MODERN GREEN HOMES

Sanctuary

INSIDE ISSUE 30 130+ green products and design tips; Design for climate change in the tropics; Creative reuse in Tassie; Brisbane jewel; Design workshop comes to Melbourne

A 9 STAR HOME FOR ALL AGES

+

Biomimicry

Off-grid in the city

Cooking with induction

WIN

A Siddons Solarstream hot water heat pump

Offer open to Australian residents only.

ISSUE 30 • AUTUMN 2015
AUD$11.95 • NZ$12.95
SANCTUARYMAGAZINE.ORG.AU
ISSN 1833-1416
9 771833 141000

MODERN GREEN HOMES

Sanctuary

Contents

—Issue 30

34

14

64

Contents

—Issue 30

70

78

High achiever

The latest project by Positive Footprints is the first in a series of off-the-plan 9 Star homes and an attempt to bring sustainability to the mainstream.

WORDS Emily Braham
PHOTOGRAPHY Nick Stephenson

Windows to north and south of rooms are aligned to channel prevailing summer breezes through living spaces for natural cooling and effective night purging. Casement windows with flyscreens scoop breezes inside to cool the house at night. When the night is still, automatic hopper clerestory windows open to release hot air.

JEREMY SPENCER AND CHI LU OF Positive Footprints have found an approach that works – meticulous planning, building, and then living in their projects to experience a home's performance firsthand. Their latest, in Melbourne's bayside suburb of Seaholme, where they live with their two primary school-aged children and Jeremy's ageing parents, represents the culmination of over 10 years' practice in sustainable building and design.

The project is one of four 9 Star designs, which aim to make the commercial case for energy-efficient, affordable homes (this one is the most expensive in the series at $495,000, the cheapest $350,000). "We wanted to make it easier for people to have a beautifully designed sustainable home which doesn't cost a million dollars," says Chi.

They have called this smart system-automated home Solar Sollew – a playful take on Dr Seuss's mythical city Solla Sollew – 'where they never have troubles, at least, very few'. The four designs allow for various orientations, with window location, shape and structure of the building varying to optimise passive solar design. All designs integrate indoor and outdoor spaces and focus on enabling sustainable living. "One of the reasons we went down this path (to design and build sustainable homes) was the realisation that often people try to live →

All appliances are highly energy-efficient, something Jeremy recommends all clients reserve some budget for. "From an environmental point of view it's a more effective way to spend your money. It's not worth going for that extra star for all the expense if the carbon you emit in the house and your whole lifestyle negates that."

sustainably but their house actually stops them," Jeremy says.

The home's low carbon output (it was carbon positive by 2.3 tonnes after the first four months) is aided by its highly energy-efficient appliances, for which Jeremy recommends all his clients reserve some budget. "From an environmental point of view it's a more effective way to spend your money," he says. "It's not worth going for that extra star for all the expense if the carbon you emit in the house and your whole lifestyle negates that."

Accessibility features are also designed in to suit a range of occupants over the home's lifespan. There are lower than normal benchtops, wide doors, ramps & stepless thresholds and a disabled bathroom downstairs, while walls upstairs are solid blocked internally for the easy addition of grab rails if required. Catering for Jeremy's father, who is in a wheelchair, made such considerations necessary, but designing for multiple users and co-generational living is a natural fit with Jeremy and Chi's values and is now incorporated into all of their designs.

But perhaps the stand-out feature of the home is its integrated intelligence. The Building Control Management System (BCMS) monitors wind speed and temperatures; a generous awning above the north-facing rear windows closes to prevent damage if the wind is too strong, and clerestory windows open if it is cooler outside and too warm inside (above 24 degrees). The system also regulates the greywater irrigation system and the earth tube cooling, an experiment in dealing with extreme heat, bringing in cool air from the stable 17 to 18 degree summer earth when the house reaches 24 and it is hotter outside.

Predictions of more frequent extended high summer temperatures also influenced the use of phase change materials (PCM) upstairs. Uninterrupted flow from the wide windows of the skillion roof at the back of

the upper level to the deck and windows at the front allows the PCM to cool down and reset in the evenings with sea breezes. Breezes are also channelled across the bright and spacious open-plan living areas on the ground floor, with bifold doors overlooking the productive garden.

The carefully planned garden is landscaped with recycled concrete pavers, reclaimed railway sleepers, native grasses for the lawns and indigenous and edible plants for ground cover (300 strawberry plants). Plants are either chosen to benefit native microfauna, including several endangered butterflies found in the area, or are edible to help cut down on food miles. There are about 30 fruit trees watered from an underground greywater system, fed by water from the bathroom and laundry. A small greenhouse constructed with leftover materials from the build has a wide range of functions, including seed growing, a place to dry clothes in the rain and, eventually, a home for chickens. →

There are 30 fruit trees watered from an underground greywater system fed by the bathroom and laundry, which also works to cool the earth tubes. 'Worm juice' supplements the plants' growth.

The north-facing productive garden uses recycled concrete pavers, reclaimed railway sleepers, native grasses for the lawns and indigenous and edible plants for ground covers (300 strawberry plants). A 7000L Colorbond rainwater tank collects water from the roof. There is also a solar power-lit shower in the garden for return trips from the nearby beach.

Nature's blueprint

WORDS

Jenna Waite

Wonder at nature and its complex web of systems is nothing new, but an emerging field of practice which mimics the natural process may just change the face (and function) of contemporary architecture, as *Sanctuary* intern Jenna Waite finds out.

NATURAL TECHNOLOGY

Biomimicry was popularised in 1997 when Janine Benyus published *Biomimicry: Innovation Inspired by Nature*. She describes biomimicry as 'the technology of biology', defining it as "learning from and then emulating natural forms processes, and ecosystems to create more sustainable designs."

"At its most practical, biomimicry is a way of seeking sustainable solutions by borrowing life's blueprints, chemical recipes, and ecosystem strategies." (Benyus Biomimicry primer 3.8)

OVER THE LAST 3.8 BILLION YEARS AN EXTRAORDINARY kind of research and development process has taken place, producing a sourcebook of evolutionary designs. The natural world has had a long time to adapt its systems to create the effective ecosystems that define it, and so it makes sense that a growing field of architects, designers and engineers are looking no further for inspiration. Biomimics emulate nature's forms and functions, drawing on tried and tested strategies, such as organisms' regulation of temperature, optimisation of light and natural ventilation systems to solve sustainable design problems.

For Tim Angus, an architect specialising in passive design and a passionate biomimic, the natural world is the best example of sustainable design. "Nature is the definition of sustainability; it combines stunning beauty with incredible performance all in a diversely integrated ecosystem," he says. "I see biomimicry as a way of taking architectural passive design to the next level."

While biomimicry is a new and emerging field, it is not a new design paradigm. Architects and artists have long emulated nature's aesthetic in their work, but what is new, Tim says, is the emulation of its functionality. Tim has collaborated with Ian Jones of Vipac Engineers and Scientists on several bio-inspired design projects. "I would come to Ian with a biomimetic design idea and Ian would apply his fantastic engineering brain to the issue at hand."

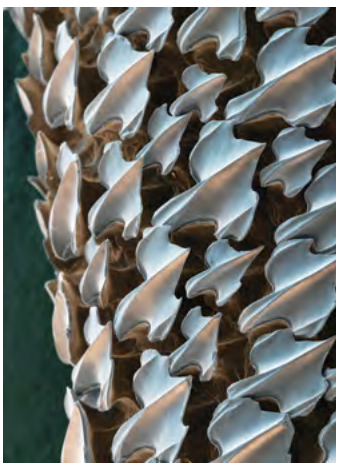
LILY OF THE SEA

Fittingly Tim's first biomimetic project evolved organically. Then at Elenberg Fraser Architects, Tim worked with Ian to design a naturally ventilated apartment complex in Melbourne's South Yarra. Ian used advanced computer modelling and algorithms to analyse how the building would interact with the environment; how the wind would track around it and whether this wind could be controlled and utilised to ventilate the apartments (traditional cross-ventilation is often difficult to achieve in high density apartments, particularly where external windows are only placed on one facade).

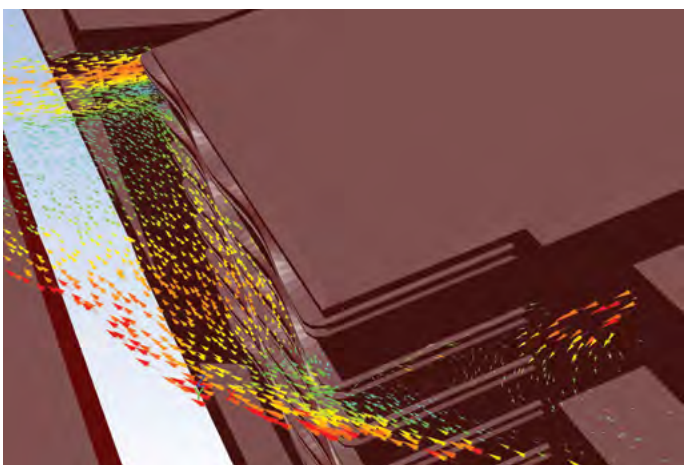
The resulting linear, undulating facade fins work to stabilise the surrounding airstream by reducing wind turbulence into flows of micro turbulence, and offer sun-shading. Strategically placed casement windows also act as 'wind scoops' to capture summer afternoon sea breezes, allowing a through-flow of cool air, reducing the need for active cooling.

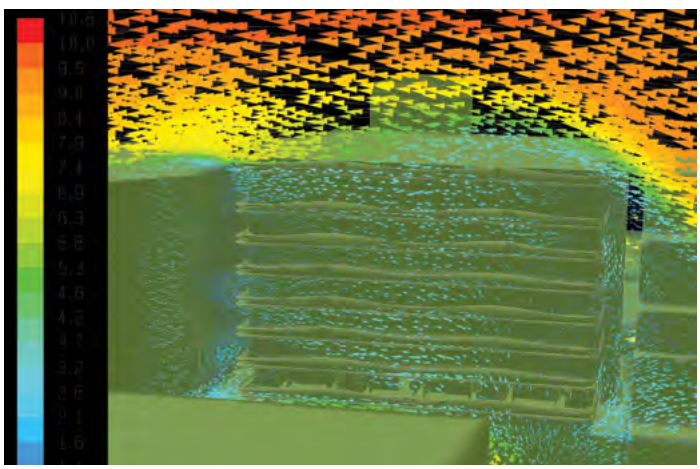
While biomimicry was part of the thinking from the start, it was only after going through the design process that the team discovered their emulation of great white shark skin. The hydrodynamics of shark skin naturally decreases the drag and turbulence of water, allowing the massive fish to glide swiftly through the water. "There was this serendipitous moment when we realised that what we designed, nature had already solved," says Ian. →

The contours of the denticles of the great white shark (on the left) were replicated in the facade of the Lilli Apartments to create a wind flow around and the through the building, reducing downwash. Image on left courtesy of Photo Science Library, on right: Peter Clarke Photography.



The linear facade fins and casement windows of the Lilli Apartments aid natural ventilation. External air is induced through the apartment balcony, through the living space and out through the bedroom (or vice versa depending on wind direction). Image courtesy of Peter Clarke Photography.





Thermal imaging by Vipac with CFD (computational fluid dynamics studies) shows how the wind tracks around the building, with the cool air flowing up and through the complex and hot air pushing out the side. These wind pressure differentials emulate how water glides past shark skin.

Tamara and Aiden want to renovate their existing north Melbourne weatherboard family home, retaining front garden for vegetable growing.

The existing back garden is used by the children to play and is occupied by their pet dog and chickens. They would like to retain as much of this space as possible.

STEFFEN WELSCH ARCHITECTS' DESIGN RESPONSE

Tamara and Aidan have a great attitude to renovating their home. They see their home as a focal point, a retreat as well as communal hub for friends and family, and they want to keep using their land sensibly. Their sense of community and neighbourhood belonging is also clear in their consideration of the impact they could have on their neighbours, and how any subsequent development might impact on their own home.

Their existing house has some shortcomings in addition to those already highlighted. In particular, it lacks

- An articulated relationship to the block
- convenient access to both the front and backyards
- adequate storage
- natural light
- flexibility
- functional wet areas
- clear and functional zoning.

A successful sustainable home design should encourage what we would call active sustainability. Living in your home should minimise resource use, maximise energy and water efficiency and help protect the environment through practices that utilise your land in respectful ways.

In this case it meant analysing how Tamara and Aidan use their home and their land, how sunlight access and air movement could be utilised for a passive solar design, how future developments next door might affect the energy efficiency and amenity; asking "how can we futureproof their home?"

GOING UP VERSUS GOING OUT

Tamara and Aidan are considering a second storey so as not to encroach on their outdoor space. Two-storey houses have a few advantages and disadvantages. A smaller overall building footprint means their house would have a larger backyard and garden, and more room for stormwater retention on site. Two-storey houses are also often more energy-efficient because they have a smaller external surface area. Living areas upstairs can also reduce heating and cooling needs as warm air rises to heat them while keeping downstairs bedroom areas comfortable.

Yet there are some disadvantages, including the likely greater expense. Upstairs living areas also compromise direct access to outside, and can make access for elderly people more difficult. A second storey also often creates overlooking issues with neighbours and can mean privacy screens are needed, limiting views. A second storey not placed appropriately can also overshadow adjoining buildings, potentially reducing their solar access and energy efficiency.

A single-storey design reduces the open space, creates a bigger footprint and it may require more energy to heat and cool due to greater external surface area. However, a single storey home can be more space efficient since it needs less circulation. It would also better connect living spaces to the land and encourage the informal lifestyle that Tamara and Aiden enjoy. Therefore, we have proposed a space-efficient solar passive, single-storey dwelling for a neighbourhood-friendly, relaxed indoor/outdoor home with optimum solar access.

PROPOSED PLANS

LEGEND

1. Bedroom
2. Bathroom/wet areas
3. Storage
4. Porch
5. Herb garden
6. Playroom/study
7. Kitchen
8. Living and dining
9. Courtyard
10. Shed
11. Chook shed
12. Covered outdoor area
13. Roof overhangs
14. Foyer

STEFFEN WELSCH ARCHITECTS' ALTERNATIVE DESIGN

Our proposed design solution takes into account Tamara, Aidan and their family's current informal lifestyle, which revolves around working in the garden, cooking and entertaining in the house, their changing needs as the children grow up and their desire to make the best possible use of the block.

The design also aims to create a good relationship between inside and outside living spaces. It optimises flow and functionality within the house by re-zoning a living area that relates to the back and front yards and a bedroom wing that can be used flexibly. There are no wasted spaces, the design allows them to open and close spaces, it makes the home comfortable to use year-round, day and night and for private and/or shared activities. It also zones the house to minimise operational energy use.

By demolishing the lean-to and placing a new living room wing along the southern boundary, the length of the backyard is increased and a large north-facing facade is created that catches sunlight and allows backyard access from the current lounge – which has been converted into a bedroom. All wet areas are consolidated and placed on the southern side of the house.

The entry is along this southern side with the bike shed along the fence and raised planter boxes before you get to the porch. From the porch you can enter to a new foyer to the right or directly into the kitchen on the southern boundary. The planter boxes adjacent to the kitchen can grow herbs that can be picked easily when needed for cooking.

From the foyer you get a glimpse of the backyard and can enter the new living spaces facing the garden to the left or the bedroom wing to the right. Opposite the bedrooms facing south are the toilet, the upgraded bathroom and a laundry that has ample storage – this will become invaluable as the children grow up and require more space. The laundry can be accessed directly from the porch, allowing dirty shoes and clothes to be stored when arriving from outside.

Between the living area and foyer is a small room that can work as a playroom for children. an intimate reading room at night or a study. The kitchen is located in a central spot that opens to the dining room and allows views to the front yard. Opposite the island bench there is a window seat that allows interaction with someone working in the kitchen.

Adjacent to the dining area is the living room. It opens to the dining area and can remain open in summer during the day or when guests are over. When the living and dining rooms are combined they allow for a long table that can sit more than 20 people. Closing bifold doors separate these two rooms in winter, at night or when privacy is needed.

Outside the south-west corner of the living room is a small courtyard. A nice feature as you enter the space, it throws light into the back of the house and so balances natural light inside. The window can draw cold air in and maximises cross-ventilation, which will be valuable after hot summer days when a cool change comes.

THE BUILDING FORM

A building's performance in itself, its impact on neighbouring buildings, the impact of current and future adjacent buildings and their performance should drive the building form. The design for Tamara and Aidan's new extension is an elongated building covered with two single sloped roofs that create tall ceilings and clerestory windows to the north and low ceilings along the southern boundary. This will maintain good sun access for

"Choosing materials for their environmental credentials goes without saying. The most important aspects to consider are embodied energy, thermal properties that minimise operational energy during the lifetime of the home, maintenance, longevity and recyclability."

- Steffen Welsch, director Steffen Welsch Architects

neighbours on the southern side and reduce heat loss to the south. The tall northern windows allow solar access in winter, and should do so even if two-storey units are built opposite. Openable clerestory windows allow for night purging in summer and tall ceilings provide plenty of space for ceiling fans that assist with air movement and good thermal comfort levels. Roof overhangs shade the glass from the summer sun.

MATERIALS

We believe exterior and interior materials should reflect the lifestyle and personality of the owners. As such, homeowner preferences as well as the way different materials respond to the context of the building ultimately create the home's identity. Choosing materials for their environmental credentials goes without saying. The most important aspects to consider are embodied energy, thermal properties that minimise operational energy during the building's lifetime, maintenance, longevity and recyclability.

For Tamara and Aidan's renovation we have suggested a slab on ground as a heat sink. It could be burnished, polished or tiled with stone tiles. The key is to not cover it with rugs or carpet where the sun hits the floor so it can work effectively. A concrete or stone floor also allows children to ride their scooters around the dining table.

Walls are best as reverse brick veneer with the thermal mass inside and thick thermal insulation in the timber frame on the outside. The bricks inside work best when bagged or rendered with a large porous surface that can soak up the heat. Other options could be hemp walls or rammed earth, which have similar thermal and acoustic qualities. External cladding could be a combination of metal and timber. Timber can be a very warm and tactile material. Over time timbers age and develop a different texture and the experience of maturing and ageing timber becomes part of living in the home.

Roofing should be corrugated iron. This suits the casual building form and expresses the suburban context of the house. It could also be used to re-clad the old house's walls, holding the old and new together aesthetically. Doors and windows are all double-glazed and framed in timber. For large units the right choice of timber is important to avoid sagging or warping which can create gaps and counteract the insulation qualities of the double glazing.

FINALLY

The success of a sustainable home comes down to use; the house's design is only sustainable if it encourages sustainable use, if it is easy to operate, convenient, functional and comfortable. It needs to allow its occupants to retreat when they wish or to be open and welcoming. And the house needs an identity and to feel like a home that its occupants are proud of and want to look after.

Steffen Welsch Architects is a Melbourne based practice with expertise in residential, commercial and institutional buildings. Its founder Steffen Welsch arrived in Australia in 1993 from Vienna and established the office in 2001.

Now a team of architects from various cultural backgrounds, they specialise in what they call 'active sustainability'.

www.steffenwelsch.com.au

Would you like your house plans Design Workshopped? Send us an email at designworkshop@sanctuarymagazine.org.au with a brief summary and plans of your project.

Shopfront revival

Architect Chris Clinton's adaptive reuse of a 1960s bootmakers cum take-away shop is much more than an exercise in recycling.

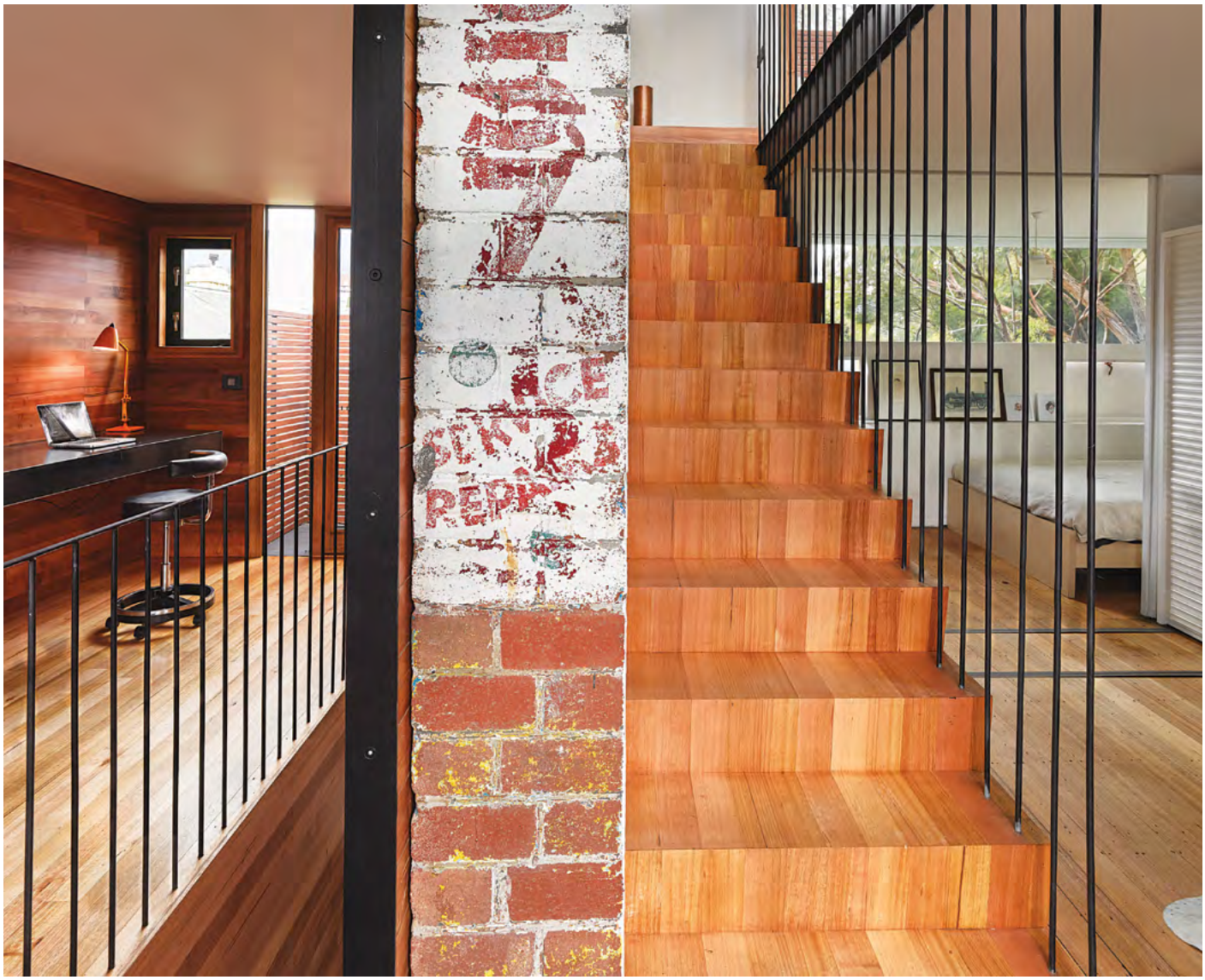
WORDS Gabi Mocatta
PHOTOGRAPHY Peter Whyte

SET ON ONE OF HOBART'S SMALLEST residential blocks (just 76 square metres), the former fish and chip shop had stood disused for some years. But Chris saw the tiny site as an opportunity – and so began six years of architectural experimentation that culminated in a compact, innovative home where salvaging and re-invention reign.

"The whole place is an experiment," says Chris. It was also about economy. "I wanted to retain as much of the original building as I could," and he wanted to undertake much of the work himself.

And so he moved in with his son Alec, now 19, and began a complete re-purposing. Keeping the core of the old shop to live in, he worked nights and weekends, expanding the house out wherever possible. He painstakingly excavated a lower floor – 48 tonnes of earth – mostly by hand to create the soundproof music studio that doubles as Alec's bedroom. He stepped the building out to the pavement at the front and added a level on top. Over time, the original 22-square-metre building grew to 100 square metres over three floors. The tiny take-away became a modest two-bedroom,

The facade consists of vertically stacked Hebel block columns, with remachined VJ timber infill panels salvaged from a local primary school interior. The studio recess (at left) frames a self-made steel and recycled textured glass window and incorporates a seat for passers-by.



As much of the original shop was retained as possible, including some of the bootmaker's brick walls and signage.

two-bathroom home, with two flexible living spaces and an architectural studio.

The rectangular column and reclaimed timber panel facade is perhaps its most striking feature. "It was important for me to make a contribution to the street," Chris says. The stacked Hebel concrete blocks, which he laid himself over time, are left exposed in the interior, providing useful thermal mass.

These add to a mixed palette of reused materials, including the building's original red brick walls, some still bearing the bootmaker's painted signage. Almost all of the ruby-hued myrtle, used in the wall panelling and in the kitchen bench, has been reclaimed for a second use, and the majority of the Tasmanian oak floor is also recycled. The upstairs living area is lined on two sides with striated plywood panelling salvaged from a nearby '50s home, and re-used dado board makes up part of the custom-built kitchen sideboard. A textured patchwork in the studio wall, also visible from the street, is made up of a store of collected glass and steel, salvaged piece by piece over the years.

Chris drew on his earlier experience in steelwork to create the dark, mild steel features of the kitchen benchtop, the studio workbench and the simple steel banisters. The steel is offset by glossy black mosaic

ATA research - Should we be going off gas?

WORDS

Kate Leslie

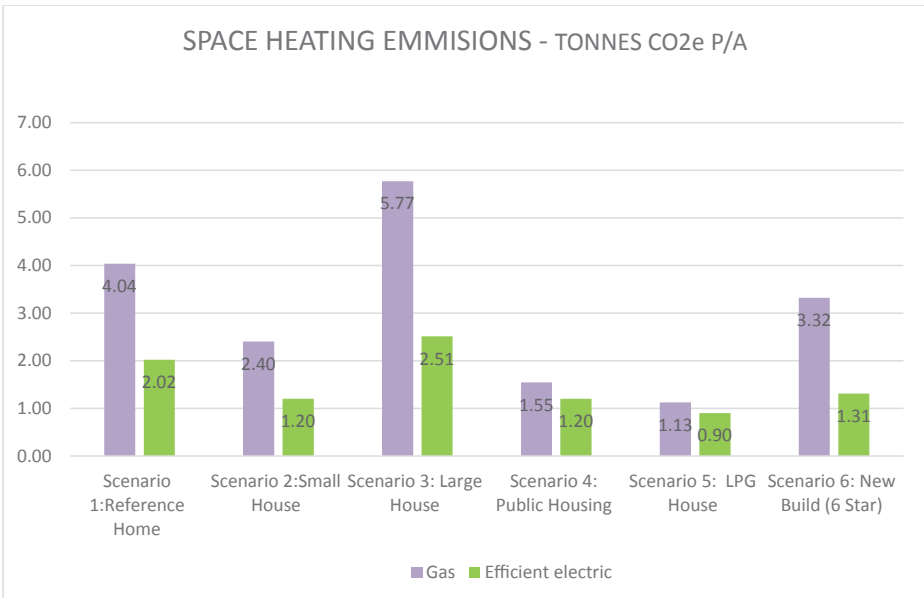
In the face of rising gas prices, efficient electric appliances may be more cost-effective for heating and cooking, and better for the environment, according to a recently launched report by The Alternative Technology Association.

Results for hot water varied – switching from gas storage to heat pump hot water systems may result in slightly higher emissions in the ACT and Victoria. This could remain the case for solar hot water systems, where the electric boost uses about the same amount of electricity per year as a heat pump. However, if powered by onsite solar PV or offset with 100% GreenPower, emissions can be virtually zero. Image by Nic Granleese.

GAS IS TYPICALLY USED IN HOMES FOR SPACE HEATING, water heating and/or cooking in Australia, but efficient electric solutions now widely available offer an alternative. Funded by the Consumer Advocacy Panel, the ATA considered locations and household types that may benefit by switching from gas to efficient electric appliance use – or by staying off the gas network in the first place. The results were surprising and represent a significant shift in the way we think about and use energy.

The research modelled 26 different 'gas zones', six different household types and a range of different 'replacement cases'. It considered the economics of switching to three specific efficient electric appliances: heat pump reverse-cycle air conditioners for space heating; heat pump hot water systems for water heating, and induction cooktops and energy-efficient electric ovens for cooking. The research also analysed the environmental impact of these potential switching decisions.

Switching from gas to efficient electric for space heating was consistently the most cost-effective option for all areas, based on the ATA's modelling. Hydronic heaters such as this can be gas or electric. Image by Nick Stephenson.



Estimated greenhouse gas emissions (in tonnes per annum of carbon dioxide equivalent) in Victoria for space heating. Taken individually, switching to efficient electric space heating has the clearest positive environmental impact, according to the ATA report.

Switching from gas to an induction cooktop and electric oven was only found to be cost-effective when combined with disconnecting from the gas network, and thus avoiding the gas fixed charge. [Ed note: for more on induction cooktops on p 78] Image by Nic Granleese.

COST-EFFECTIVENESS

The modelling consistently showed that for new and existing homes without gas, it is more cost-effective to stay all-electric than to connect to gas, as long as efficient electric appliances can be installed. For existing homes already connected to gas, the situation is more complex and depends on a range of different factors. Nevertheless, there were some clear findings for specific appliances and climate zones.

SPACE HEATING

Switching from gas to efficient electric for space heating was found to be the most cost-effective in all areas. In warmer climate regions, switching all gas appliances to efficient electric ones and disconnecting from the gas network offers better economic returns than in cooler climates – partly due to improved performance of heat pumps in warmer climates, and partly due to higher gas prices in these regions.

HOT WATER SYSTEMS

Heat pump hot water systems were found to be more cost-effective than gas hot water systems where gas prices are relatively high compared to electricity prices and/or where the climate is warmer (and so the systems perform more efficiently). Gas hot water systems were found to be more cost-effective in cooler climates with lower gas prices.

COOKING

Switching from gas to an induction cooktop and electric oven was only found to be cost-effective when combined with disconnecting from the gas network, and thus avoiding the gas fixed charge. [Ed note: for more on induction cooking see p 78]

ENVIRONMENTAL IMPACT

The ATA also considered the greenhouse gas impact of switching from gas to efficient electric appliances. The findings were promising: for the clear majority of homes using natural gas for all three end uses, emissions will reduce if they switch all three to efficient electric, regardless of home type or location.

Taken individually, switching to electric space heating has the clearest positive environmental impact. Results for hot water varied – switching from gas storage to heat pump hot water systems may result in slightly higher emissions in the ACT and Victoria. Efficient electric cooking increases greenhouse gas emissions in all locations except Tasmania. However, any emissions increase associated with

In the city, off the grid

Spiralling energy prices, concern for climate change and general dissatisfaction with energy retailers have led to growing interest in going off the electricity grid. Energy independence, a net-zero household and no bill surprises are certainly enticing, but how realistic is it for most of us?

WORDS Emily Braham

IN RURAL AREAS WHERE THE COST OF connecting to the grid can reach as high as $100,000, supply is unreliable and solar feed-in-tariffs offer little relief, unplugging from the network is for some a no-brainer. But in our cities and regional towns it has, until now, been a different story.

It can be a challenge to install enough rooftop solar PV capacity to fully supply the average household. Damien Moyse, policy and research manager with the Alternative Technology Association (publisher of *Sanctuary*), says the average house could need between 6 and 10 kW of panels to allow for the not so sunny days. The biggest barrier to year-round sun-powered energy remains the issue of storage. The frustrating mismatch between the sunniest part of the day/year and peak energy demand hours has meant disconnecting from the grid is not an option for most people.

Battery storage of solar energy is a way around this problem, but high technology costs have prevented all but the most adventurous of early adopters from installing battery banks in urban homes.

"We need the cost to come down probably by around 50 per cent for there to be a critical mass for large numbers of people to go off-grid," Damien says. A 2014 Alternative Technology Association (ATA) report, *What Happens When We Unplug?* suggests this could happen by 2020, at which point the transition could be "quick and dramatic".

Damien says the replacement of space and water heaters, the most intensive users of household energy in Australia's southern states, with wood heating could make the cost and necessary size of battery storage more feasible. However, wood-burning stoves can be inefficient and cause air pollution.

He believes costs could come down if the car industry manufactures lithium-ion batteries for electric cars on a mass scale, which could then be applied in household battery banks.

In fact, construction of the largest battery factory in the world is already underway by US electric vehicle pioneer Tesla Motors, with plans to make the associated technology and results freely available. Globally, government subsidies for battery storage systems such as those in Germany, and more recently in Japan, are also likely to have a positive impact on uptake and development.

Interest in off-grid technology is growing. While most of it has not yet

translated into action, some are venturing boldly into the unknown. Guy Stewart, the director of Australian solar company Rainbow Power, says public enquiries about battery storage and off-grid set-ups have become their most common.

"Stand-alone power systems were previously a rural client base, but now people are getting a taste of grid-connected solar and they want to know what steps they can take to make use of all the power they are producing or to get off the grid completely," he says. For many, the next step would be 'single-day autonomy', where modest battery storage would allow users to shift solar energy consumption to peak usage times at the start and end of the day, but remain connected to the grid. While few are actually taking it to the next level, Guy says it is only a matter of time. "It's clear that it is going to happen and people are organising themselves so they are ready."

DESIGN FOR OFF-GRID HOMES

For Tim Adams, principal designer of F2 Designs and former president of the Building Designers Association of Victoria, the tipping point is closer. "I think we are getting to that point now – the figures stack up if we do our job properly and make sure that we design houses efficiently from a passive design point of view and from the fabric point of view," he says. For new houses, where the roof can be designed specifically for maximum solar array and battery storage can be worked into the home loan with low-interest, Tim says it can be a cost-effective option when considered against lifetime energy costs.

Tim's own home on Victoria's surf coast has a 3kW solar system, producing on average 13kWh per day for his all-electric house – an amount he says is more than ample. There are no batteries installed at the moment, as they benefit from the

The design will feature the 'butterfly-wing' roof, which characterises Tim's own house and which allows optimum orientation for solar gain. The roof will also have a flat area between the panels to enable easy maintenance and the harvesting of enough rainwater for the home's needs. Image by Lindsay Edwards.