ReNew

Technology for a sustainable future

Issue 143

BUILDING MATERIALS SPECIAL

WIN a Flex PowerPlay smart solar home system valued at up to **$7999**

*Australian residents only; details p97

Windows: *retrofit or replace?*

9 glazing case studies

PLUS

Off-grid on the edge

Fabric of flooring

How new feed-in tariffs affect you

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Electric vehicles: make your home EV-ready
Drawdown: plan to reverse global warming
Gas vs electricity: your hip pocket guide
Living buildings: beauty + performance

Window and Film Buyers Guide inside

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Building materials special
Flooring options, windows guide + more

↑ This eco-housing estate in Castlemaine, Victoria, is being built to the Living Building Challenge requirements. We have a look at what's involved. Page 24.

↑ A new type of feed-in tariff could reduce your energy bills: we look at time-varying FiTs, proposed for Victoria. Page 38.

↑ This sustainable reno included some interesting material choices, including phase change materials under a timber floor structure. Page 52.

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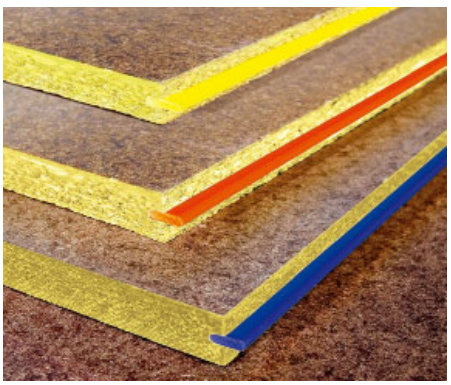
Special: Building materials

↑ Paul Hawken's Drawdown project brings together peer-reviewed science on the "top 100 solutions to climate change". Page 20.



↑ Tongue-and-groove particleboard is a popular floor substrate material as it is relatively low cost, strong and durable. We explore this and other options for floors and sub-floors. Page 42.

← **Cover image: Hilary Bradford.**
Large east-facing double-glazed timber windows and sliding doors are a key feature of this extension in inner-northern Melbourne, designed by Baker Drofenik Architects. They help fulfil the brief to admit plenty of light into the new kitchen and living space, and improve the family's connection with their beloved garden. Read the full house profile in *Sanctuary 38*. Find our guide to improving your windows on page 56, with case studies showing how nine households went about it, starting page 68.

Window and film buyers guide

Image: Paarhammer.

↑ Windows can be critical for good home energy efficiency. We check out the options for high-performance windows and upgrades, starting on page 56.

Electric vehicles

↑ Secondary glazing can even be installed DIY, as described in our case studies. Page 72.

↑ What does it take to get your house EV-ready? Page 86.

Regulars

Small battery uptick

Recent figures from the Clean Energy Regulator, outlining the uptake in Australia of small-scale battery storage, reveal a 914% increase (693 to 7032 units) from 2014 to 2018. The figures represent voluntary disclosure of new system installations, and don't account for those not disclosed nor those that may have been retrofitted, so the real figures are likely to be higher. And although battery system uptake only constitutes 2.5% of total PV systems installed in Australia last year, this is still just over double what was installed in 2016 (1.18%).

On the back of this sort of interest in storage batteries and sales growth, alongside nation-leading renewable energy policy and targets, and incentives promised by both major parties, German battery manufacturer Sonnen will be setting up a manufacturing plant in South Australia and moving its current Sydney headquarters to Adelaide. This will not only create around 400 jobs, but will also provide a cheaper battery storage option for the local market, using locally sourced components (apart from the cells, which are manufactured in Japan) and eliminating the significant cost currently tied up in shipping complete battery units from China or Germany. Sonnen hopes the SA plant will be established and producing its first batteries by the end of this year.

www.cleanenergyregulator.gov.au, www.bit.ly/2FtjOUw

Year	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Total
2014	8	208	3	129	34	5	137	169	693
2015	3	133	1	186	21	6	163	24	537
2016	105	667	6	331	130	18	240	70	1567
2017	183	1742	16	773	445	90	686	204	4139
2018	7	38	0	26	12	0	9	4	96
Total	306	2788	26	1445	642	119	1235	471	7032

↑ New solar PV systems with battery storage by year and state/territory as at 31/1/2018. Note that RET certificates can be created up to 12 months after installation, so 2017+ figures will rise.

A new Z-Net shire with ATA help

Following in the footsteps of Australia's first Z-Net town (Uralla NSW, as reported in *ReNew 141*), Hepburn Shire in central Victoria is focusing its efforts between February and August this year to develop its Z-Net blueprint in a journey to become carbon neutral and source its energy from 100% renewable sources.

Once this blueprint is completed, the Coalition for Community Energy (C4CE), of which the ATA is a member and active contributor to this project, will work with the community and key stakeholders (including Hepburn Wind, Council and local sustainability groups) to develop a transition plan for the Shire to achieve its goals as outlined in the blueprint.

The majority of funding for the project ($80,000) comes from Sustainability Victoria, as part of its TAKE2 Community Transition Pilot—a climate change program that supports individuals and organisations to help achieve the state's target of net zero emissions by 2050 and keep global temperature rise under 2°C.

www.bit.ly/2I8gYHU, www.take2.vic.gov.au

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

Block the heat, not the light

If you have an existing skylight that lets in too much heat, you could install an internal skylight blind, but that still lets in heat proportional to the amount of light allowed in.

The Solar Shade from Solar-Shades in the USA is a simple cover that is fitted to the outside of the skylight. You provide your skylight measurements and they make the cover to fit, and ship it to you.

Covers are available in two different materials—80% and 90% heat and UV blockout—and five different colours—stucco, grey, beige, brown and black. The 80% blockout still allows in 75% of visible light, so you have the advantage of a skylight without the heat and UV problems, which is much better than an internal skylight blind.

The covers can be designed to fit any skylight shape (square and rectangular are the standard shapes) and are held in place with a simple pull-tight cord arrangement. They don't need to be removed in winter, so you fit them once and forget them.

Rated lifespan is 15 to 20 years, depending on material used, your location, skylight orientation and the shape of your skylight dome (flat skylight shades tend to last longer). The covers come with a two-year warranty for domestic covers and three years for commercial covers.

RRP: POA. For more information and to order, contact Solar-Shade, wfalch@sbcglobal.net, www.solar-shade.com

02

Reducing ocean plastics

In recent years it has become clear that the ocean is full of plastic—it's an environmental disaster.

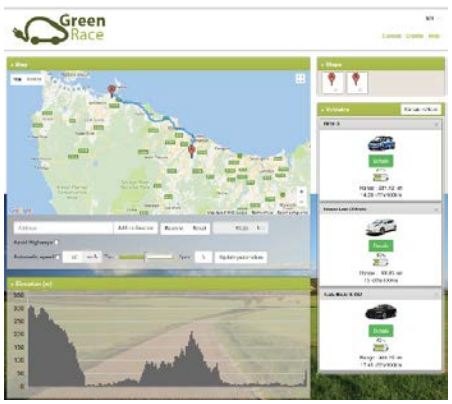
The Seabin, designed by avid surfers Andrew Turton and Pete Ceglinski, is a simple device to remove plastics from the ocean. It consists of a floating basket which sits just below the surface, through which high volumes of seawater (up to 25,000 litres per hour) are drawn by a pump at the bottom of the basket. Any floating debris near the Seabin is drawn into the basket and retained, with the now much cleaner seawater returned to the ocean.

The Seabin can extract around 1.5kg of debris a day, or half a tonne per year for each Seabin. It will extract any debris down to 2mm in size, so can help remove microplastics. Given each marina and port could host dozens of Seabins, it's not hard to see that a lot of plastic could be removed if many of the world's marinas and ports installed these devices.

The Seabin's pump draws around 500W, so the total load can become significant. This is the main drawback we can see with this design, although if powered by renewables, this problem can be eliminated—maybe a solar-powered version is needed!

The Seabin Project is currently based in Europe, but launches in Australia in early 2018.

RRP: €3300 (discounts apply for quantities above 10), currently only available to ports, marinas and yacht clubs. For more information go to www.seabinproject.com



03

Better EV range estimates

Have you been looking for a way to accurately estimate your EV range on the trip you are planning and are not sure whether your EV's built-in range 'guessometer' is accurate enough? Well, you might want to visit the GreenRace website.

By selecting the EV you drive and the route you plan to travel, the site will show you a far better estimate of whether you have the range required than you'll get from the meters found in most EVs.

Once the route is chosen, the screen will also show you the elevation of all sections of the trip, as well as give you the choice of reducing average speed or avoiding highways to extend the range in marginal situations. For more advanced users, you can even modify the vehicle parameters to allow for battery degradation etc.

You can also hit the reverse button, which shows you the route in reverse, adjusting the range estimate accordingly, so you can work out if you have enough range to do a roundtrip without charging.

Combine this site with PlugShare (which shows where charging stations are, including shared home stations) and you have all the tools you need to plan your next long-distance EV adventure.

RRP: Free to use. For more information and to use the range estimator, go to www.jurassictest.ch/GR. PlugShare is available at www.plugshare.com

Drawdown
A plan to reverse global warming

Paul Hawken's Drawdown project brings together peer-reviewed science on the "top 100 solutions to climate change", highlighting the benefits and costs of each. ATA member Tom Hunt met with him recently in Melbourne.

IN MID February, I was privileged to meet Paul Hawken in Melbourne while we were both touring Australia. I was merely on holidays while the US environmentalist, entrepreneur, journalist and author was presenting the Drawdown project to a large and enthusiastic audience at an event organised by Sustainability Victoria at RMIT. Having presented on the Drawdown project myself at our local ATA branch meeting in Wollongong, I was keen to meet the man behind it all. I learned more than I expected during a spare 15 minutes he had before his presentation—including some good advice about yoga for my ailing back!

Drawdown, the book, is Paul Hawken's latest bestseller, but it is far more than a well-illustrated and readable tome. It represents the combined work of 70 scientists and researchers, and tells an inspiring story of the most important things we can do to combat climate change. It calculates just what we can achieve in terms of greenhouse gas emission reduction by applying the technologies and knowledge already at our disposal. The book is supported by the drawdown.org website, which also presents the data in a very accessible way, gives more information on the methodologies and updates the results as research continues.

Deciding what's important

So what is the most important thing to focus on in the battle to combat climate change? Is it more important to replace coal with wind turbines, to put solar on every rooftop, to switch to electric vehicles or just to stop eating meat?

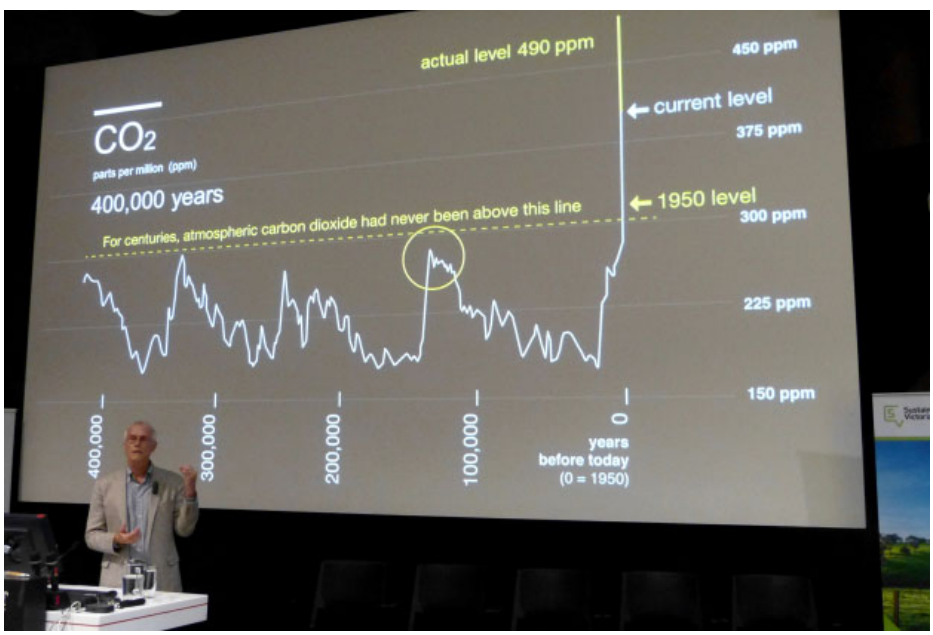
This is the type of question many people have posed, but few have properly explored. Back in 2001 Paul Hawken started asking the experts: "Do we know what we need to do in order to arrest and reverse global warming?" But the experts had no overall picture, only the knowledge within their own spheres of expertise.

Greenhouse gases are at an all-time high. In 2013 Paul was so concerned by talk of the unthinkable 'game over', he decided to pull together all the experts he could and work out, for us all, just where we stand on global warming with the options we have.

Drawdown, touted on the cover as "the most comprehensive plan ever proposed to reverse global warming", was on the *New York Times* bestseller list within a few weeks of its release mid last year. The very readable book gives a brief chapter to each of 80 well-researched currently available solutions and to a further 22 upcoming technologies that hold great promise.

Each of the 80 proven solutions comes with a solid calculation of what effect it can have on slowing global warming, measured in gigatonnes of CO_2-e (CO_2 and equivalent gases) reduction. For each solution, the research considers the resources and infrastructure required, and the costs, and estimates what can be achieved within the next 30 years, as a plausible target for implementation.

Also contained are chapters on 22 very promising but as yet not-fully-explored solutions that can take us further, to draw down the atmospheric CO_2 to a level we can live with.



↑ Paul Hawken presenting in Melbourne on Drawdown. This graphic slide, included in the book, shows CO2 levels in the atmosphere over the last 400,000 years, with a huge increase since 1950.

Living building challenge
Enhancing the local environment

Central to the Living Building Challenge is design that takes account of much more than thermal performance, such as giving back to the local economy. Sasha Shtargot looks at one of the first projects taking this on in Australia.

WHEN architect Geoff Crosby was approached in 2008 by Neil and Heather Barrett about their plans to develop an eco-housing estate, The Paddock, on their 1.4-hectare site in Castlemaine in central Victoria, he was keen to find a rigorous green design framework.

Geoff had been to a talk at Melbourne University about the Living Building Challenge (LBC) and was impressed enough to do some more research and eventually use it in his own work. The framework appealed because it was thorough in its approach to sustainability and it accorded with his own philosophy of tackling issues like water conservation, community and connection to nature firmly through a local lens: "My perspective is that good things come from the local context—you get much richer solutions that way."

The LBC "ticked all the boxes" for both him and the green-focused site owners. The building standard, set up in the USA in 2006 by the International Living Future Institute, consists of seven performance areas, known as 'petals': place, water, energy, health and happiness, materials, equity and beauty. The aim of the LBC is to create excellence in green design; it visualises the ideal building as functioning as cleanly and efficiently as a flower with many petals.

The standard seeks to create healthy, regenerative and efficient spaces that give more than they take out of the environment, making a positive impact on people and nature. Geoff describes it as "the most rigorous and realistic approach to sustainable design he has found so far." Sustainability academic (and keen supporter of the LBC, and this project) Dominique Hes notes: "There's a reason it's called a challenge!"

Registering with the LBC indicates a commitment to meeting the standard, but certification is only possible 12 months after the building is completed, when third-party auditors come in to ensure performance stacks up to what is required.

The strenuousness lies in the comprehensive nature of the LBC—within the seven areas covered by the standard are 20 'imperatives': requirements that must be fulfilled. They include net positive energy, net positive water, net positive waste, urban agriculture, limits to growth, a biophilic environment (the human-natural environment connection which improves both a sense of wellbeing in people and enhances local ecology), habitat exchange, responsible industry and living economy sourcing (project materials and services must be within a local radius, improving the local economy).

Of the three key areas of energy, materials and water, the latter two, Geoff says, have been the hardest in planning The Paddock: "With energy, the technology is there to make us net-positive, so water and materials are where the challenges lie."

He learnt much from an earlier project, the Bull Street Terraces in Castlemaine, which he also designed to LBC specifications: "We learnt that the LBC was doable but that water was going to be the hardest petal to achieve, even though everyone talked about materials being the most work (which it is!)."

Building work on part of the Terraces project has started and has taught Geoff much about the demands of working with tradespeople not used to the rigour of an LBC design, as well as dealing with waste and finding materials, fixtures and fittings that will fit a budget and still comply with the LBC.

↑ At the site with owner Heather Barrett and architect Geoff Crosby. The paddock-like site has some existing trees which will be kept as part of the restoration plans.

Off-grid on the edge
Not quite off-grid, but reliable

Jayne and Cathy Malcholm struggled with power reliability in their location on the edge of Melbourne, so in 2016 they installed battery backup as part of their long-term plan to go off-grid. They describe the system and results.

WE LIVE on the outer edge of Melbourne in a low-energy house which was designed with solar in mind. It has a north-facing roof pitched at 45 degrees to slightly favour winter solar collection. We are on the end of a SWER (single wire, earth return) power line, which over the years has proved to be very unreliable. It was this unreliability that drove us towards a solar + battery system; the power would go off a couple of times a week, resetting our clocks and dropping out the computer, not to mention the inconvenience of sitting in the dark.

We began our project in mid-2015 with some research on solar installers and chose a company that does both domestic and commercial installations. With Jayne having a technical background, she had a lot of questions before we signed on the bottom line. The negotiation took about three months. We kept refining the system specification as we better understood what was being offered and what seemed appropriate for our needs.

If you are thinking of going down the solar or battery storage route, our advice would be to pick a reliable company that is willing to spend the time answering all those difficult questions. It may cost you a little more, but our experience is that you get what you pay for, both in terms of product and installation quality.

↑ The solar panels are mounted at the eastern end of the house to avoid afternoon shading issues. There is some morning shading, which is dealt with by the microinverters which are mounted on the panels at the east end of the array.

System requirements

Our requirements were based on our long-term goal of being able to go off-grid; we are already off-grid for water. We decided to design for going off-grid while initially keeping our system on the grid to enable us to test whether it would meet our needs.

We wanted the system to be able to power the house for two days without significant solar input and to be able to start a water pump for fire-fighting purposes. As we were intending to install solar hot water collectors, we did not consider PV water heating at this stage.

Choosing the battery type and size

We spent some time looking at which battery chemistry would best meet our needs. Lithium batteries looked impressive with their ability to handle a low state of charge (SOC), but at the time the price was outside our budget. We also had some concerns about lithium batteries in a fire.

We also considered the Aquion salt-based batteries and while these appeared to have a good minimum SOC capability and good environmental credentials, their size was an issue: they are much larger to deliver the same load as the other chemistries we looked at and would not fit the space we had available.

A few other battery chemistries were becoming available at the time, but they hadn't been on the market long enough to see if they were up for the long haul. In the end, we opted for 32 kWh of lead-acid gel batteries.

Settling on the configuration

Our configuration is a little out of the ordinary in that it uses both AC- and DC-

Feeding the grid
Varying solar payments by time of day

The ATA's Keiran Price explains how minimum solar feed-in tariffs are set and helps demystify an intriguing new time-of-day feed-in tariff proposed for Victoria from July.

A FEED-IN tariff is a pretty straightforward concept—it's the money paid to a household or business for solar electricity which they generate and export to the energy grid.

Feed-in tariffs were initially designed to ensure that a home or business that installed solar (or other renewable energy generation) achieved a competitive payback over the life of the system. Nowadays, the key purpose of the feed-in tariff is to ensure that homes and businesses are fairly compensated for the renewable electricity that they provide into the grid. But that competitive payback is still there!

↑ Feed-in tariffs for solar generation have decreased over time, moving from providing a competitive payback over the life of the system to ensuring fair compensation for the renewable electricity supplied to the grid.

Germany led the way

It can be argued that Germany is the home of the feed-in tariff. They introduced the world's first feed-in tariff specifically targeted to subsidise renewables in 2000. Since then, feed-in tariffs for renewable energy generation have been introduced in over 40 countries, including Australia in 2008 (in South Australia and Queensland).

Early feed-in tariffs were designed to give certainty to renewable energy generators on the level of return that they would see on their investments. By having a fixed payment per kilowatt-hour, for a fixed period, it was easy to determine the payback time—how long it would take to earn enough money to pay for the initial investment and then start profiting—which made financing easier. The aim was to increase uptake and installation of renewable energy generation, with the multiple benefits that flow from that.

One such benefit is the reduction in greenhouse gas emissions that flows from increased renewable energy generation. This makes it easier for governments to meet targets for renewable energy. Another benefit comes from the increased demand for renewable energy technologies; this increases research and innovation in the industry, and leads to increased levels of production and cheaper products for consumers—as we've seen with the incredible price drops of solar technology.

As the cost of installing renewable energy generation like solar has decreased, the level of support from feed-in tariff schemes has also decreased. In Germany, Australia and other countries, the feed-in tariffs provided have decreased to the point that the initial tariffs look unbelievably generous!

In Germany in 2004, the feed-in tariffs guaranteed to new solar PV for a period of 20 years ranged from 45.7 to 57.4 c/kWh. By 2014 the rates had fallen to 8.9 to 12.9 c/kWh (still guaranteed for 20 years). However, at the same time the cost of installing solar PV has been decreasing by around 14% per year. Installing rooftop solar PV is now more than 75% cheaper in Germany than it was in 2006, with the cost of the solar panels themselves reducing even more.

The net effect is that the 'levelised cost of power' for solar PV has stayed roughly the same in Germany from 2000 to now. With low solar PV prices, new purchasers of solar are getting a similar payback time and percentage return on investment, even though the feed-in paid per kWh has dropped significantly.

Decreasing feed-in tariffs in Australia

Unlike in Germany, the retail energy markets and feed-in tariffs in Australia are managed at a state level, rather than nationally. But similar to the German experience, every state and

Strength, stability and performance
The right floor for your build

When building, you may put a lot of thought into the floor coverings, but what about the sub-floor structure? Both are important to ensure a sustainable result. Lance Turner surveys the options.

WHEN building a home, often very little thought is given to the type of flooring and sub-floor structure used. Yet different sites need different materials, with some being far more appropriate for particular sites. The design of the rest of the house will also help determine the type of floor and sub-floor used.

Your architect will have good ideas about the best flooring system to use, based on their experience with the type of building system you are using and the site specifics. But it helps to have a good understanding of the flooring systems available, so that you can consider the pros and cons of different systems and materials, and ensure that your sustainability or other requirements are met.

So let's take a look at the most common types of flooring systems (or, more accurately, sub-flooring systems), the materials most commonly used and the types of flooring materials they can support.

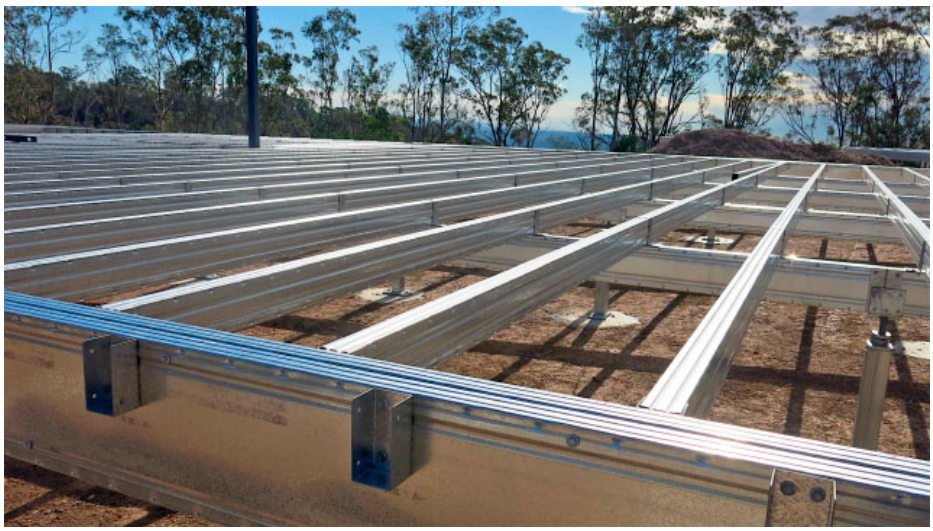


Image: Spantec Systems

↑ Lightweight steel framing, such as this Spantec Systems sub-floor, is not only termite-proof when used with steel wall and roof framing, but can reduce the number of footings required due to the ability to have wider spans between beams.

Flooring requirements

A floor/sub-floor system must obviously be able to bear the entire load on top of it, potentially including the house, contents and occupants (some floor structures, such as upper floors, will only need to support the contents/occupants).

The floor's footing system must be suitable for the type of soil you have on your block. A soil report will be required which will tell you your soil type and how reactive it is. Reactive soils are soils with a high clay content which swell when wet and shrink as they dry. This expansion and contraction can cause structural cracking, sinking and other site issues. See www.bit.ly/2oKu9GC for a quick rundown of soil types.

The level of insulation required for your home will also be a factor in the type of floor you select. If you are in a cold climate then you will need a highly insulated floor, so an insulated slab or a floor on stumps that can be insulated underneath will be required.

Insulation doesn't just mean thermal; you should also consider noise. For detached dwellings, noise transfer up through a ground slab is normally not an issue. Downward noise transfer from an upper level through a suspended slab to the lower level can be a problem, and underslab insulation can reduce this. The same applies to a floor on stumps—underfloor insulation will reduce noise ingress, especially if the insulation is acoustic grade.

Of course, durability is also important: the floor must last the life of the home—for example, you don't want to have to be restumping in 10 years due to degradation of the stumps or soil movement.

Thermal mass must also be considered if your house design makes use of it. A slab provides high levels of thermal mass, although heavyweight walls (on the room-side of the insulation) tend to provide better thermal mass both in winter and summer than do concrete ground slabs. Other floor types can have thermal mass added using a number of methods, from thick ceramic tiles or slate, to adding PCMs (phase change materials).

If you live in a bushfire zone then fire resistance will be an important consideration. With a raised floor, you don't want materials that can easily combust, so a heavy steel sub-floor is a good option (lightweight steel subfloors can absorb heat, soften and fail). For

Material beauty
Floor and glazing upgrades

Dion and Amy Zappacosta's reno included some interesting material choices, including a raised timber floor rather than a concrete slab, recycled materials and eco-finishes. They describe how they went about it, and the results.

↑ Looking out to the backyard from the finished kitchen/living room, with the recycled timber benchtop.

BACK in 2013, our family of four was looking for a new home in Wollongong, NSW. One of our main criteria was that it be on a flat block, as our previous home was a pole house on a very steep block—not great for family living! We were also looking for a house where the kitchen faced the backyard, and the yard itself had the potential to be kid-friendly and accommodate a decent vegie garden and fruit trees.

The house we found wasn't ideal, but it had potential. A timber-framed weatherboard, around 80 years old, it was showing its age, but still retained some of the charm of its era.

There were lots of problems. It was suffering from some pretty average additions and modifications done in the 60s, including a filled-in section of the western verandah and an unattractive bathroom/laundry fibro extension. The layout and thermal performance of the house wasn't great, as we found after living in it for 18 months. It was cold and draughty in winter, with only a sliver of winter sun landing on the kitchen bench. The high ceilings and steep pitched roof helped in the summer, but cross-ventilation was non-existent and most evenings were warm and clammy. The bedrooms and living room were a decent size, but the kitchen/dining space was very cramped. We knew we could work with it though.

The advantage of using an architect

From the outset we knew we wanted a bit more space and to improve the layout and remedy some of the dodgy alterations. We had no intention of demolishing the original part of the house, and were looking to improve the kitchen, dining, bathroom and laundry, as well as add some living space. We also wanted to do it in a way that improved the thermal performance of the house and not have to sit at the breakfast table shivering in a dressing gown and slippers!

We talked to architects and draftspeople with a brief of wanting to make sustainable modifications which incorporated passive solar design. The choice to go with Andy Marlow from Envirotecture was easy. We developed a good rapport with him from the first meeting; being aligned in our views on sustainability and the environment was a great reference point for discussing the designs and materials Andy had in mind.

The architectural fees through to start of construction can be daunting at first, but we decided the value of having an architect on board far outweighed this. Andy found ways to include what we wanted on a smaller construction footprint, which reduced our costs significantly. The comfort the finished house provides is also superior to what we could have specified ourselves. The specification schedule and scope of works documents vastly simplified the builder engagement process and the build itself.

It took about five months for Andy to provide initial plans, which were developed from our initial brief and a site visit to walk through what we were envisioning. It took another five months to refine the plans and lodge for approval. After going through the process of finding the right builder and organising finance, construction commenced 12 months later in 2016.

Windows that perform
A window and film buyers guide

Poorly performing windows can drag down the thermal performance of your home. Lance Turner looks at some solutions.

REDUCING heat flows through windows and doors is critical for maintaining a comfortable temperature during weather extremes. Heat flowing through an unprotected single-pane window can be considerable, affecting the thermal performance of an otherwise well-insulated house. In fact, a single-pane plain glass window has almost no insulating ability—around R0.2.

The Australian Window Association (AWA) estimates up to 40% of a home's heating energy can be lost through windows and up to 87% of its heat gained through them. Choosing high-performance windows, combined with sensible window placement, insulating blinds and other window improvement methods such as special films and coatings, can reduce energy costs and improve thermal comfort. Understanding how different windows interact with the design of your home can be key in window selection.

↑ Double glazing can be used in any window, such as this bay window made by Rylock.

Heat transfer

There are three main ways heat transfers through windows: radiation, conduction and air infiltration.

Firstly, heat is lost by indirect radiation. Warm objects inside the room radiate heat at long wavelengths (between 5 and 40 micrometres). This energy cannot pass directly through plain glass as it is opaque to such long-wavelength radiation. However, some radiant energy is absorbed by the glass and this is conducted through the glass to the outside. In summer, the reverse occurs, with long-wavelength radiant heat (radiated by hot air and hot surfaces outside) passing indirectly through the glass into the room.

Still greater is the transmission of radiant short-wavelength solar energy—consisting of visible sunlight plus near-infrared radiation—which is largely transmitted directly through clear glass.

Secondly, heat is lost through conduction—direct transfer of heat from the warm side of the window to the cool side. In aluminium frames with no thermal break, heat is conducted up to six times more readily through the frame than the glass, as aluminium is such a good heat conductor.

In winter, conduction from inside to outside also drives a convection current on the inside of the window, accelerating the rate of heat loss. Warm indoor air cools when it comes in contact with cold glass and falls to the floor, drawing in more warm air from above. This heat loss method can remove a great deal of heat from a room.

If your heating system has outlets directly under or above the windows, this will increase heat loss by increasing the temperature differential at the glass and breaking up the air layer on the inside of the window (although deflecting the warm air away from the window will help).

A final method of heat transfer is air infiltration. This occurs when air leaks through the gaps between the inner frame

Glazed and enthused
Window replacement case studies

Replacing the entire window with a new double-glazed one was the answer to greater energy efficiency and thermal performance for these homeowners.

Switching to double glazing as part of a renovation

by Anna Cumming

Last year, we did a small renovation at the back of our 1920s Californian bungalow in Melbourne's north, opening up the space across the back of the house and putting in a new kitchen. As part of the renovation, we installed glazed French doors opening onto our deck and new windows in the kitchen; we also took the opportunity to replace ugly aluminium-framed windows in our living room and a bedroom with efficient new windows.

We wanted timber frames for aesthetic reasons and to fit the character of the house. Sustainably harvested, ideally local timber was important to us, and I wanted the flyscreens to be timber-framed too as they are internal and thus quite visible. For thermal efficiency, we upgraded to double glazing, but did not dig too deeply into the precise performance specifications of the various options as we are realistic about our old, leaky weatherboard house—basic double glazing would definitely be an improvement, but top-spec windows, low-e coatings and so on probably not worth the extra money!

Our first step was to decide on sizes and styles and put together a brief for our four new windows and one glazed door unit. Two of the windows were direct replacements for medium-sized existing ones, although we opted for casement openings to catch breezes instead of sliding openings. In the new kitchen, we replaced a large west-facing window that had admitted far too much afternoon sun with a long, narrow fixed glazing 'splashback' window between the new benchtop and overhead cupboards; above the sink on the north wall we decided on a 1100 x 1800 mm window with a sliding opening. In the centre of the north wall, we replaced the existing single back door with a pair of double-glazed doors we'd been lucky to acquire for $100 several years earlier from a neighbour's builder—they had been made the wrong size for the job. As part of our windows order, we had a frame made to fit the doors, with an extra window pane on one side.

We sent the brief (see box) to seven

↓ A large window on this western wall that admitted too much afternoon heat was replaced with a long, narrow 'splashback' window for the new kitchen. External shading is planned to further mitigate the effects of afternoon sun and glare.

→ Anna and her partner Sacha's window order included a frame for a pair of double-glazed timber doors that they acquired from a neighbour, with an extra fixed window alongside. On the north wall, this glazing offers views and improved connection to the deck and back garden.

Understanding EV emissions
Are electric vehicles really so great?

Does it really make a difference to your emissions if you buy an EV but run it on fossil fuel generated electricity, compared to sticking with the petrol guzzler? Bryce Gaton re-examines this issue.

↑ Will buying an electric vehicle like the now-available Renault Zoe (seen here being taken for a test drive at the ATA's recent EV Expo) really reduce your emissions compared to a petrol car?

DOES owning an EV make any difference to your personal transport emissions? In the light of recent statements about EV emissions from Liberal MP Craig Kelly, it seemed a good time to revisit my 2012 analysis of carbon emissions from electric vehicles (EVs) versus petrol vehicles.

In 2012, the result was positive for the only new EV available in Australia at that time—the Mitsubishi iMiEV—when stacked up against a comparable small car, the Toyota Corolla. The iMiEV had lower emissions when driven in all states in Australia on the 'city cycle' (modelling typical car use around the city). Only in Victoria on the 'combined' city/country cycle did the EV have slightly higher emissions—and that situation could be avoided if it was charged using solar and/or GreenPower.

Six years later, the grid has changed, and the EV and petrol car offerings have changed. So has the result changed too?

To investigate this, I will look at three scenarios for calculating your personal transport CO_2 emissions:

1. Buy an EV for city driving, but take no other CO_2 reduction measures.
2. Combine an EV with a solar array at home.
3. Other methods for reduction of CO_2 for EV electricity consumption.

Scenario 1: Buy an EV for city driving, but take no other CO_2 reduction measures

For this scenario, the answer will depend on where you live. Individual states and territories continue to use different mixes of brown or black coal, natural gas, hydro, wind and solar to generate electricity used in EV charging. These different generation methods produce different amounts of CO_2 and other greenhouse pollutants (together referred to as CO_2-e).

For petrol- or diesel-powered internal combustion engine (ICE) vehicles, the figures generally stated for CO_2 emissions are not the full story. For ICE vehicles, CO_2-e includes the CO_2 from combustion, plus the direct greenhouse potential from CH_4 (methane) and N_2O (nitrous oxide) and the indirect emissions from extraction, refining and transport. Adding in these factors enables an 'apples-for-apples' comparison.

These factors for both electricity and petrol emissions are sourced from the *National Greenhouse Accounts (NGA) Factors* report published by the Department of the Environment and Energy and last updated in July 2017. The data on energy/fuel use is sourced from the Green Vehicle Guide (www.greenvehicleguide.gov.au, see note 2).

Calculation 1: Internal combustion engine CO_2-e emissions

Vehicle: Current model Toyota Corolla; 1.8 L petrol, auto, city cycle, 8.3 L/100 km

Assumptions:

- Vehicle travels 10,000 km per year
- City cycle chosen as most comparable to EV use.

The EVs are coming! The EVs are coming!
But is your home EV-ready?

Electrical contractor, EV charging point installer and EV owner Bryce Gaton looks at what you need to know to assess the potential hidden installation costs and practical considerations in preparing your home for an EV.

AFFORDABLE electric vehicles (EVs) with a range of 300+ kilometres are about to hit the showrooms (see Table 1). If this is going to be your year to make the shift to electric transport, then now is the time to assess your home's electrics and prepare for the installation of an EV charging point, commonly called an EVSE (electric vehicle supply equipment).

Here are four steps to help you prepare:

1. Assess your home's electrics for its capacity to deliver the fastest possible charging time.
2. Choose your EVSE charging mode and current.
3. Decide where to position the EVSE.
4. Choose which EVSE to buy.

Image: Courtesy of ClipperCreek

↑ Your EVSE doesn't have to be in the garage, there are fully weatherproof units that can be installed outside.

1. Assessing your home's electrics

At one end of the spectrum, you might just need a 15 A socket outlet, with cost starting around $400 installed. At the other end, you might require a complete switchboard and supply upgrade, and full home rewiring. Costs for this can be $10,000 or more, and of course it will also entail time (possibly many months) to get the work done.

It boils down to what speed of charging you want/need and how much electrical energy your current household wiring can deliver.

First, let's look at what the current and coming crop of EVs need if you intend to charge them as fast as you can at home. Table 2 lists the AC charging needs for all the EVs available now or coming soon to Australia.

From Table 2, we can work out what additional load (in amps) the EV will add to the household use. The next step is to assess the existing wiring, incoming supply and switchboard in your home to gauge if it is likely to be able to supply this load.

To assess your home's electrical wiring and switchboard capacity to supply an EVSE, begin with the following checklist (of course, you will still need your installing electrician to check this via a full inspection before installation).

1. Is your home less than 20 years old or has it been fully rewired in the last 20 years?
2. Does your switchboard have at least one spare slot?
3. Do you have three-phase power?

You answered 'Yes' to questions 1 and 2:

If you answered 'Yes' to questions 1 and 2 then you should just need to have your electrician do a maximum demand calculation to find out how much electricity you currently draw. This will tell you how much is left to supply the EVSE. Most likely, you will be able to install a 32 A capable EVSE. Your costs will most likely be only the EVSE itself plus wiring it in, with a total cost starting around $2000. Note that some manufacturers include the cost of a simple EVSE installation in the price of the car.

If you answered 'Yes' to question 3 as well, you have won the charging speed jackpot if buying a Zoe, Tesla or BMW i3!

If you answered 'No' to either questions 1 or 2, then you are likely to be up for additional work before the EVSE can be installed, or you may need to dial back your expectations for your EV charging speed. Here are some of the options.

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