structural insulated panels (SIPs), the main living area and half-length mezzanine bedroom float three metres off the ground on two rectangular concrete block pods. The pods double as cyclone shelters and usable space, with one a bedroom and the other 'wet' spaces: a laundry and bathroom.

The elevated main living area keeps us above the splashback of torrential rain, reduces accidental visits by things that slither, creep, bite or hop and maximises airflow beneath and within the living area. The height also permits the abundant nocturnal wildlife to transit the site undisturbed.

↑ Paul and family built their trapezoidal mountain habitat in far north Queensland using a steel frame and SIPs (structural insulated panels) for walls and roof, resting on two cyclone-rated concrete pods. The sun- and weather-prone east and west walls have no windows, though the SIPs design means they could cut and install windows or skylights in the future if desired. Ventilation is well managed through high ceilings and adjustable openings at each end of the main living area.

Building with SIPs

We chose to build the living area from a metal frame combined with steel-enclosed SIPs—being durable and termite-proof, metal suits the challenging humid rainforest conditions.

The SIPs (walls by Askin, roof by Ausdeck) comprise two layers of steel enclosing expanded polystyrene (EPS) foam insulation. The Colorbond provides a durable painted exterior and interior surface, minimising maintenance—it may need a repaint in 25 years time! Once a year we spray using a very dilute swimming-pool-type algicide on the exterior walls; the next rain then clears the walls of any potential growth. The SIPs provide insulation and sound-proofing and can span long distances unsupported.

They're also much faster and easier to build with. The high cost of the panels (and steel frame) was offset in our build by the faster building time and reduced labour. Labour cost was about 18.5% of $280,000 all up; a version minus pods and slab would come in well under $200,000, and urban prices would

Mass effect
The messy realities of mass

Mass in buildings can help moderate internal temperatures, but it can also be tricky to control its effects. Alan Pears examines when and where mass works well—and when it doesn't.

THE way buildings work is very complicated. That's why designers increasingly use computer models that simulate hourly performance over a year to try to deliver good performance. Even that has its challenges! Adding mass to a building is no exception; it can bring significant benefits—and some problems.

This article is an attempt to explore the role of mass in buildings and suggest some paths forward for building owners and designers.

First, 'mass' is not actually what we want. The beneficial feature of mass is that it increases the heat storage capacity of a building so that, for a given amount of heat input or loss, the change in temperature inside the building is reduced. This outcome can be achieved by using a lot of material (mass), materials with a high heat capacity per unit of mass (e.g. water can store about twice as much heat per cubic metre as concrete for the same temperature rise in the material), or by storing energy as 'latent heat' in what are known as phase change materials (PCMs, see more on these later).

High mass buildings tend to sit close to the 24-hour average temperature for the time of year, because it takes a lot of energy to shift the temperature of a heavy building. In much of Australia, especially when 24-hour average temperatures are 18 to 24°C, this means the building tends to be closer to a comfortable temperature more of the time.

Thick, heavy walls slow down the rate of heat transfer into or out of a building, as the 'wave' of heat has to work its way through the thick material. This can delay the heat flow until it cools down (or heats up) outside, reducing heating or cooling energy.

Image: Emma Cross

↑ An uninsulated concrete slab (with fly-ash) and reverse brick veneer are used as thermal mass in this Melbourne house to stabilise internal temperatures. Good insulation and blinds on doors and windows prevent escape of heat when the sun has set. The owners have needed to add active heating for cool mornings and nights, particularly when there's a run of cloudy days; they've found the house works better in the heat than in the cold.

But it can have a downside. I once lived in a house with a west-facing uninsulated cavity brick bedroom wall. It would delay the heat flow from the afternoon sun until after bedtime, so I would cook at night unless the outdoor temperature had cooled enough for me to flush out the heat.

Note that mass does not provide better insulation—but under varying temperature conditions it can have a similar impact on energy use to a small amount of insulation. Confused? Let's look at what this all means in practice.

High mass vs lightweight in operation

Consider two houses of identical design and insulation except that one has high mass (actually, high heat capacity), while the other is lightweight. Let's also assume no heating or cooling equipment is operating.

During daytime, the heat from the sun (and indoor activities) will tend to warm up a house. For the same amount of heat input, the lightweight house will warm up much more. At night when it is cooler, heat leaks from both houses, but the temperature of the lightweight house will drop much faster than that of the high mass house.

Designed to last
Long live sustainable housing

What would our houses look like if we designed them to last 100 years, or longer? Ande Bunbury, designer of the award-winning Double Century House concept, examines the issues.

WITH many houses in Australia designed for just a 30-year lifespan (alongside some that may only last the length of the builder's warranty before major repairs are required), a massive amount of embodied energy is being wasted in our housing stock. Surely we should be designing buildings to outlast us.

We do have examples here in Australia of houses that are 100 to 200 years old. Overseas, there are many still-useful houses that are even older. But effective longevity requires more than just lasting the distance—this article looks at some of the issues to consider when designing houses that last.

↑ The Double Century House concept includes flexible spaces, passive solar design and durable materials and finishes. The modular design uses standard building material sizes to minimise construction waste, and has a small footprint (134 m²) reducing construction and furnishing materials, energy use in operation and maintenance. Materials include a concrete slab with fly-ash, recycled timber boards, reverse brick veneer walls with double-stud construction and external zinc or timber cladding, and rammed earth internal walls.

Sustainable design

First up, there is no point designing a house to last if it doesn't have all the basics right, such as good orientation and aspect, internal thermal mass (where appropriate) and a location with access to transport and connection to community and services. Tweaks can be made later but if the fundamentals aren't right the house could be an ongoing liability rather than an asset.

Of course, existing homes may not have these fundamentals. It's even more important to make the most of the housing stock that we have and renovate well, when possible.

Sustainable design in our changing climate also means considering a warmer or more variable future climate. For example, with increasing heatwaves in parts of Australia, what is the role for thermal mass? In *ReNew 130* (and a recent series in *Sanctuary*), Dick Clarke and the late Chris Reardon considered the difficult question of design for climate change in detail. Long-lived designs need to be adaptable to different future climates.

Flexibility

One term bandied around when considering long-lasting design is 'loose fit': the idea that spaces should be flexible and adaptable. People's needs for housing change over time—small children want to be in the same space as their parents so open-plan design works well; teenagers want more separation and privacy; eventually, the house may become home to multi-generations, with parents and adult children (and their partners) living together, or it may house empty nesters. A well-designed house should be able to adapt to these changing needs without needing to go through multiple renovations. Flexibility for all via universal design is one approach to this (see box).

Another thing that changes a lot over time is technology. Who knows what cooking appliances, for example, may be available in 30 years? That built-in microwave and coffee machine may look really good in your new kitchen, but do you really want to have to replace your kitchen joinery when the appliance dies? A loose-fit design with adjustable shelves and panels can adapt to suit the new fridge or have space for as-yet-unknown devices of the future.

Simplicity

The simpler a system is the less there is to break down and the easier it is to repair. When selecting a system for use in a long-lived house, ask yourself whether it could be repaired if the original company goes out of business or they stop making that product or component.

For example, I prefer close-coupled solar hot water units over split systems, as they don't need a pump to shift the water from the panels into the tank. Another example, perhaps more controversial, is a preference for timber window frames over thermally broken (insulated) aluminium as the hardware to operate them is simpler and can be replaced, and the frames can be repaired and even partially rebuilt if needed.

Go with the flow
A micro-hydro buyers guide

A micro-hydro turbine can be one of the cheapest sources of reliable electricity—if you have the right site. Lance Turner looks at what's available.

Image: Eco Innovation

↑ Hydro turbines are small compared to other renewable technologies, and on a suitable site can have minimal environmental impact.

SOLAR panels are the energy generators of choice for most domestic renewable energy systems, but there are other forms of renewable energy generation that can provide supplementary or even primary power generation if you have the right site.

One possibility is a micro-hydro system: the production of energy from water, with domestic-scale systems sized up to 100 kW. If you have a rural property with a suitable water source, then micro-hydro may be a good option, particularly if a high tree canopy precludes the use of solar panels or wind turbines.

The kinetic energy stored in flowing water can be considerable. You just need to look at the deep pools often found below large waterfalls or how the rocks in a creek are worn smooth by the flow of water. To get an idea of the forces involved, try aiming the jet from an ordinary garden hose at your hand. You will feel the force of the water striking your hand and being deflected. This is basically how many hydro turbines work.

Run-of-river versus dammed

Hydro systems fall into two broad designs—run-of-river and dammed systems.

Run-of-river systems simply take water from a high point of the river or creek, pass it through the hydro turbine and return it to the river or creek at a lower point. Only a portion of the water in the water source is diverted through the system.

In a dammed system, the water source is dammed, producing a water reservoir. The height of the water behind the dam produces the required head for the hydro turbine (the head is the term commonly used to describe the vertical height of the water column that is producing the pressure to run the turbine).

Most domestic systems are run-of-river types, as these produce the least environmental impact and are the cheapest to install. They are also the type your council and/or water authority is most likely to approve. After all, damming a water source can cause considerable environmental disruption and should be avoided.

Some run-of-river systems do use a small dam, known as pondage, to ensure an adequate flow into the intake pipe. The amount of pondage can be small or may be increased to provide more reliable energy output from the turbine during times of lower water flows in the water source. It is possible to use pondage that is separated from the water source completely, to prevent any negative effects on the water source.

Layout of a system

The basic layout of most micro-hydro systems involves a turbine, mounted at some low point on the creek or river, being fed by a supply pipe running from a higher point in the water source. The weight of water in the pipe causes a relatively high water pressure at

Cooking Challenge
ReNew enters the kitchen

For our recent cooking challenge, we asked *ReNew* readers how they're reducing their energy use in the kitchen. In true *ReNew* fashion, we got entries addressing the problem from a range of DIY angles.

AS ALAN Pears highlighted in *ReNew 130*, while the kitchen is a small part of energy use in the full food system, it can be a significant part of household energy use, particularly for low-energy-use households. From improving our understanding of the energy efficiency of appliances and cooking techniques to improving the insulation in saucepans, Alan presented a range of things to think about when you get into the kitchen.

The entries in our competition reflected that. Several tackled the topic by looking at equipment, with pressure cookers, solar ovens and haybox cooking featuring. Several looked at techniques, such as not cooking with a half-empty oven, defrosting food in the fridge (or on the bench) and even cooking multiple things in a stack of pots, to use the escaping heat.

And the winner is...

The ATA crew particularly like Jan Heskes's entry, making that our winner: it's a practical, simple approach to reducing energy use. We've included the winning entry in full, along with parts of several other entries that reflect the range of responses. Jan wins a GoalZero portable solar USB charger kindly donated by Laughing Mind and valued at $169.

↑ Four loaves of bread, one large lasagne, 12 chocolate chip and walnut biscuits, 15 herb and mushroom quiches and 12 tofu patties—all cooked in one cooking session of 90 minutes, including pre-heating the oven, compared with about 250 minutes if each item was cooked separately.

WINNER: Never cook with a half-empty oven

Jan Heskes

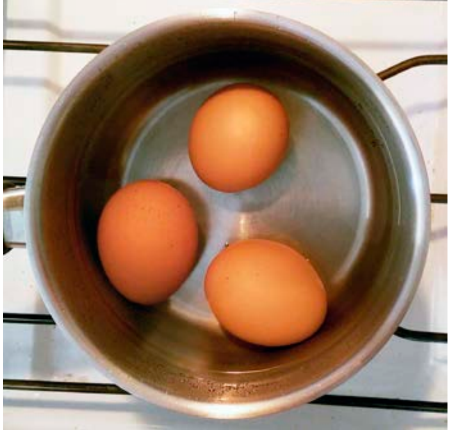
Much as we would like to, we cannot always afford to have the latest energy-efficient appliances in our home. However, by using what we do have more thoughtfully, we are still able to significantly reduce our energy consumption.

Our kitchen contains a standard-sized stove with a fan-forced electric oven and gas cooktop. The stove is a few years old and would have been energy efficient for its time. Before turning on the oven I plan and prepare as many dishes as possible to bake while the oven is heated. Surplus food produced is stored in the freezer for future meals. The freezer is also used efficiently by avoiding operating partially empty. With ongoing planning, food is defrosted passively and reheated either quickly in the microwave or, if possible, in conjunction with accompanying dishes. As a result the oven is generally only used about once a week in our house even though nearly all of the food we consume is homemade.

Performing under pressure

David Gobbett

Pressure cooker, pressure cooker, pressure cooker...and did I mention using a pressure cooker? Reduces cooking times and at lower temperatures, once pressure is reached.



Egg-cellent eating

Pauline Grayson

Here's a handy tip I learnt about boiling eggs. In a pot of water, bring the water with the eggs to the boil (cover on). Turn off the heat. Leave for 3 minutes for soft boiled eggs and about 10 for hard boiled. Feels great every time I switch off the heat knowing I don't need it to get perfect eggs!

Resurrecting discarded power tools
Black & Decker 'Orange' drills

Julian Edgar shows us how to assemble a recycled electric power drill for nearly nothing.

↑ Almost like a new one! It's easy to assemble a good working drill from a few faulty ones.

WANT a high quality mains-powered drill that will cost nothing and last nearly forever? You can—just assemble one good power drill from a bunch of old and broken Black & Decker drills.

But first, why would you bother?

Black & Decker must have sold tens of thousands of their 'orange' drills in Australia in the 1970s and 80s. In those days, well before cheap Chinese-made drills flooded the market, these power drills were relatively expensive—and well made. They were also designed to be repaired as required, rather than just thrown away.

And they were tough. Drop one on concrete and it just bounced. Overload it by driving a 50mm hole-saw through chipboard and you could make the windings smoke. But if you then stopped drilling and free-ran the motor for a minute to cool it, you'd have likely done no damage.

So, unlike the vast majority of modern-day drills, these drills are durable and easy to repair. Furthermore, although the drills were produced in different models over the years, many parts are interchangeable. If you have (say) three broken B&D orange drills, the chances are that you can easily make one working drill—and it will then last you another decade or two.

Collecting

It's worth picking up every old orange B&D power drill that you can find. At rubbish tip shops you'll often find drills with the cord cut off (so they don't have to test and tag it)—buy them for a dollar anyway. Some drills have chucks that are old and worn—grab them. Others will be covered in paint splatters or abrasions—pick them up and take them home.

A surprising number of these old drills will be fully operational—and still be available free or for only a few dollars.

Testing

The first step after collecting a drill is to test it.

Make sure that the chuck rotates smoothly and grips drill bits correctly. There shouldn't be any lateral movement in the chuck and when you rotate the unpowered drill by turning the chuck, the motor should spin smoothly.

If the cable and plug are still intact, power-up the drill and check it works correctly without odd noises, or sparks from the commutator (the part of the drill motor's rotor that the brushes rub against).

Disassembly

If you have a defective drill, the first step is to pull apart the handle, revealing the speed control (integrated into the trigger switch), wiring and brush holders. Older drills have normal Phillips head fasteners in the handle, but later models use tamper-proof fittings. Screwdriver bits are available for these tamper-proof fittings, or you can remove the screws by drilling out their heads—although note that the screws are quite hard.

The gearbox on the front of the drill—cast aluminium cased in older models and plastic on later models—is held on with normal Phillips head screws, so these can be easily removed. While you are looking at the