ReNew

Technology for a sustainable future

Issue 140

ALL-ELECTRIC HOME SPECIAL

WIN a hot water heat pump valued at up to **$5500**

*Australian and NZ residents only; details p97

Low bill living

Why solar homes are ditching gas

PLUS

Winter window coverings

Prefab performance with SIPs

Upsize your solar

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Gas vs electricity: which fuel is cheapest?
Insulation upgrades: it's worth it!
Energy justice: renewables for First Nations
Induction cooking: tips from a convert

Insulation Buyers Guide inside

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All-electric homes

How-tos, case studies, insulation buyers guide + more

↑ Insulated panels (SIPs) make this house a little like an esky. Page 28.

↑ No longer cooking with gas! Induction cooking is part of this Melbourne family's money-saving transition to an all-electric house. Page 52.

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↑ The formation of the First Nations Renewable Energy Alliance was one of the highlights of February's Community Energy Congress. Page 32.

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← **Cover image: Gas-free tranquillity base, Trentham, Victoria; photo by Chris Neylon Photography**
Ian and Pam Cornthwaite have been living in their newly built all-electric sustainable home outside tranquil Trentham, north-west of Melbourne, since September 2015. Mains gas is unavailable in their area, but even if it had been, Ian and Pam would never have considered connecting to it: "We didn't want to use a non-renewable energy source," says Ian. Along with their design team at Maxa Designs, they gave plenty of consideration to the energy efficiency and thermal performance of the home. They chose efficient electric appliances; hot water is provided by an electric-boosted evacuated tube solar hot water system; and their minimal active heating needs are covered by efficient Daikin split systems and a wood heater. Their 3 kW solar PV system goes a long way to covering their electricity needs. "We love living in an all-electric home," says Ian. "We try to use the dishwasher, washing machine and so on during daytime sunshine to maximise the benefit of our solar harvest. It's all painless and becomes second nature if you're committed." Full profile in *Sanctuary 38*; read about other all-electric homes and what's involved in our special feature starting page 42.

Guide

Insulation buyers guide

↑ Many types of insulation can be DIY installed, like this underfloor insulation. This and other reader insulation upgrade stories are on page 86.

Regulars

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

Use your excess solar energy

If you only get a low feed-in tariff then solar diverters are a great way to use excess solar energy production for water heating, rather than sending it to the grid for a few cents per kilowatt-hour.

Catch Power diverters come in three models. The Blue Catch and the Blue-3 (a three-phase version to be released in June 2017) come with a smart controller which learns your energy usage patterns and monitors current weather conditions to decide how/when to use your excess power for hot water heating. The Green Catch is a simpler version with manual control—better suited to locations that don't have the reliable internet access the Blue Catch requires.

The Catch Power units are designed to work with any resistive element water heater up to 4.8 kW (7.2 kW for the Blue-3), which covers almost any domestic hot water system in Australia and is well suited to underfloor heating as well.

Catch Power units are Australian developed, engineered and manufactured by Project H Pty Ltd.

RRP: $1000 for the Green Catch, $1700 for the Blue Catch and $1995 for the Blue-3. Prices include GST and installation but may vary depending on complexity of the installation requirements. For more information contact Catch Power, ph:1300 131 995, www.catchpower.com.au

02

Smarter energy monitoring

Most home energy monitors tell you how much energy you're using, but not which appliances are using it. However, smarter electronics is changing that.

The Smappee is the first (that we have seen) energy monitor that measures the actual energy consumption signature (consisting of the electrical current draw waveform and operating times) of each appliance as it is used, to build up a library of each appliance and its energy use. The Smappee is simply mounted near your meter box and connected to mains power and your home wi-fi network. A simple clip-on sensor, fitted to wiring in the home's meter box, samples the current flow thousands of times each second to create the energy signature for each appliance.

Over time the monitor will be able to present you with a summary via the Smappee app of the appliances in your home and what they are costing you. This lets you fix or replace the inefficient ones, or simply turn them off when not in use. There are a few devices the Smappee has trouble monitoring—mostly small loads like single LED bulbs.

There is not just one Smappee, but several, including one for solar energy systems and even one that can measure water and gas usage without breaking into the pipework.

RRP: $299 for the energy monitor kit, $449 for the solar monitor kit and $179 for the gas and water monitor kit. For more information and to buy, go to www.smappee.com/au

03

More power, same space

Solar panels have gotten quite large in recent years, but there is a physical size limit to what is practical to install on a roof.

To improve power density, LG has increased the efficiency of their NeON range of panels with the new monocrystalline NeON R, which has higher output for the same physical size.

The 60-cell NeON R is rated at 350 to 360 watts output while measuring 1700 x 1016 x 40 mm, giving it a module efficiency of up to 20.8%. Operating temperature range is -40 °C to +90 °C and weight is 18.5 kg.

Other features include a 6000 Pa front/5400 Pa rear wind load rating, black anodised frame, MC4 connectors on one-metre flying leads, a power rating of 0% to +3%, a 25-year linear power warranty and a 25-year product warranty. Warranties are also transferable should you sell your home.

RRP: POA

For more information and to find your local LG solar dealer, contact LG Energy, solar.sales@lge.com.au, www.lgenergy.com.au

Not just window dressing
High-performance curtains and blinds

Internal window coverings can protect privacy and dramatically improve the thermal function of a house, and if you choose with care, they can help keep you comfortable for years, writes Anna Cumming.

WINDOWS are a complex and interesting part of the building fabric of a house. They admit light, warmth and fresh air; they connect the occupants visually with the outside world; sometimes they frame spectacular views. But from an energy efficiency point of view they are usually the weak link in the building structure. Through windows up to 40% of a home's heating energy can be lost and up to 87% of its heat gained, according to *Your Home*. High-performance, double or even triple glazing helps this equation, as does careful consideration of window size, location and orientation. But to ensure the best thermal performance of your home, you'll need effective window furnishings. Blinds, curtains and shutters can improve a window's performance, make your home more comfortable and reduce energy costs.

Image courtesy Emma Byrnes & Brave New Eco

Heavy curtains that touch the walls on each side of a window, reach to the floor and have an enclosed pelmet at the top are very effective at preventing heat transfer between the interior of the room and the window, and thus outside. Good design for curtains includes allowing enough space beside the window to store the open curtain without blocking part of the glazing.

What's the purpose?

"Internal window furnishings serve a variety of purposes, including light control, privacy, reducing glare, heat reduction and heat retention," says interior designer Megan Norgate of Brave New Eco. Soft window furnishings can also buffer sound. If you're building or renovating, consider window treatments as part of the design process, because taking into account the associated requirements and thermal contributions may mean you make different decisions about the extent and location of your glazing.

It's important to consider the main purpose when choosing window coverings. If minimising heat gain in summer is the main aim, it's best to keep the sun off the glass in the first place with an external shading device such as an eave or awning (see our article on external shading options in *ReNew 138*). Semi-transparent blinds or curtains are a good option if privacy or glare reduction is the primary aim; they can be combined with heavier curtains for night-time heat retention.

Thermal performance is where great window coverings really come into their own: "They can act like de-facto double glazing if they are multi-layered and tight fitting to the window," says designer Dick Clarke of Envirotecture. Snugly fitted and insulative blinds and curtains trap a layer of still air next to the window, reducing transfer of heat from the room to the window and thus outside. They also provide a feeling of cosiness: "If you are sitting in a warm room at night between an uncovered window and your heating source it is likely you will feel a chill, partly because of the draught created by the interior heat making a beeline for the cool exterior. Properly fitted and lined curtains and window treatments are the best way to avoid this effect," explains Megan.

Choosing your style

There are a wide range of products available depending on the purpose to be served, your budget and your design preferences.

CURTAINS

According to Megan, "Heavy curtains are best for thermal performance and are great to block out light, but may not work where floor space is limited or there is no space above the window to mount tracks or at the side to accommodate the open curtains." There are other considerations to ensure your curtains are effective: they should have an enclosed

Solar sizing
Big returns

Why it's now advisable to 'go big' when installing a solar system, even if you don't use much electricity: Andrew Reddaway presents the latest ATA modelling.

MANY people ask us what size grid-connected solar system they should get. Traditionally, the ATA (*ReNew*'s publisher), has advised people to consider this carefully. If you primarily want to help the environment and cost is of little concern, it has always made sense to install as many panels as possible, as all their generation displaces electricity from dirty, centralised power plants. But most people have budgetary constraints, so their solar system needs to make economic sense as well as help the environment. To achieve this, we've previously recommended that people size a solar system based on their electricity consumption and maximise their other opportunities, such as energy efficiency. However, things have changed.

Two big changes

SOLAR SYSTEM PRICES

The last five years have seen significant price reductions, especially for larger solar systems. Prices vary with component quality and location, but on average a 5kW solar system now costs around $6200 according to Solar Choice's residential price benchmark data.

Let's compare a 5kW system to its smaller 2kW cousin. To compare two different system sizes, the cost is presented in dollars per watt. Figure 1 reveals that since August 2012, the larger systems have halved in price, while the smaller ones have dropped by only a quarter.

Larger systems have always enjoyed economies of scale compared to smaller systems, because while the installer is on the roof it's relatively easy for them to add more panels. One difference now is that the price of solar panels has fallen faster than other components. The industry has also become more familiar with larger systems, as they are now more frequently installed than small ones.

FEED-IN TARIFFS

The Victorian government recently announced that solar feed-in tariffs will rise to 11.3c/kWh from 1 July 2017, roughly double their previous level, and IPART has recently recommended a similar change in NSW. These changes are primarily due to wholesale electricity prices in the eastern states roughly doubling over the past year to around 10c/kWh. We expect other states to follow suit, as feed-in tariffs below the wholesale electricity price are clearly unfair to people with solar. (In WA, a similar rise in wholesale rates hasn't occurred, but prices might still rise due to the state government winding back its subsidy of electricity prices.)

What this means for solar system sizing

Given these changes, if you're planning a solar system, is it worth it to upsize from, say, 2kW to 5kW?

The extra panels will be relatively cheap but more of their generation will be exported, which doesn't help the economics. For example, depending on household consumption, a solar system rated at 5kW might export 80% of its generation. Electricity exported to the grid only earns the feed-in tariff, ranging from 5c to 14c per kWh, depending on your location and electricity plan. Solar electricity used on-site, rather than exported, saves you paying the grid tariff, typically around 20c to 35c per kWh.

Surprisingly, our modelling of the economics found that a 5kW system now has a shorter or equivalent payback time to the 2kW system. We studied the economics by simulating a large number of scenarios in half-hour intervals for a whole year using Sunulator, ATA's free solar feasibility calculator.

Our primary economic measure is payback time, the number of years until bill savings recoup the installation cost—the fewer years the better. Payback times shorter than 10 years are generally considered attractive to solar customers, as the system is likely to pay for itself before any significant expenses, such as replacing the inverter. The panels should last at least 20 years, so cumulative bill savings are large, especially for a larger system.

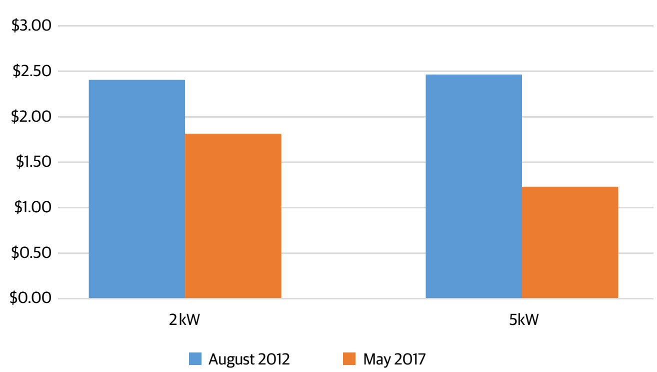


Figure 1: Solar system cost per watt in 2012 and 2017. Note the much greater reduction for 5kW systems.

Gas vs electricity
Which fuel is cheapest?

The ATA is updating its modelling on the economics of going off gas, particularly for households with solar. The new research considers changes in tariffs, solar prices and the increasing efficiency of electric appliances. Dean Lombard and Keiran Price explain.

Image: Kyle O'Farrell

↑ If you have a solar array then you are likely to be better off using electric appliances over gas.

PEOPLE may not realise that every time they replace a fixed appliance, such as a heater, oven/cooktop or hot water system, they are also making a fuel choice decision: gas or electricity. Among the many reasons for choosing one way or the other, the economics is largely a mystery to most people. Which fuel is cheaper for the same output?

Gas has historically been cheaper, but this is not necessarily still true. Gas and electricity bills have both risen spectacularly in recent years, and changes in tariff structures—with daily supply charges rising faster than consumption unit charges—have altered the relationship between consumption and cost.

Appliances have also become more efficient, especially electric ones. In particular, heat pumps, which output more energy than the electricity they consume, have become more widespread in space heating and hot water systems. This means that even if gas is cheaper than electricity on a per-unit basis (when converted to the same units, such as kilowatt-hours), it's not necessarily cheaper at doing the same work (because a gas heater might need five to ten times as many kilowatt-hours to produce the same heat as a reverse-cycle air conditioner).

In 2014, with the prospect of sharp increases in gas prices on the horizon, the ATA analysed the comparative economics of gas and electricity for a household faced with a fuel choice decision (a project funded by the Consumer Advocacy Panel). We found that in many situations (especially new builds and existing all-electric homes), choosing the electric option was cheaper—even if gas prices didn't skyrocket.

In 2017, after a few more years of energy price rises and improvements in appliance efficiency, we are redoing this analysis. This time we are also looking at the impact of home solar generation on the economics of fuel choice.

The 2014 approach and findings

For the 2014 project, we identified six archetypal households—a small, medium and large home; a typical public housing property; a medium home connected to LPG rather than mains gas; and a large newly-built home—and estimated the amount of cooking, heating and water-heating energy required per year. The estimates were derived from a range of sources based on a combination of surveys, measurements and modelling.

We selected typical new gas and electric appliances as replacement candidates and used their specifications to calculate how much gas or electricity they would consume to produce the required output energy. The running cost of each was calculated over ten years using the relevant retail energy tariffs and an allowance derived from forecasts for future energy price rises; this was added to the capital cost to determine the total cost for each appliance. Each household type was examined under a range of scenarios (for example, replacing one, two or three major appliances) and the ten-year costs of replacing with gas or electric appliances were compared.

The findings from 2014 were pretty clear:

- It was always cost-effective to avoid a gas connection in a new home or an existing all-electric home—unless heat pump heating (i.e. reverse-cycle air conditioning)

Capital improvements
The path to all-electric

Switching to electric appliances wasn't really thought of as economically or environmentally beneficial 10 years ago when Ben Elliston's household started their efficiency improvements, so theirs has been a gradual path to all-electric. By Robyn Deed.

YOU could call Ben Elliston's household a 'poster child' for getting off gas, but that's not how it began. Rather, when they started the process to improve the efficiency of their Canberra home 10 years ago, the family's mindset was aligned with the message at that time that gas was a cheaper and relatively clean fuel, compared to grid electricity. Ten years on and several 'face-palm-why-did-we do-that' moments later, they are now enthusiastically all-electric, with their energy use, operating costs and greenhouse gas emissions all pleasingly reduced—and with some added advantages of their new electric appliances that they didn't expect.

Looking back, Ben says one of the biggest shifts has been in what a state-of-the-art electric appliance looks like. From the simple electric element appliances of the 80s (the coil cooktop, electric blow heaters and electric element tanks), many of the newer appliances offer not only lower running costs—over both gas and older electric units—but also safety and other benefits. Ben says, "There were lots of advantages we hadn't anticipated when we shifted to electric appliances. For example, our induction cooktop has smarts to switch off if it senses that a pot is too hot and has run dry; our heat pump air conditioner is also much quieter than our old gas wall heater."

The other major factor for Ben's family is environmental. With the ACT now well on the way to 100% renewable electricity by 2020, Ben says, "In 2020, our household will be net zero emissions, which would not be possible if we were still using any gas appliances."

↑ Well on the way to net zero emissions: with solar panels, solar thermal hot water and an electric vehicle, this all-electric home in Canberra is leading the way in showing the environmental and financial benefits of going off gas.

The benefit of hindsight

However, travelling back to 2006/07, the landscape was still one where gas was preferred. So they began improvements on their new home with two "face-palm moments"—two decisions which they later came to see as "big mistakes". Firstly, they plumbed their barbecue to natural gas: great for convenience and lower cost, but not so great when they decided to quit the gas network. However, this was relatively easy to undo in 2017, when they converted the barbecue back to bottled gas.

The other "mistake" proved more problematic. In 2007, Ben was keen to install solar thermal hot water, and best practice at that time suggested gas-boosted solar. Unfortunately, the tank in this system didn't include an electric element, so they couldn't easily switch to electric boosting. Not wanting to throw away their investment in a solar thermal system, it took some time and a bit of luck to get the system off gas. The luck came in early 2017 in the form of an electric tank on Gumtree, compatible with their system and which they were able to buy and plumb in for $700 (with free delivery from Sydney in the back of a friend's car!).

Decision to go all-electric

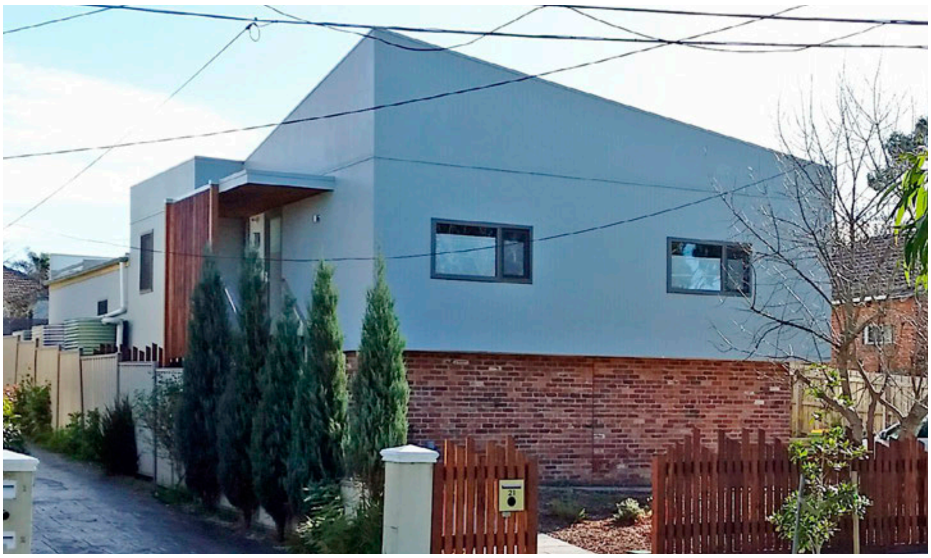
The household's impetus to switch to all-electric only really began in 2013, tapping into discussions online about the environmental and financial benefits, combined with advocacy by Beyond Zero Emissions in their *Buildings Plan* (2013), the ATA's report 'Are We Still Cooking With Gas' (2014) and Richard Keech's *Energy-Freedom Home* (2015). Dave Southgate's online publications laying out his family's steps to become fossil-fuel-free provided more inspiration.

Ben and his family decided to tackle their house's conversion as a long-term project, not wanting to discard working appliances without being sure of the benefits.

Sealed with a SIP

Comfortable and energy-positive

Last year the energy costs for this four-person household came to just $560 (basically just the daily charge), due to an airtight house design, a PV system well-matched to usage and a switch to all-electric. Kyle O'Farrell describes how they got there.



↑ At 150 m², the new home is bigger than the 1950s double-brick it replaced (100 m²), but uses half the energy while maintaining a much more stable and comfortable internal temperature.

IN DECEMBER 2012 we were living in a small double-brick ex-Housing Commission home in the northern suburbs of Melbourne. With two growing kids sharing a bedroom and a very non-user-friendly layout, we knew it wasn't going to work in the longer term. However, we liked where we were living and didn't want to move. The house was built in 1953 and, aside from some minor wall cracking, it was basically sound and could probably be used as a base for a renovation. So what to do?

We asked architect Mark Sanders at Third Ecology to create three concept house designs for us: two incorporating the existing house and one a completely new build. To our surprise, the estimated cost for the new build was only around 10% more than the renovations. And, with the existing house set well back on the block, the most logical renovation design would mean building in our north-facing backyard with a significant loss of garden space, not something we were keen to do.

Thus we decided on a new build, given the benefits in orientation, block placement, reduction in project time and cost risk (renovations often throw up costly issues along the way), design layout and improved thermal performance.

The previous house was connected to the gas network, but we disconnected it during demolition and we wanted it to stay that way: for environmental, health and financial reasons, not least of which is that gas is a fossil fuel which contributes to climate change. We were also planning to install solar PV and wanted to maximise on-site usage of electricity, rather than pay the expense of a gas connection, gas plumbing and increasing gas prices. Finally, we were planning to build a very well-sealed house, so we felt that piping an asphyxiating and explosive gas into it was worth avoiding if possible. We also didn't want the combustion products (mainly CO_2 and water vapour, but also nitrogen oxides and carbon monoxide) in the house.

Around the same time, Beyond Zero Emissions released its *Buildings Plan*, which strongly supported going gas-free and outlined how to do it. Nice report.

Design for thermal performance

When it came to the house design, we liked the features of the Passive House approach to house construction, but knew there was a higher cost associated with the additional design, construction and certification requirements. Looking around for construction methods that could achieve similar insulation and air sealing, without additional building costs, we found structural insulated panels (SIPs). These are wall panels with a foam core and rigid panels glued to each side. The panels are weight bearing, so timber framework for the external walls is not required.

After researching SIP suppliers (we identified four at the time) we decided to use Habitech Systems, which provides SIP-centric architectural design and also supplies the SIPs. Habitech was very transparent about the SIP costing which allayed our concerns about locking into a SIP supplier without being able to compare quotes.

By the end of August 2014 we had a 150 m² house design by Habitech and had engaged Henry Netherway to build it, with a contract build cost around 5% less than the estimate by Third Ecology: so we don't think we paid a price premium by choosing SIPs.

Introduction to induction
Tips from a convert

Keen cook Sophie Liu loved cooking on gas until induction came along. She describes why it won her over.

IT'S BEEN two years since I researched and purchased an induction cooktop, and wrote a product profile for *ReNew*'s sister magazine, *Sanctuary* (see issue 30). Since then I've been using this new technology on a daily basis and it's official—I'm an induction convert!

I am a keen cook and for the longest time I loved cooking on gas. But the advantages of induction for the environment and usability won me over. Like any new appliance, it took a while to get used to, and there are a few tips and issues worth pointing out and a few downsides to avoid. I've also outlined my good experiences and the many advantages of induction cooking below.

Renewably sourced electricity—one, Gas—nil

While cooking makes up a small part of a household's energy use, it is still important to a home's environmental footprint and running costs, particularly when other higher energy use areas have been addressed (see 'Energy-efficient cooking' and 'Are we still cooking with gas?' in *ReNew 130*). In terms of energy efficiency, ATA's analysts have found induction comes out on top, just ahead of ceramic electric resistive cooktops, and with both these electric options ahead of gas hobs (input: induction 600 MJ/year, ceramic electric 667 MJ/year, gas 1200 MJ/year, all for the same energy output of 480 MJ/year).

ATA energy analysts estimate that energy use for an average household with a gas cooktop and oven is 2000 MJ/year—less than 4% of the average household's energy use. By contrast, an induction cooktop and electric oven come out at 1000 MJ/year, 50% less. I also prefer electric induction to gas as I can run it on renewable electricity rather than using a fossil fuel.

↑ You'll need cookware that a magnet sticks to and Sophie recommends testing the whole base of the pot to ensure even cooking. It's not hard to find, such as this espresso coffee pot and cast-iron saucepan.

With great power comes great responsibility

My experience of cooking with induction is that it's the fastest, most responsive and most powerful method of cooking out there—aside from the occasional accidental flambé situation I had on my old gas hob! Now, using induction, any flambé action is intentional, controlled and planned.

It took some time to get used to the faster, more powerful cooking. At the start, I certainly burnt or overcooked a lot of things—I even spectacularly ruined rice one night, which, with my Chinese heritage, is embarrassing to admit!

However, as with any new appliance, you gradually learn how to use it successfully. Now I know the power levels to start rice or pasta on, then what to turn them down to. We can slow cook things, too, and not have to worry about the gas going out, which often happened on low with our old hob.

I feel the need ... the need for speed!

It's fast, really fast. I've timed making espresso in my stovetop pot using various gas cooktops and our induction cooktop. The gas takes around six minutes, the induction around three. So, with my daily coffee routine, each year I'm saving 3 x 365 = 1095 minutes, or over 18 hours!

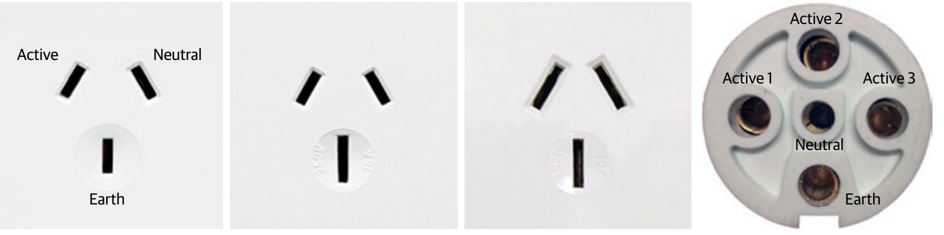
A watched pot never boils

Except on induction! They really are quick at boiling water; for example, I can boil 1.75 L of water in an 18 cm pot, with lid on, in just under four minutes. Pasta pronto!

One phase or three

Configuring multi-phase at home

If your home has a three-phase power connection, there are a few extra decisions to make when buying appliances, connecting solar or adding batteries. Lance Turner explains.



↑ We are all familiar with single-phase sockets as the common household power points. The connections are shown on the 10 A version of the socket, at left, which is the most common socket found in homes. 15 A (larger earth pin) and 20 A (all pins larger) versions also exist for appliances with heavier power draws, although most higher power appliances such as stoves and water heaters are permanently wired in. Note that a lower rated plug can fit higher rated sockets, but not vice versa. At right you can see a three-phase socket, with the three separate phases with a neutral in the centre (some sockets omit this) and earth at the bottom. The matching plug can only be inserted the correct way around due to the keying notch at the bottom of the socket.

ALL AC grid electricity is generated using a three-phase system. Because of their relatively modest power needs, most homes are only connected to one of those three phases. However, some homes, such as those that have larger loads, and most commercial premises, have a three-phase electricity connection.

Larger loads can mean that a single-phase connection would be heavily loaded at times. A three-phase connection may be used as it spreads the power draw across all three phases instead of just one. Interestingly, some homes are connected to just two of the three phases.

If moving your home from gas to all-electric, you may also consider upgrading an existing single-phase connection to a three-phase connection. For an energy-efficient home this shouldn't really be necessary, but for larger homes or homes with a single large load such as an EV fast charger, an upgrade to a three-phase connection may be desirable or even necessary.

At the very least, smaller (40 amp) single-phase connections may need to be upgraded to something larger, such as an 80 amp connection. Any grid connection upgrade will usually require cables between the residence and the grid to be replaced, which can be expensive, depending on your energy company, location, cable installation type (overhead or underground) and length of cable back to the grid, and may run to several thousand dollars. Shifting from single phase to three-phase will definitely need cable replacement—each phase needs its own cable, and will also require a meter upgrade.

Having a three-phase connection to a home does allow for greater flexibility with appliance selection as you can use either single-phase or three-phase appliances as desired. If you are upgrading to a three-phase connection purely to install a large solar system, then the cost of the connection upgrade must be added to the system cost when factoring in system payback times.

Three-phase and loads

Even in a three-phase home, most 'loads'—your energy-using appliances, lights etc—are single-phase. These single-phase loads are connected to the individual phases in a distributed fashion. For example, your home might have six separate circuits for light and power points, with two of these circuits connected to each phase.

With a three-phase connection it is best to try and balance energy flows on the three phases as well as possible. This means distributing loads across phases such that all the large loads don't end up on just one phase. This requires some planning when the home is first wired and there are limits to how balanced the loading can remain (as loads change over time as appliances are moved or replaced).

As an example, a home might have some appliances with larger power draws, such as an oven/cooktop, a large pool pump and a ducted reverse-cycle air conditioner. To balance the loads, you would connect each one of these loads to a different phase. There would, of course, be numerous smaller appliances, but which phases they are connected to is less consequential.

Alternatively you might consider using three-phase versions of these loads. Pool pumps and some air conditioning systems are available in three-phase versions, so they might be the better option. If you opt for a whole-house electric instantaneous hot water system, then a three-phase connection is likely required. While single-phase units are available up to 20 kW or so, they are really only suitable for homes with low hot water demands. A three-phase unit gives greater hot water capacity and can heat a given flow rate to a higher temperature as it can draw more power from the grid than a single-phase unit. Other loads, such as workshop equipment

The key to thermal performance
Insulation buyers guide

Is your home hot in summer and freezing in winter? It probably has little or no insulation. Lance Turner takes a look at how insulation can help.

INSULATION, like orientation, is often overlooked by householders, perhaps because it's not on display, hidden as it is in the ceiling, walls or underfloor. You may not be able to see it, but, in most homes, you can feel its presence, or absence. Insulation is key to providing a liveable home when the weather cools down or heats up, without breaking the bank on energy costs.

Insulation works by resisting the flow of heat, slowing down heat loss in winter and heat gains in summer. In a well-insulated home, once the home has been heated to a comfortable level in winter, it will stay warm with far less energy input than an uninsulated or poorly insulated home would require.

The same applies in summer: a properly insulated home will take longer to heat up and, if an air conditioner is used, it will use less energy than one cooling an uninsulated house. One summer-time caveat: any windows that receive direct sunlight need to be shaded, particularly west windows, as insulation can slow the ability of the house to cool down if there are large heat gains from windows.

Image: iStock:MyrKu

↑ Glass wool materials come as both batts and blankets on a roll, shown here. Blankets make for faster installation where there are long sections with no crossing joists to fit around.

Heat transfer and insulation

There are three ways that heat is transferred to or from a building: conduction, convection and radiation (and through gaps, of course, but draughtproofing is outside the scope of this guide).

Conduction is the transfer of heat through a substance, in this case the walls, floor and ceiling of a house. The type of insulation used to reduce conductive heat transfer is known as 'bulk' insulation.

This is the most common home insulation and may be in the form of fluffy 'batts' or 'blankets' made of materials such as polyester, glass or mineral wool or sheep's wool. Bulk insulation may also use a loose-fill material, which is pumped into the roof or wall cavities and sealed with a spray-on cap. All these materials are poor conductors of heat and so reduce the rate of heat flow, provided they are installed correctly.

Convection heat transfer—heat transferred through the circulation of air—is the undoing of many insulation jobs. Circulating air can pass between poorly installed insulation materials and thus transfer heat into or out of the house, vastly reducing the effectiveness of the insulation.

Radiation is a different type of heat transfer. All warm objects radiate heat in the form of infrared radiation. This heat can be reflected back to where it has come from using reflective foil insulation, so that heat loss or gain through radiation is greatly reduced.

Reflective surfaces such as foil don't just reflect, they also have low emissivity—the ability to emit radiation, or heat in this case. This means heat that has entered the material from the non-reflective side is not emitted from the reflective side easily. Thus, foils work to reduce heat flows in both directions, even if only one side of the material is reflective.

Bulk insulation

BATTS, BLANKETS AND BOARDS

Bulk insulation is primarily used in ceilings, where it is usually installed directly on top of

Staying warm, and cool
Insulation upgrades

Three reader stories on how they improved the thermal performance of their homes, while reducing energy bills. By Eva Matthews.

Whole-house insulation

Dennis Kavanagh has been incrementally improving his home in Blackburn, in Melbourne's east, over the last few years.

↑ The granulated Rockwool is pumped into wall cavities from the top, or through holes in the wall which are later filled.

AS WELL as deciding to go all-electric and installing a 9.8 kW solar PV system on his roof around 11 months ago, Dennis turned his attention to improving the home's thermal performance through insulation and draughtproofing.

Little existing insulation

After attending a free EnviroGroup presentation run by ecoMaster on these topics, Dennis ordered a premium assessment for his home, which resulted in a number of recommendations and quotations to address them. They identified his ceiling insulation, which had been installed about 40 years ago, as being in reasonable condition but only rated R1.0. There was no insulation in the walls or underfloor. With Dennis unable to "crawl up or into awkward spots" himself, ecoMaster installed the insulation in the roof and underfloor in August 2015, both in the same day. Access to the roof was via the manhole; underfloor access was limited under the bathroom, laundry and some of the third bedroom, so they achieved around 70% coverage there.

For the walls, being brick veneer, Dennis's best option was to have the insulation pumped in. As this type of application can cause a fire hazard, and the installers ecoMaster recommend require an electrical safety certificate, Dennis organised an inspection prior to the installation, using electricians from EnviroGroup. After checking behind power points and testing at the meterbox, and with Dennis having upgraded his wiring recently, they determined that all was good to go.

In January 2017, one man with a truck of granulated Rockwool (mineral wool) pumped in the insulation in less than a day. Most of the walls were accessible by shifting some tiles on the roof, through which the insulation was pumped in down a flexible hose. Solar panels were in the way in some spots, so not all the walls could be accessed from above; in this case Dennis thinks the insulation may have been pumped across from a neighbouring entry point. Holes were then drilled under the windows to pump into those lower spaces, and a mortar mix used to patch them. Although Dennis was somewhat concerned about whether it would match the existing mortar, he says it worked out well: "Unless you look closely, you don't even notice it." Also, batts were put in to fill gaps between the top of the timber wall framing and roof.

The end result

So has all this insulation made a difference to the comfort of Dennis's home and his energy bills? In terms of comfort, subjectively, he feels that it has; though, he notes that he can't be sure (not having direct contact with the floorboards due to carpeting and tiles can make it more difficult to tell). Dennis feels that once he's plugged the last major hole in his "leaky bucket"—attending to the windows (perhaps, he notes, by trying out the DIY double-glazing outlined in Alan Cotterill's article from *ReNew 135*)—then the "overall combination of everything will make a bigger difference."