ReNew

Technology for a sustainable future

Issue 144

SMART HOMES SPECIAL

WIN a $5000 Biofilta sustainable garden package

*Australian residents only; details p18

Get smart

Automation that works

PLUS

Measuring emissions from gas

Solar upgrades

Backyard farming

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Electric vehicles: ending the ICE age
Small and smart: a clever little home
Owner-built: communication is key
Data mining at home: monitoring mania

Smart electric heating options

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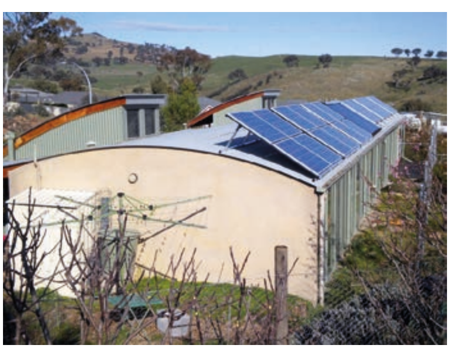
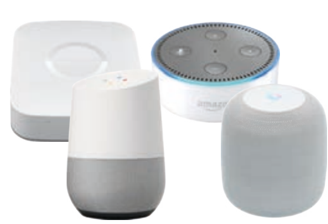
Smarter homes special
Heating, monitoring, automating + more

↑ Simeon Hanscamp is engaged in intensive backyard food production. Page 20.

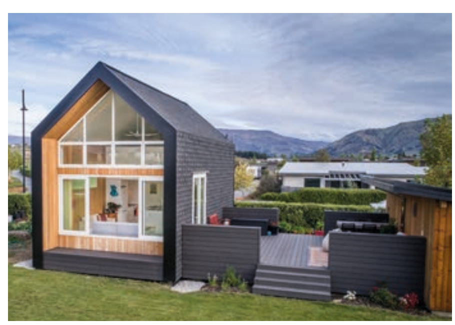
↑ Gas production emissions just keep on growing, but no one is keeping score! Page 30.



↑ The home of this solar enthusiast has seen five solar systems in fifteen years as he fine-tunes to make the most of changing technology. Page 26.



↑ A well-planned smart home can reduce energy consumption. Page 42.

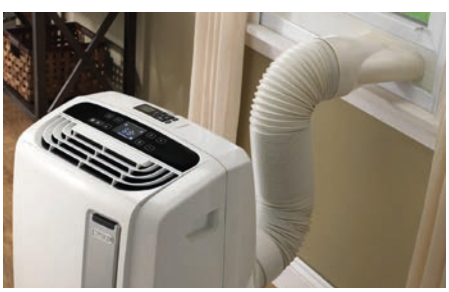


↑ Smart tech has made this clever little home in New Zealand simpler and cheaper to run. Page 50.

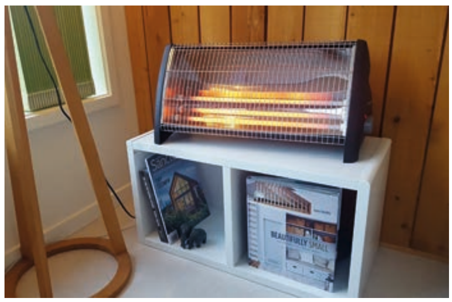
← **Cover image: Shane Harris, Arch Imagery.**
Paul Hendy's home is a great example of using smart home technology to reduce your energy footprint. His home uses a KNX-based system to control ventilation to enhance the performance of the passive solar design. Paul's home will be open on Sustainable House Day in September; if you live in Adelaide, it's definitely worth checking out. You can also find out more about Paul's home design in the article 'Renovation Automation' in issue 41 of *ReNew*'s sister magazine, *Sanctuary*. See details of Paul's KNX system on page 48, and our smart homes feature starts on page 42.

Special: Smart heating options

Efficient electric heating guide



↑ Even renters can have energy-efficient heating. See how, page 59.



↑ Can a cheap bar heater really be the best heating option? In the right circumstances, it certainly can be. Page 69.

Electric vehicles

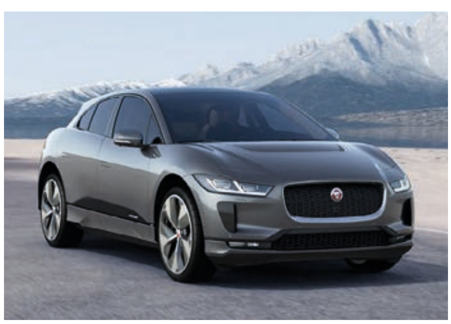


Image: Jaguar UK

↑ The Australian EV market is (slowly) heating up. Page 82.

Regulars

Up front

2017 a record year for renewables, but it's not enough

The latest annual report on the global state of renewables from policy organisation REN21, the Renewables 2018 Global Status Report, looks good at first glance. In 2017, a record 178 GW of renewable energy capacity was installed worldwide: $US 310 billion in new investment. However, there's little change in the transport, cooling and heating sectors, meaning that the world is lagging behind its Paris climate goals.

These three sectors together account for around 80% of the world's energy demand, and yet only 42 countries have targets for renewable energy use in transport, and only 48 have similar targets for heating and cooling. In the report, REN21 calls on governments to do more, saying investors are stepping up in unprecedented numbers, but could do so much more if governments acted too. www.bit.ly/2y9MunE, www.bit.ly/2JHKIii

'Water battery' to help Sunshine Coast students chill out

In a quest to be carbon neutral by 2025, the University of the Sunshine Coast has redesigned its chilled-water air conditioning system to benefit from 5800 rooftop solar panels, a decision which is expected to cut overall grid energy use by as much as 36%. Currently 60% of the university's energy use on its main campus at Supply Downs is attributed to air conditioning. Dubbed a "giant water battery" by the vice-chancellor, the innovative new system will use solar electricity from the 2.1 MW system to pre-cool water stored in a 4.5 ML tank. The chilled water is then circulated to industrial air conditioners located throughout campus buildings. On days where demand outstrips supply, the refrigeration-based cooling system is equipped to automatically switch between the stored chilled water, solar energy and electricity from the grid.

The project is being delivered together with project partner Veolia, and is expected to save over 92 thousand tonnes of CO_2 over the 25-year project period. It will also save 802 ML of potable water over that time, by pumping water from the campus lake. In cool news for local students, the project will be used to teach the next generation of sustainability and engineering practitioners. www.bit.ly/2Ml4jDw

Image: University of the Sunshine Coast

→ The water battery cooling system to be installed at the University of the Sunshine Coast.

Battery reliability testing

If you have been thinking of adding a battery to your solar power system then the ongoing battery testing being done by ITP Renewables should be of interest.

The 'Battery Testing Report 4' document gives the results to date. With some battery units having been tested past 1000 cycles, there are some interesting issues starting to appear in the results.

Batteries tested range from lithium ion and lead acid, to saltwater and redox flow batteries, so all of the common chemistries are being looked at.

The report can be downloaded as a PDF, and real-time data and historic data is also available. For the report, real-time and historic data, go to www.batterytestcentre.com.au

NEM chat

In a new column, Jonathan Prendergast, energy consultant, provides some insights into the National Electricity Market (NEM).

Our NEM spreads from Cairns in the north, to Hobart in the south and across to Port Lincoln in the west. It is interconnected between states, to help balance supply and demand at all times and to achieve lowest cost.

It is a delicate balance and a temporary undersupply can see prices rocket from $60 or $80 per MWh up to the maximum of $14,000 per MWh. An oversupply can see the price drop, making plants uneconomic, particularly coal power stations that need to run year round and are not able to easily turn off during low prices, and on during high prices.

Prior to Hazelwood's closure, retirements came about mainly due to decreasing demand and new wind generation taking market share. When new renewables were built, the price reduced and a coal-fired power station left the market. However, during the Abbott years, large-scale renewables investment stopped, so when Hazelwood retired, we were caught short. This saw a flood of reactive investment in renewables, around 6 GW, which is now being built or has been commissioned. These projects will see Hazelwood replaced 150%. But we are seeing some short-term high prices until the new projects come online.

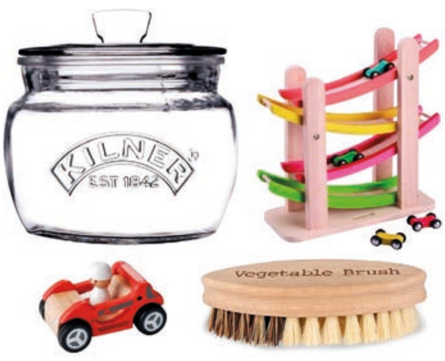
For more, see Facebook group NEM Watch.

Power station	Capacity (MW)	Year retired
Munmora, NSW	1400	2010
Swanbank B, Qld	480	2012
Playford, SA	240	2012
Wallerang, NSW	1000	2014
Redbank, NSW	144	2014
EnergyBrix, Vic	170	2014
Anglesea, Vic	180	2015
Collinsville, Qld	180	2016, possibly
Northern, SA	546	2016
Hazelwood, Vic	1600	2017

↑ Coal-fired power stations retired since 2009.

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

Go plastic-free

With the world slowly waking up to the environmental disaster that is petroleum-based plastics, more non-plastic options for all kinds of common household items are becoming more readily available.

Biome, one of Australia's original eco-stores, has an entire section dedicated purely to alternative, long-lasting products that are completely plastic-free.

Products include glass, stainless steel and bamboo drinking straws; glass and stainless steel kitchen containers, jars and utensils; bamboo and wood toothbrushes, hair and scrubbing brushes; stainless steel and wood clothes pegs; fabric/beeswax reusable food wrap sheets; natural fibre baskets and bags; unwrapped or paper-wrapped personal care products; wood and bamboo toys; stainless steel and glass water bottles and coffee cups; the Solidteknics range of cookware; even organic and biodegradable hair scrunchies—the list is huge, with almost 600 plastic-free products.

While many of the products will cost more than their plastic equivalents from the local supermarket, they are free from petrochemicals and are either environmentally benign or biodegradable.

For more information and to buy, contact Biome, ph: 1300 301 767, shop@biome.com.au, www.biome.com.au/911-plastic-free-life

02

Tiny extendable prefab

There are many small kit buildings available, but probably none as interesting as the Imby (in my back yard), which uses 600mm x 2850mm structural modules made from FSC-certified plantation pine plywood, layered up to form a series of frames that support the roof, wall and floor claddings/linings.

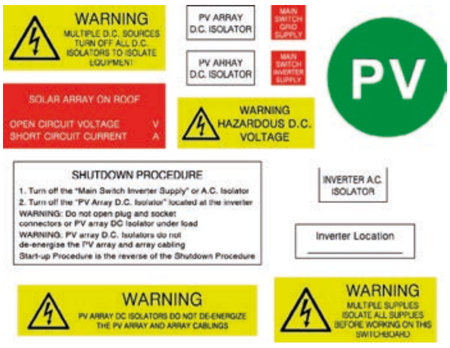
Additional 600mm sections can be added or subtracted as needs dictate, or multiple Imbys can be placed side-by-side to extend floor area.

The frames are assembled using interlocking wedge-through mortice and tenon joints, so there are no bolts, nails or screws used for the framing—allowing construction novices to erect the main structural elements.

The Imby is structurally certified for wind regions, soil classes and terrain types to make it suitable for most locations in Australia.

A standard Imby kit includes the CNC-milled structural plywood frame, CNC-milled clear acrylic window infill panels to end bays, CNC-milled furniture-grade plywood internal lining, Colorbond roofing and external cladding, 50mm bulk insulation to walls and roof to R1.5 minimum, reflective foil sarking to walls and roof, structural plywood flooring panels and one door, plywood frame assembly wedges and H3-treated pine bearers. There are also various window and cladding options available.

For more information, contact IMBY, ph: (02) 9114 6300, info@imby.com.au, www.imby.com.au



03

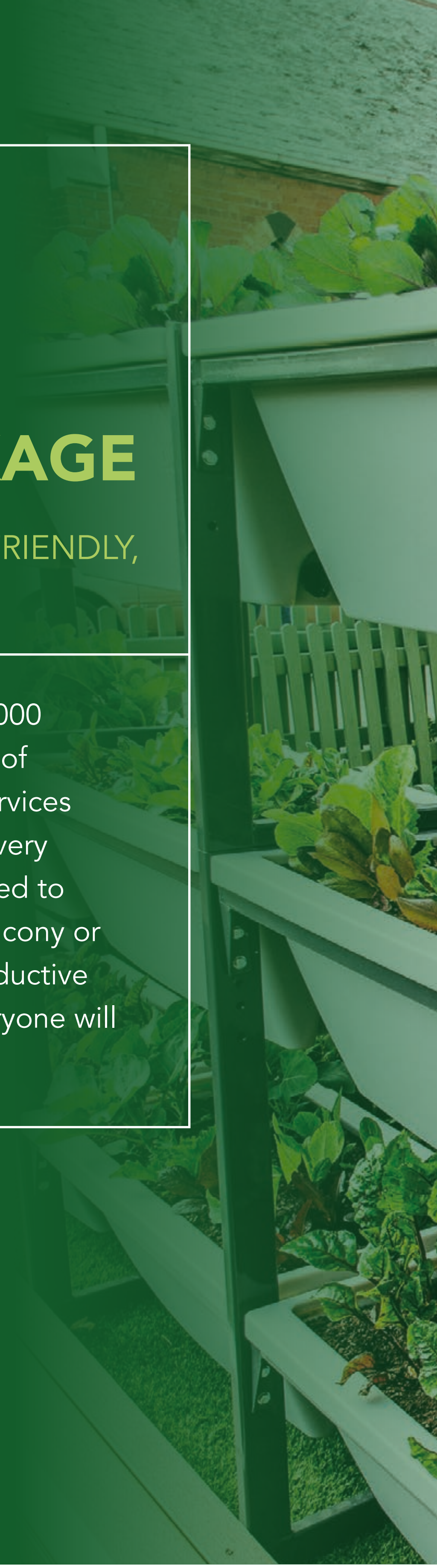
Keep your system up to code

Making sure that your PV system has the correct labelling in the correct places is not only important for safety, for grid-connected systems it is a legal requirement.

Aussie Solar Labels has engraved label kits for almost any PV system, whether it be grid-connected with a string inverter, grid-connected with microinverters, or off-grid. They also have specific individual labels for components such as isolators, battery banks (including shutdown procedure signs), PV arrays and inverters—ideal for the solar DIYer who wants to keep their system looking professional. Custom labels are also available.

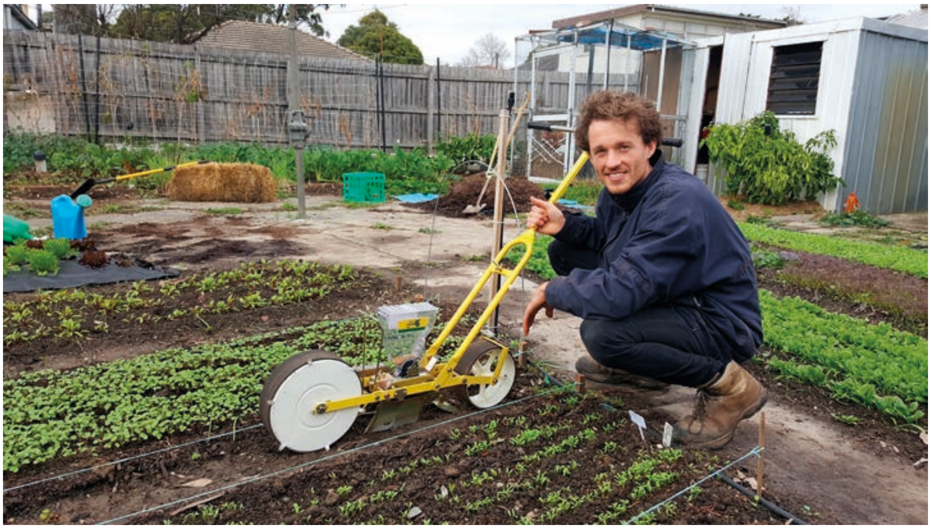
The labels are made from two-layer UV-stabilised engraved phenolic plastic (Traffolyte) so that they won't fade or wear off, and come with adhesive backing.

RRP: From as low as 35 cents per label, up to $29.95 for the Off Grid Label Deluxe kit. For more information and to buy, contact Aussie Solar Labels, 41 Goodman Drive, Noble Park VIC 3174, ph: (03) 9711 1286, sales@aussiesolarlabels.com.au, www.aussiesolarlabels.com.au



The farmer next door
Is backyard farming ripe for growth?

On a standard surburban block in Melbourne, Simeon Hanscamp is growing enough food to provide his local community with vegie boxes—and himself with an income. Anna Cumming visited him to find out what it takes to be a successful backyard farmer.



↑ As funds allow, backyard farmer Simeon Hanscamp is investing in market garden scale tools and equipment such as this precision seeder. Standardised garden beds take up all the available space in the front and back yards of his rented property.

BACKYARD fruit and vegie gardening is enduringly popular in Australia; one 2014 study found that 52% of Australian households reported growing at least some of their own food at home. Most of us—especially those who live in urban areas—stick to a few herbs and some tomatoes, or at most a handful of fruit trees and a productive vegie patch. But with a bit of determination and a suitable site, the potential is there to scale food production up to 'backyard farming'.

One young entrepreneur in Melbourne has done just that. Both front and back yards of the rental house Simeon Hanscamp shares with two housemates in West Heidelberg, 10 kilometres north-east of the city centre, are laid out in neat, regular-sized garden beds, in which he grows greens and other vegetables. "I have about 220 square metres of growing space, and it produces $200 to $400 worth of food per week, depending on the season," says Simeon. He sells it to neighbours via a 'farm gate' box at the front of the property, and through a vegie box scheme: his subscribers—15 to 20 local families—either collect their weekly boxes from the house, or pay a little extra for bike delivery. Recently, he's also started attending the weekly farmers' market at Melbourne University.

Getting started as a backyard farmer

Simeon's backyard farm is the result of careful research and planning. He got the gardening 'bug' when he was involved in starting up a compost heap during his gap year; a few years later he spent time working at Transition Farm, a market garden on the Mornington Peninsula. "It was the best food I ever ate," he remembers, "and I developed more of an interest in soil biology and so on."

He also discovered 'community supported agriculture' (CSA). "Transition Farm's CSA program means that around 100 families commit up front to buying weekly food boxes. The farm has a bit more financial security that way and planning production is easier. Typically recipients are also more involved in the story of where their food comes from."

Inspired to become a farmer, Simeon spent three and a half years researching and learning, and developing his own business idea. "I wanted to be near family and also my partner's city workplace, so the big question for me was how do I juggle proximity to the city with farming? The answer was urban farming."

Farming on rented land

Simeon has based his enterprise on the methods of Canadian farmer Curtis Stone, author of *The Urban Farmer: Growing food for profit on leased and borrowed land* [see box]. "A lot of would-be growers think they need to have their own land, but it's not true," he says. "You don't need to buy land to be a farmer."

He spent time looking for a suitable rental property, scouring online mapping sites for larger blocks that would afford at least 150 m² of growing space. "I needed a flat site with good sun access, and importantly, no soil contamination," he says, "plus an undercover area for tools and for washing and packing produce."

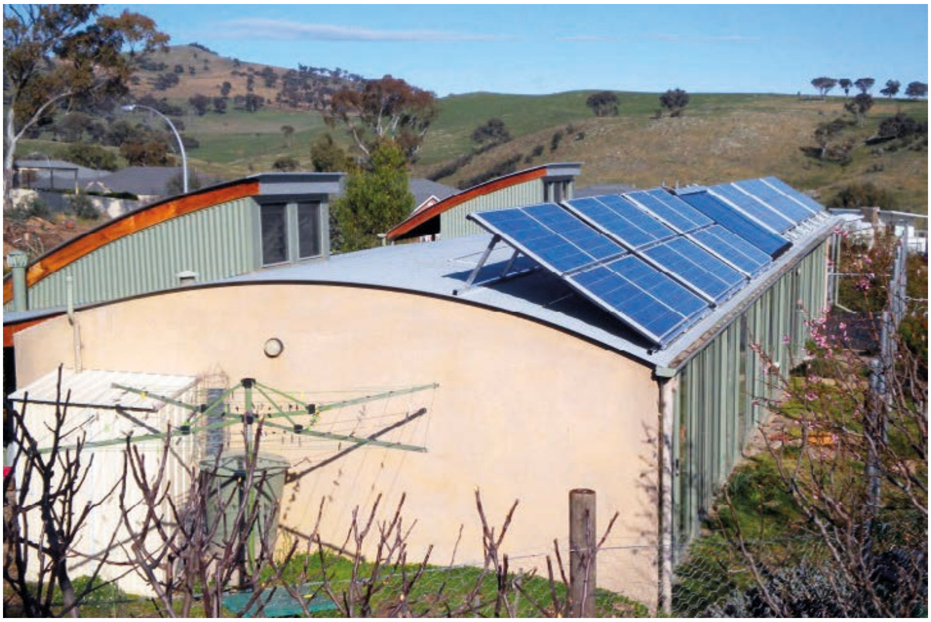
Of course, the final crucial element was a supportive landlord, as he needed permission

On the solarcoaster
Fifteen years, five solar systems

Jeff Knowles is a self-confessed solar enthusiast, and his rooftop bears that out with a higher-than-average number of solar upgrades that reflect changing installation standards. He explains the motivations for each iteration here—and the next chapter to come!

MY PARTNER Chrissy and I live in a purpose-built passive solar home in Jerrabomberra, NSW, near Queanbeyan and just over the border from Canberra. When you see that Canberra has had a run of 12 °C days, you might be tempted to think "ugh, that's cold!"—mostly, though, we get a lot of sun with that 12 degrees and, surprisingly, winter can be a time when we generate more per day than Sydney or Brisbane using a similar-sized PV array.

Being a solar enthusiast, I have always been interested in how much we can generate on our roof. Our PV system has been an ongoing 'project' as the technology and our knowledge has improved. In fact, since 2003, we have had five iterations of our solar system—Solace #1 to Solace #5—using a variety of panels, inverters and optimisers—perhaps something of a record!



↑ This is the system iteration known as Solace #3, one of five different systems this roof has seen over the years.

Solace #1: 2003

Solace #1 in 2003 used 12 x 150 W BP panels mounted almost flat on the roof. The installer hailed from Victoria and came up for the two-day install (as there were no local installers in the ACT in 2003, and the Victorian installer offered the best price and timeframe). The system was sized on paper—we calculated energy use in our all-electric home and what a panel could produce in a year in our region—thereby arriving at 12 panels. It cost $20,000, before the $8000 government grant.

The system failed in its aim to produce as much as we used in a year, partly because of the way we installed it, with a long piece of steel to mount the panels. The steel got really hot in summer, and so did the panels. Hot panels are less efficient; keeping panels cool is ideal for maximum production of DC electricity. We finished up having to move them because, ironically, while the install was designed to produce the most in summer (they were only 12 degrees to horizontal), they were getting too hot to do so.

Solace #2: 2007

Solace #2 in 2007 took advantage of two fortuitous events. We were able to employ a local installer who we knew as a friend, plus we were able to grab two extra 150 W BP panels. These were hard to find by then, as panel manufacturers were continually upgrading their offerings, but we needed to put like with like. We installed them at 35 degrees to the horizontal and took the opportunity to also fit a 40-tube Hills Solar evacuated tube collector; this latter meant that the electricity needed to boost the hot water in winter was more than halved compared to what the flat panel hot water system had been using.

We went from paying for electricity to being energy neutral. In 2007, this was quite unusual for on-grid PV homes. As we were not changing the nominal output of the system to any great degree, we did not need to talk to Country Energy (our retailer) and installation standards didn't exist at that time! At this stage, Chrissy and I both thought that Solace #2 would see us through, so we turned to other things.

Solace #3: 2011

Solace #3 in 2011 came about for three main reasons. First, we had a panel on Solace #2 shatter at the end of 2010, rendering one

Greenhouse gas footprint
What we do and don't know about gas

Do you want to know the greenhouse footprint of Australian gas? Tim Forcey says, "how would we know?"—because no one is keeping track.

Photo: Lock the Gate Alliance

↑ Aerial photograph showing Queensland coal seam gas (CSG) wells. With 40,000 CSG wells planned for Queensland, imagine this image multiplied hundreds of times.

ENERGY and environmental planners like to do calculations and compare alternatives. Questions researchers might explore include: *Which is cleaner: electricity made from coal or gas or renewables? What is the greenest way to heat your home, have a shower or cook spaghetti?*

But there is a problem when it comes to evaluating the greenness of gas. Such comparisons need to be built on data. And, unfortunately, as we found recently in research at the University of Melbourne[1], although Australia may produce more fossil gas than nearly every other country, when it comes to digging up information around the greenhouse footprint of Australian gas, particularly unconventional gas, data is in short supply.

The greenness of gas depends significantly on how much is released into the earth's atmosphere. Fossil gas predominantly consists of methane which is a powerful greenhouse gas—with worse climate impacts than carbon dioxide (see box). Our research found that if just 3% of the produced gas is released into the atmosphere, the climate-change impact of this released methane is equivalent to or worse than the climate impact of burning (and thereby converting to carbon dioxide) the other 97%.

It is critical, therefore, that we know how much gas is released during production and other stages.

Unconventional vs conventional gas

We've all heard of fracking and coal seam gas, but it can be easy to miss just how much these 'unconventional' gas production methods have escalated in recent years in Australia. There is some real (measured) data on emissions from conventional gas extraction, but these measurements can't simply be applied to unconventional gas.

Data on Australian unconventional gas emissions—an empty slate

As we wrote in our report, despite Australian government greenhouse gas reporting requirements having been established in 2009 and Australia's unconventional gas industry operating at significant scale in 2010 and rapidly expanding since, there has as yet been no comprehensive, rigorous, independently verifiable audit of gas emissions from unconventional gas.

Indeed, to quote CSIRO[2], "reliable measurements on Australian oil and gas production facilities are yet to be made."

Despite our 2016 report and similar findings by the CSIRO dating back to 2014 and earlier, we are now in 2018 and nothing has changed.

ReNew readers are probably aware that Australia reports greenhouse gas emissions to bodies such as the United Nations. You might then ask: "How is this data blindspot possible?"

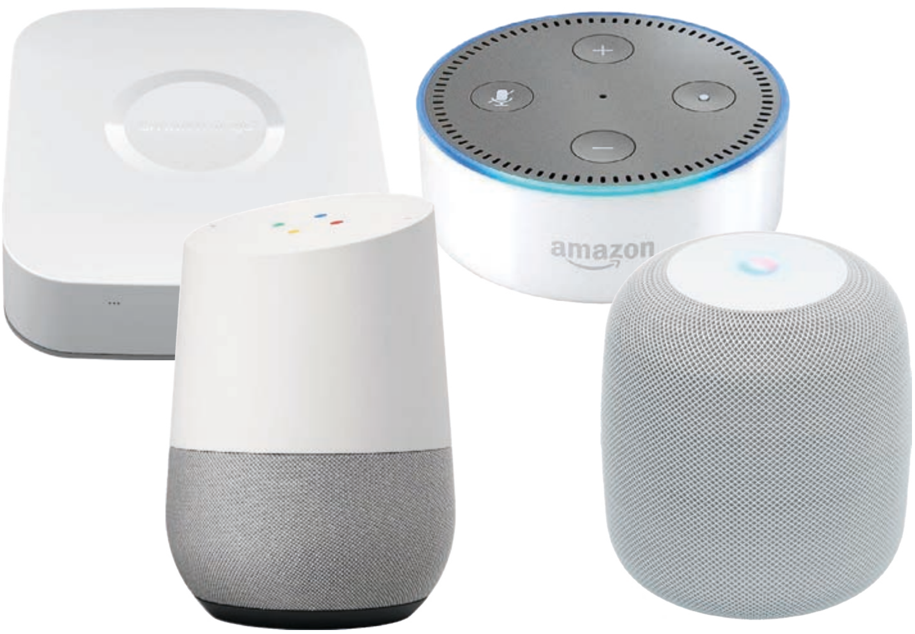
Our ignorance persists because government regulators do not require oil and gas companies to actually measure emissions as a basis for accounting and reporting. Rather, assumptions and simple factors may be used.

Zeroing out gas field emissions

For example, when it comes to coal seam gas fields, the factors used to calculate emissions from the extensive network of lines, compressors and pumps which connect

Houses that think
Are smart homes really a smart idea?

Smart home technology is touted as the way of the future, helping to make life easier while reducing energy use. But is that really the case? Lance Turner investigates.



↑ Many smart homes use a hub to tie different devices to the same network. Here are four popular hubs (not to scale), clockwise from top-left: Samsung SmartThings, Amazon Echo Dot, Apple HomePod and Google Home.

In the last few years there has been ever-escalating enthusiasm for internet-connected appliances and devices, in the belief that connecting devices to the rest of the world can make life better for householders. However, there are both pros and cons of making your house smarter, and there are varying degrees of 'smart', so what level of automation should you be aiming for?

What is a smart home?

A smart home can be defined as one that contains one or more devices that collect data, store that data, either locally or in the 'cloud' (on an online server), and can act on that data to make decisions as to what they should do. The motivation behind adding smart devices is usually to improve comfort levels, safety and security of a home, and may also be to help an occupant with a disability.

Most likely, your home probably already contains at least one smart device, whether you realise it or not. For example, TVs usually have some level of network connectivity and many collect data, or can be programmed to. Other typical smart devices can be seen in List 1.

What are smart devices?

So what exactly makes a device 'smart'? Firstly, as mentioned, it will need network connectivity. This may be via common wi-fi or wired ethernet, which allow it to connect to your existing home network directly, or it may be via one of a number of other protocols (see List 3). If the device uses one of these other protocols, then it will need to connect to an intermediate device, known as a hub or controller (see List 2). This hub then allows it to connect to the home network, and hence other devices in that network, as well as communicate with the wider internet.

Smart devices are usually also able to collect data and store it, either locally in the network or on a cloud server. They can usually also make decisions based on that data. For example, a smart window opener might close windows if it detects rain.

Smart devices can often also use external data sources to make decisions. For example, a smart irrigation controller, such as the Hydrawise unit, might use weather data from a weather service to decide if it should water the garden or not.

Many smart devices can also communicate with other smart devices in their own home network. For example, a smart smoke alarm, such as the Nest Protect unit, can cause a Nest camera to send you a photo when the alarm is triggered.

There's more to smart devices than just hardware. To make a smart device useful, it must have a good human interface. This is usually a mobile app, with many devices also giving you the option of accessing your devices via a web page.

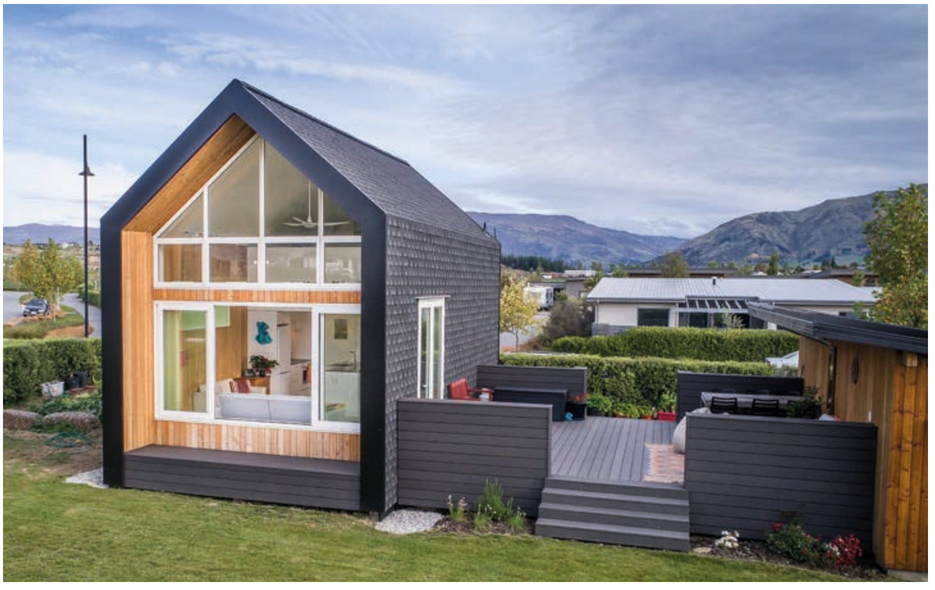
Some smart hubs go one better than a simple app and include a smart assistant as part of their own operating system. For example, the Amazon Echo and Echo Dot hubs use the Alexa interface, which not only speaks to you, but allows you to give voice commands, so you don't need a mobile

A clever little home

Tour a smart tiny home

Contrary to many people's experience, Will Croxford and his wife have found that smart tech has made their house simpler and cheaper to run. He explains the features they use.

Image courtesy Condon Scott Architects, Photography Simon Larkin.



↑ This small but smart home shows that even the tiniest home can benefit from smart home technology.

YOU might have seen our tiny house on the cover of the latest issue of *Sanctuary* (*ReNew*'s sister magazine on sustainable design). After years of research and planning, we built and then moved in on 1 August 2017. Our house has a footprint of only 30 m², but it feels well designed and spacious. It is built using SIPs (structural insulated panels) for the floor, walls and roof, and is close to Passive House standard. We also incorporated smart technology which helps reduce our energy bills, light up the house and keep us warm in winter. Contrary to many people's experience with smart house tech, our life is simpler because of it. This is how we do it.

Aiming for 'best in class'

One way to get a 'smart home' is to purchase a single integrated system. Such systems are usually installed by a professional and are often simple to use and robust. Another way, which is what we opted for, is to use a DIY approach with separate systems and multiple apps. In a DIY system, things aren't always simple and there may be limited integration between apps.

Even though it's not as a simple, the DIY approach suited us. I'm a tech person who loves tweaking settings and working with programs that I feel are the best. I like to think of this as a 'best in class' approach. For example, our smart lighting is the Philips Hue system because we think it's the best in class. Obviously some will disagree; maybe 'best in class' is better described as 'best for us'.

A downside with 'best in class' is that the many and varied systems used may be proprietary and hard to integrate together. But there are always ways around these problems.

Our smart tech

Here's what we have so far:

- Philips Hue lighting, www.meethue.com
- Trust Smart Home smart plugs that control heater and fan, www.trust.com/en/smarthome
- Smappee electricity monitor, smappee.com
- Sesame Smart Lock, www.candyhouse.co
- Davis weather station, www.davisnet.com
- IFTTT website (If This, Then That) to integrate all of these, www.ifttt.com
- Google Home voice control.

Smart way to save power

The Smappee, one of the new wave of smarter home energy monitors, is a part of our smart home that helps us save electricity and money. The Smappee app tells us how much total electricity we use and our standby (always-on) consumption. It provides useful graphs of our daily electricity use with fine-grained detail.

Smappee also analyses all appliances in our home and tries to give us a breakdown of their electricity use. It identifies appliances by their electrical signature and works well most of the time, but if two appliances use roughly the same amount of power, then the Smappee can get confused. For example, it confuses our kettle and iron as they have similar electrical signatures. When we look at the Smappee event log, it appears we do a lot of ironing when in reality we love a nice cup of tea. This means that I don't always trust the Smappee granular appliance data, but it's still useful.

The Smappee can also control smart switches to turn appliances on and off. Until recently Smappee's own smart plugs weren't available with AU/NZ plugs, but this wasn't a problem for us as the Trust Smart Home plugs use the same ZigBee protocol as Smappee. For

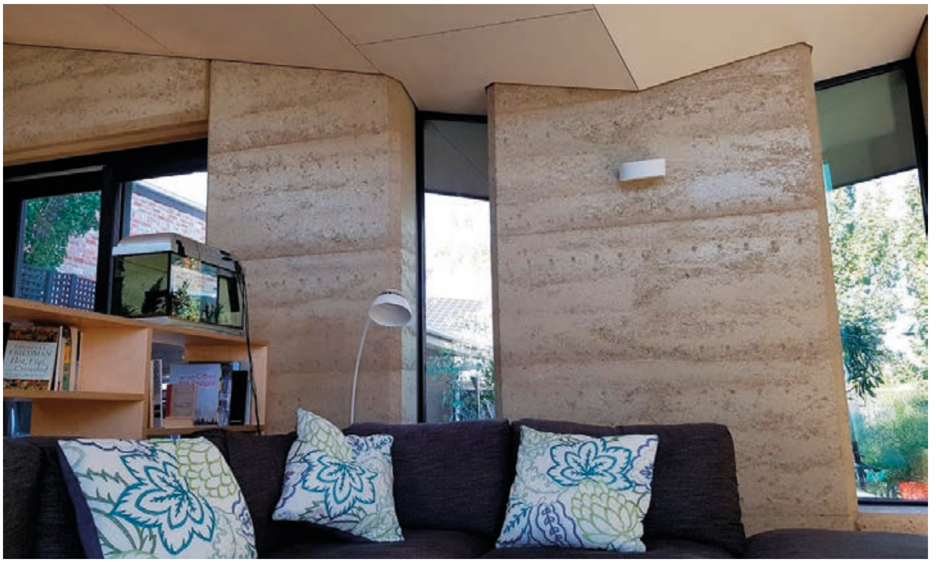
A mania for monitoring
Beyond the smart meter

When you build a high-performance house, you want to know that it's performing as expected. Cameron Munro has monitoring in place to do that—and he's producing some lovely graphs in the process!

WE MOVED into our renovated home in Melbourne in November 2016, having undertaken an extensive renovation with a focus on massively improving the energy efficiency of the building fabric (for more, see 'All-electric and hydronic' in *ReNew 141*).

Our approach was driven by a desire to produce a comfortable home no matter how hot or cold it was outside and to reduce our operating costs to as close to zero as possible. To do this we used the Passive House approach, a scientific method incorporating extensive modelling and verification. This required very high levels of insulation (including high-performance windows), avoidance of thermal bridges and a building wrap that reduces the air infiltration to about 1/15th that of a normal home. We also opted to remove the gas service; instead, we use heat pumps to provide hot water and space heating. We also installed a 6.4 kW solar PV system.

Having gone to what is, by Australian standards, extreme lengths to improve the thermal performance of our home, we were keen to understand exactly how well it performed against our expectations and modelling. Knowledge is power—we want to be able to run our home in the most energy-efficient way and to do this we need to have a good understanding of how it functions. Thus we decided to install monitoring that is well beyond the norm.



↑ The rammed earth wall is one of the high-performance features of Cameron's home, providing thermal mass to moderate internal temperatures. They've been monitoring how it performs (see Figure 6).

The big picture

First up, we've kept track of our electricity bills. Over the most recent 12 months we have exported 20% more power to the grid than we have consumed and our net electricity bill was $627, of which two-thirds was the fixed supply charge. This bill includes cooking, hot water, heating and cooling as well as our plug-in hybrid car. The car accounts for about a third of our electricity consumption and this bill of $627 contributed to driving around 9000 km over the year in all-electric mode. If we were to exclude the car we'd have earned about $520 over the year.

Over the 12 months we exported 6071 kWh to the grid and imported 5135 kWh. Our consumption of around 19 kWh/day is high compared to many households, but bear in mind that about 7 kWh/day is used by the car, 2.5 kWh/day for hot water and in winter we're using about 8–15 kWh/day for heating. Figure 8 shows our month-by-month consumption and export.

Solar performance

Our solar PV system has a SolarEdge inverter and SolarEdge DC optimisers—the latter mean each panel performs independently of the others—thus, if one panel is shaded, it doesn't pull down the performance of the others.

It also means I can readily check online or via the SolarEdge phone app how the system has performed, and indeed how each panel has performed. This has been interesting to see how our western panels are performing in comparison to those facing north, as well as those which are partially shaded at different times of the day (this can be seen instantaneously, but not historically ... yet). But probably most reassuringly, it provides the confidence that all panels are functioning correctly. Given solar panels make no noise or movement, this is indeed reassuring.

Beat the winter chills
A guide to electric heating options

As we head into the colder months, thoughts turn to staying warm. What's the best electric heating system for you? Lance Turner looks at the options, and their pros and cons.

IN PAST issues of *ReNew* we have focused on what are arguably the two most popular energy-efficient heating options—reverse-cycle air conditioning and hydronic heating. Both have advantages and disadvantages, and both suit some people, house designs and climates better than others, so which is best? Are there other options that should be explored? When it comes to heating, there are lots of questions to answer, and making the right choices is important for a comfortable, warm home with low running costs and low environmental impact.

Not gas

Firstly, we should note that we are not considering gas heating. Gas is a fossil fuel and there is simply no way to run gas appliances without greenhouse gas emissions. On the other hand, while electricity is in part generated by coal and other fossil fuels, it doesn't have to be—you can purchase 100% GreenPower or install a solar power system large enough to cover your needs throughout the year and effectively be greenhouse neutral.

The economics of gas heating also no longer stack up in almost all cases. See www.bit.ly/2Hrfebe for the ATA's research report on this subject.

Now that is out of the way, what are the electric heating options available? Firstly, we will look at the two technologies we have covered previously which tend to be used for space (whole-of-house) heating—reverse-cycle air conditioning and hydronic heating, then we will look at resistive electric heaters, solar air heaters and other heating considerations.

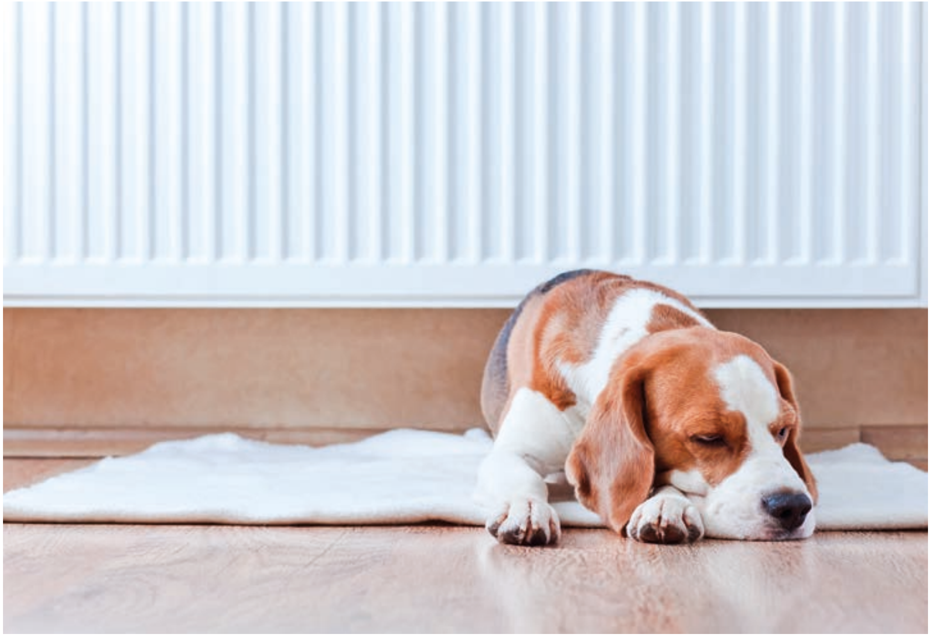


Image: igorr1 via iStock

↑ Everyone likes a warm home in winter, and with so many options, there's no need to freeze.

Reverse-cycle air conditioners

Reverse-cycle air conditioners work by compressing a gas, called a refrigerant, which then transfers heat from one place to another. The technology that does this is called a heat pump. Heat pumps are all around us; for example, in your fridge, a heat pump transfers heat from inside the cabinet to outside, which is why the outside of the fridge gets warm. In a reverse-cycle air conditioner, the transfer can go either way, hence the name. In winter, heat is taken from outside and dumped inside, and in summer the opposite occurs. See the box 'Harvesting heat' for an explanation of where the heat comes from on a cold day.

A BIG PRO FOR HEAT PUMPS: EFFICIENCY

The amazing thing about reverse-cycle air conditioners is how efficient they can be. While electric heating using resistive elements to turn the electricity into heat directly (covered later) can only ever be at most 100% efficient, the heat pumps used in reverse-cycle air conditioners are much more than 100% efficient, in fact, up to 600% efficient, meaning that they use a lot less energy to produce the same amount of heat. How can that be? As its name suggests, a heat pump pumps heat from one place to another. Instead of turning energy from one form (electricity) into another (heat), it uses electric energy to move heat from one place to another. Because heat is relatively easy

Heating people, not spaces
The advantages of personal heating

How much energy can you save by heating yourself instead of your home? Will you be as comfortable? Dave Southgate describes his personal heating experiment.

IN LATE 2012 we moved into a fairly normal, five-year-old, four-bedroom home in the Canberra suburbs. As with many Canberra houses, it was a 'gas house', using gas for heating, hot water and cooking. Around this time, frustrated by the lack of government progress on climate change, we decided that we would set out to become a fossil fuel free family.

Getting off gas was clearly fundamental to our plans. More than half of our gas use in 2013 went into our gas ducted central heating—about 6000 kWh (21,600 MJ) over the year.

When we started out on our household energy transition, I envisaged that we would be using heat pumps to replace our gas heating (that's what everyone else seemed to be doing!), but my wife, Donna, had other ideas. She said that heat pumps didn't make her feel warm, so we began to search for alternative low energy ways to heat our house. It's a long story which I've written about elsewhere, but we started by installing far infrared (FIR) heating panels. The main photo shows one of two FIR panels which we installed on the ceiling in our living/dining area.

Moving away from space heating...

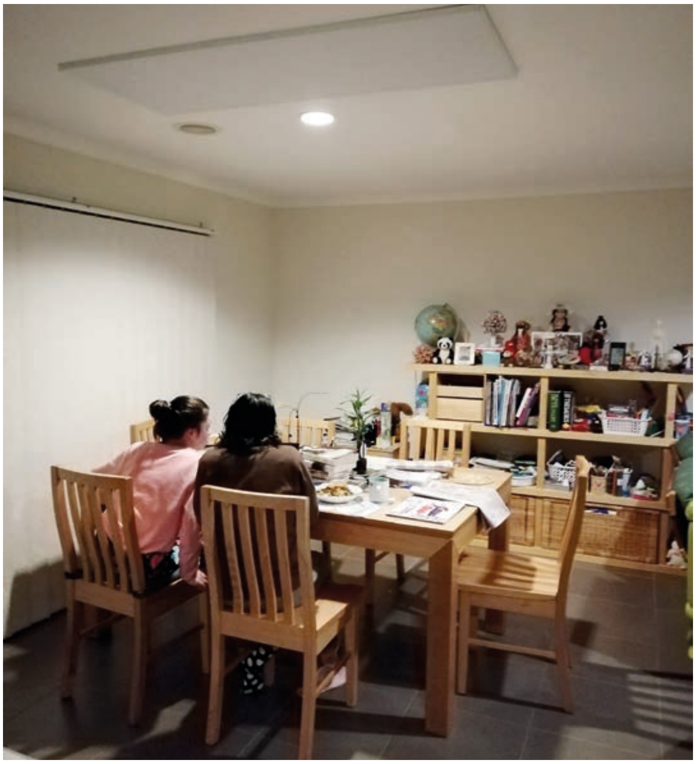
The FIR panels produce a wonderful radiant heat and I was happy that my wife had diverted us onto a different path. However, when we first installed the panels we simply used them as space heaters and controlled the room air temperature using a thermostat. It didn't take us too long (but probably longer than it should have) to work out that this was not very smart. When we were sitting under the panels the temperature of the air in the room had virtually no influence on how warm we felt. Our feeling of thermal comfort came from the direct radiant heat from the panels, not from the heat in the ambient air. Why heat all the air in the room when we didn't need to? Consequently, we changed our heating habits: we only turned on an FIR panel when we were sitting under it and no longer worried about the room air temperature; the thermostat became redundant. This gave us some serious energy savings with no loss of thermal comfort.

This simple chain of events totally changed the way I now think about heating. I came to the realisation that what is important in heating is not how warm the air in a house is, but, rather, how warm the occupants feel! I quickly adopted the philosophy 'heat people, not spaces'.

...into the world of personal heating

Once we changed our focus to heating people, rather than heating air, whole new horizons opened up. We moved into the wonderful world of personal heating devices (PHDs).

All things being equal, you would expect that the closer a heat source is to a person looking for warmth, the less energy will be required to provide that warmth. There are



The far infrared heating panel on the ceiling above the dining table.

Electric vehicle update
The end of the ICE age?

Is the end of the ICE (vehicle) age looming? Amid a flurry of announcements from car manufacturers and governments around the world, Bryce Gaton surveys the significant shifts away from ICE vehicles and towards electric.

CHANGE is afoot in the electric vehicle (EV) world. More and more EV developments are being reported in mainstream media, including further markers of the looming end of the ICE age! In this case, ICE equals internal combustion engine, or the standard petrol or diesel car. So let's look at what's been happening so far in 2018.

Electric vehicle sales

EV sales in the first quarter of 2018 hit 312,400 worldwide, 59% higher than for the same quarter in 2017. Of these sales, 66% were pure EVs (battery-only) and 34% were plug-in hybrid EVs (EVs with a plug-in rechargeable battery and an ICE engine); see Figure 1.

Even in Australia, sales of EVs were reportedly up 132% for the quarter—albeit from a very low base in 2017 when few EVs were available here. Australian EV sales currently sit at around 1000 annually, excluding Tesla sales (Tesla doesn't provide sales data to VFACTS, the private body collating Australian car sales data), which is less than 0.1% of annual new car sales.

Planning for charging stations

In Australia, one hurdle in the way of significant EV sales has been the lack of public charging infrastructure. However, in a significant shift, almost all Australian states and some businesses are addressing this.

Queensland now has what it claims as the "world's longest electric vehicle super highway in a single state", after recently completing the first stage of a fast charging network to allow electric vehicles to travel from the Gold Coast to Cairns and inland from Brisbane to Toowoomba (see Figure 2 and further info at www.bit.ly/2xHTcBr).

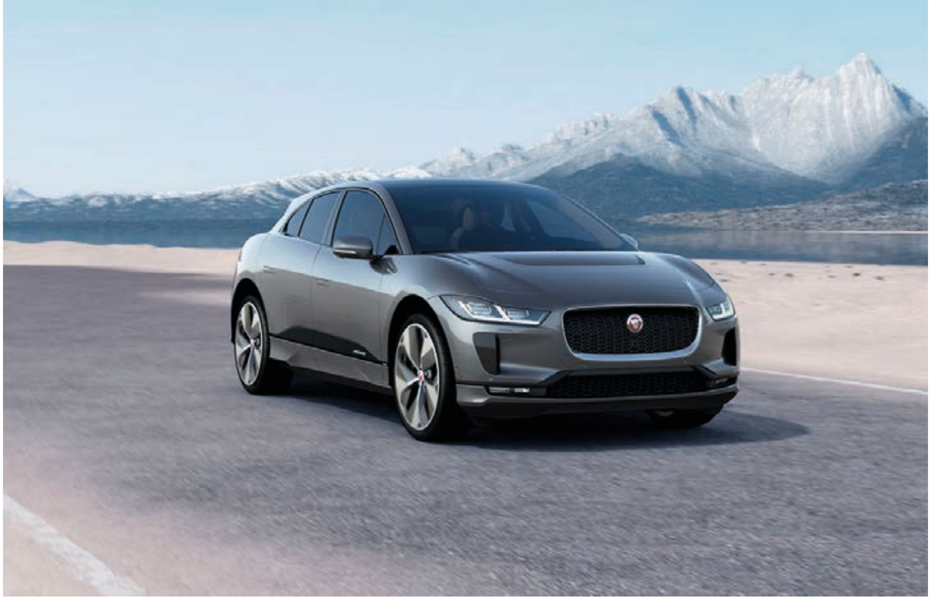


Image: Jaguar UK

↑ The Jaguar all-electric I-Pace is one of the few EVs available (or soon to be) on the Australian market.

For businesses, councils or other groups interested in installing charging stations, the Queensland government has also recently released a Practice Note (www.bit.ly/2xJ7Qs5) outlining key principles for planning electric vehicle charging to "support the selection of the right type of infrastructure at the right location."

The document includes a detailed introduction covering EV charging basics (including the helpful infographic in Figure 3), plus a practical guide to choosing the most appropriate charger type for a proposed site and tips on cost recovery.

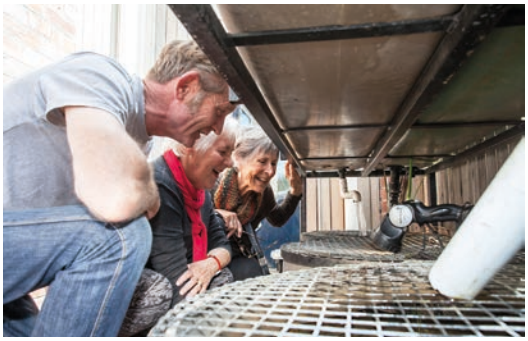
Although the document is Queensland-specific, it makes a useful starting point for any community group or local chamber of commerce that is beginning their journey in advocating for, planning or installing EV charging infrastructure.

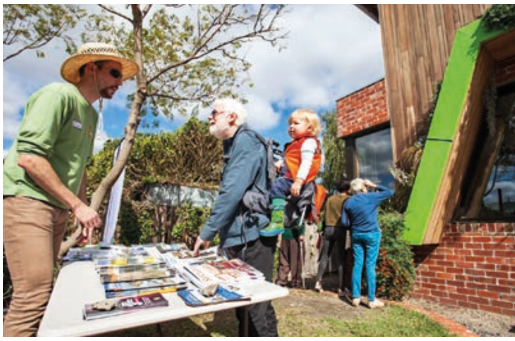
In the ACT, the government has just released a comprehensive action plan to guide the ACT's transition to zero emission vehicles. The listed actions include a requirement for all new multi-unit and mixed-use developments to install vehicle charging infrastructure. It also discusses working with local and state governments to facilitate the installation of charging stations on major routes to and from Canberra including routes to Sydney and coastal areas.

In Victoria, Infrastructure Victoria has been asked by the government to prepare a 30-year plan exploring the infrastructure needs of automated and zero emission

LOCAL SUSTAINABLE HOMES OPEN TO YOU

Learn how to make your home cheaper to run and more comfortable to live in.





SUSTAINABLE HOUSE DAY

SUNDAY 16 SEPTEMBER 2018

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