

# ReNew

Technology for a sustainable future

## Inside Issue 121

Building with structural insulated panels; Latest in solar PV, batteries, lighting and EVs; Zero carbon challenges; Hybrid solar hot water

Smart meters go online

## Where to for sustainable tech?

Houses of the future  
Electric vehicles come to Australia  
Community-owned energy



Issue 121 October–December 2012  
AUD \$7.95 NZ \$8.95  
[www.renew.org.au](http://www.renew.org.au)



**The future tech issue:** what's here now + what's just around the corner in sustainable building, renewable energy, transport & more

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a washing  
machine from  
V-ZUG!

\*Australian residents only

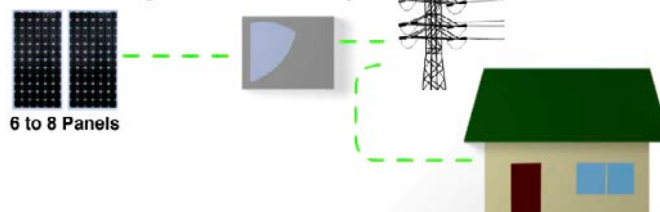
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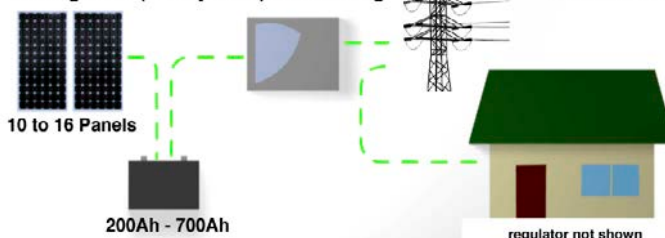
With 30 years combined experience in grid connected and battery based inverters, Latronics have a grid connected battery back up solution that keeps you generating power. If you own a PV Edge inverter, you're already half way there.

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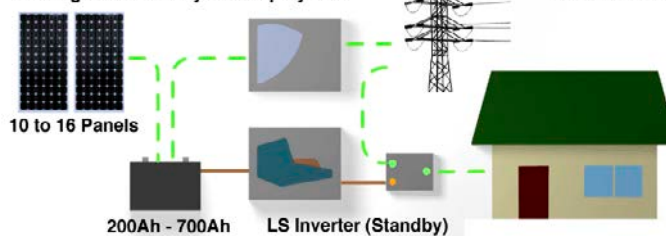


Start off with a standard system, then add panels and batteries for sustained grid output without changing your inverter at all.

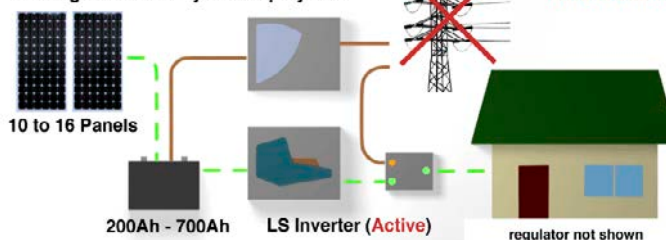
PV Edge 1200 (Battery Mode) Peak Shifting



PV Edge 1200 Battery Back Up System



PV Edge 1200 Battery Back Up System



Stage 1

Stage 2

Stage 3



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- Control up to 5kW
- Four models to choose from up to 96Amps or 250Voc
- Programmable for any battery system from 12V to 120V
- Earth Fault alarm
- Arc Fault alarm
- Ethernet for easy connection to your LAN or Internet
- USB port for simple PC connection
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- Internally parallel-able, no Hub required.
- Free firmware upgrades for life
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- Five year warranty
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# DIY POWER SOLUTIONS

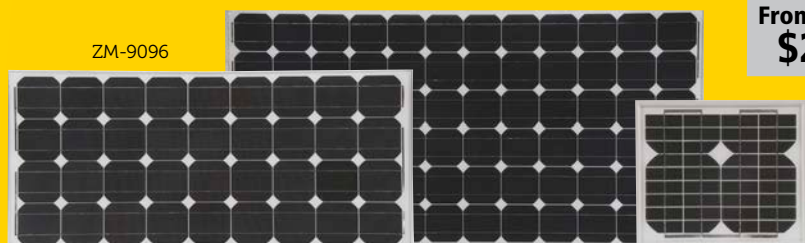
Jaycar carries an extensive range of batteries, chargers, inverters, solar panels, wind generators and lots more. Visit in store or see our website for more details on how large or how many solar panels you'll need for a particular project.

## Powertech Monocrystalline Solar Panels

Strong and tough at an attractive price. Each panel is made by connecting up an array of hand picked individual silicon solar cells to match the power specification of the panel. The larger 65W and above panels are fitted with an approved waterproof junction box with cable glands and the smaller panels are fitted with a slimline junction box with silicone cable sealant. For approval details and full specifications, ask in-store or visit our website.

- Tempered glass front panel
- Extruded aluminium frame

<b>12V 5W</b>	ZM-9091	\$22.95
<b>12V 10W</b>	ZM-9093	\$42.95
<b>12V 20W</b>	ZM-9094	\$85.00
<b>12V 40W</b>	ZM-9095	\$159.00
<b>12V 65W</b>	ZM-9096	\$269.00
<b>12V 80W</b>	ZM-9097	\$289.00
<b>12V 90W</b>	ZM-9086	\$325.00
<b>12V 120W</b>	ZM-9098	\$425.00
<b>24V 175W</b>	ZM-9099	\$619.00



From  
**\$22<sup>95</sup>**

ZM-9091

## Ecotech Solar Mounting Hardware

Designed to be used with either tiled or tin roofs, with any slope from 0-60°. For use with 35mm thick modules.

- Vertical or horizontal panel mounting
- Suitable for aluminium framed panels
- Rails, splice, hooks and clamps sold separately

### Rails:

**2 rails required for each row of solar panels in portrait layout**  
**2560mm, for 3x 800-825mm width panels HS-8800 \$49.95**  
**3405mm, for 4x 800-825mm width panels HS-8801 \$69.95**  
**4200mm, for 5x 800-810mm width panels HS-8802 \$84.95**

### Mounting Accessories:

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<b>Mid Clamp 35mm</b>	<b>HS-8805</b>	<b>\$3.95ea</b>
<b>Tin Roof Hook</b>	<b>HS-8807</b>	<b>\$8.95ea</b>
<b>Rail splice</b>	<b>HS-8803</b>	<b>\$9.95ea</b>
<b>Tile Roof Hook</b>	<b>HS-8806</b>	<b>\$26.95ea</b>

**Note:** Not stocked in all stores, but can be ordered. Please contact your local store for more details.



See website for more details

From  
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From  
**\$3<sup>95</sup>**

## 12V 150Ah AGM Deep Cycle Battery

Designed to perform in harsh tropical conditions, and with a superior high rate discharge performance and higher cycle service life, this battery is perfect for a wide array of applications including remote solar systems, 4WD, caravan and RV, motorhome, and marine. See our website for a full specification datasheet.

- Voltage: 12VDC
- Capacity: 150Ah (10hr rate), 164Ah (20hr rate)
- Weight: 52kg
- Size: 123(W) x 556(D) x 296(H)mm

**Note:** Not stocked in all stores but can be ordered. Call your nearest store for details.

**\$699<sup>00</sup>**  
SB-1822



## Deep-Cycle Gel Batteries

Genuine deep-cycle batteries that can be operated & charged in any position. They are leakproof & completely sealed.

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<b>2V 200Ah</b>	<b>SB-1696</b>	<b>\$199.00</b>

**Note:** These genuine high capacity batteries are extremely heavy. Please see website for detailed specifications.

From  
**\$129<sup>00</sup>**

SB-1699

SB-1698



## Solar Panel Power Connectors & Cables

IP67 rated for maximum environmental protection to harsh installations such as solar panels, arrays and other permanent outdoor applications.

<b>Female In-line Connector</b>	<b>PS-5100</b>
<b>Male In-line Connector</b>	<b>PP-5102</b>
<b>Panel Mount Female</b>	<b>PS-5104</b>
<b>Panel Mount Male</b>	<b>PP-5106</b>



**\$7<sup>50</sup> ea**

### UV Power cable

Very tough cables that are dust, age and UV resistant with tinned copper conductors to minimise corrosion.

- Rated current: 42A (2.5mm), 58A (4.0mm), 76A (6.0mm)
- IP65 rated

Three Types Available:

<b>2.5mm sq.</b>	<b>WH-3120</b>	<b>\$3.00</b>
<b>4mm sq.</b>	<b>WH-3121</b>	<b>\$3.50</b>
<b>6mm sq.</b>	<b>WH-3122</b>	<b>\$5.50</b>

Roll length 100 metres. Prices per metre.



From  
**\$3<sup>00</sup>/m**



## Portable Fold-Up Solar Panel Kits

Excellent for a camping, 4WD or boating trek. These fold away solar panel and charging kits easily charge a battery (not included) allowing you to run power, lights, TV etc wherever you stop. Each model features folding solar panel with alligator clamp connections on a 4m lead, and has the charge controller included so you can connect directly to your battery without fear of over-charging. All supplied with a heavy duty metal carry handle and latches, plastic protective corners and a durable nylon carry bag. Three sizes to choose from, all are 12V.

### 40W Folding Solar Panel

Cat. ZM-9132 Was \$279.00 Now \$249.00 Save \$30.00

### 80W Folding Solar Panel

Cat. ZM-9130 Was \$479.00 Now \$379.00 Save \$100.00

### 120W Folding Solar Panel

Cat. ZM-9134 Was \$699.00 Now \$499.00 Save \$200.00



From  
**\$249<sup>00</sup>**

**HOT PRICES!**

ZM-9130

## 30A MPPT Solar Charge Controller

Uses DC to DC conversion to extract the absolute maximum charging power from your solar panels. Features 3-stage battery charging, twin timer programming, 30A load control with automatic load disconnection/reconnection, and much more. Suitable for 12V or 24V systems.

- Includes temperature sensor for battery charging compensation
- 97% efficiency
- 360W(12V) or 720W(24V) max PV array

See website for full specs.

**\$249<sup>00</sup>**  
MP-3735



Want more info?

Have a burning question to ask?

[www.jaycar.com.au/powertech](http://www.jaycar.com.au/powertech)



## Remote Power Packages

For those living in locations where mains electricity isn't available, or expensive to have connected, a remote power system is the best solution to household power needs. Whilst a remote power system can be a major investment, Jaycar offers packages to suit your needs and there are government incentives (Australia only) & rebates that may support your purchase\*. Each package contains the necessary number of solar panels, a fully featured inverter-charger power management system, solar charge controller, high capacity deep cycle battery banks, cables, connectors and cable-termination tooling. Just add the appropriate panel mounting hardware. Contact our Powertech team for a customised quote.

### 3kWh Per Day with 1kW Solar

Three days system autonomy at 3kWh per day usage. About 3.5kWh solar charging provided per day on average. MP-9005 Prices from **\$10,790.00**

### 5kWh Per Day with 1.575kW Solar

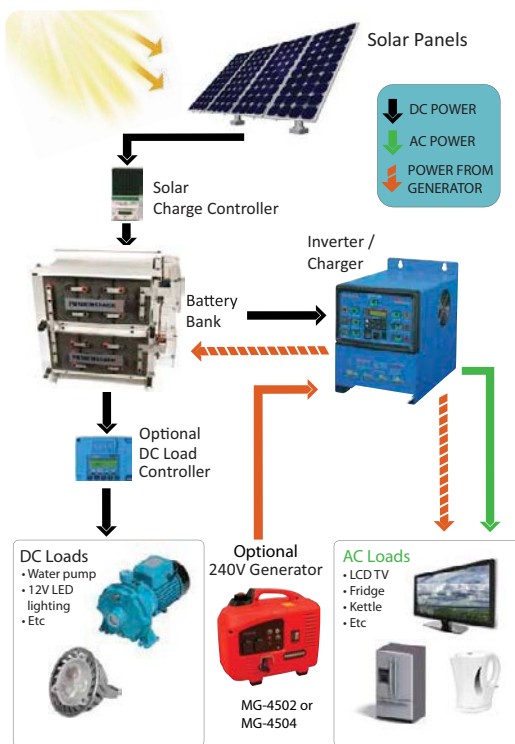
Four days system autonomy at 5kWh per day usage. About 5.2kWh solar charging provided per day on average. MP-9007 Prices from **\$17,890.00**

### Also available: 10kWh Per Day with 3.15kW Solar

MP-9009 Prices from **\$32,590.00**

\*Must meet criteria for Solar Credits scheme. See [www.orcr.gov.au](http://www.orcr.gov.au) for details

**Note:** Due to size and weight of items in these packages, not all parts are available in-store. Please speak with our staff for more information.



## Dedicated Power Systems Website

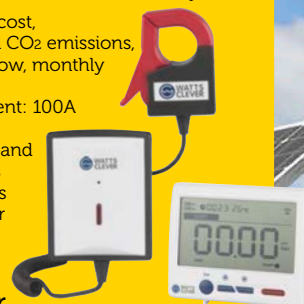
Visit

[www.jaycar.com.au/powertech](http://www.jaycar.com.au/powertech) for product info, specifications, tech papers and tech support for power systems solutions or email our team of power experts at [powertech@jaycar.com.au](mailto:powertech@jaycar.com.au)

## Power Monitors

Monitor the energy consumption of your entire home to see overall what your appliances are really costing you to run. The transmitter mounts in the fuse box and transmits up to 40m to the display. The display can be connected to a PC to download historical data for further analysis.

- Displays power, cost, temperature and CO<sub>2</sub> emissions, as well as high, low, monthly and yearly totals
- Max sensor current: 100A (0.1A sensitivity)
- Works on Single and 3-phase systems (3-phase requires additional sensor pack, MS-6166 \$29.95)



### Mains Power Monitor with USB interface

- Display size: 79(L) x 48.5(H)mm

**\$119<sup>00</sup>**  
MS-6165

### Grid-Connect Solar Power Monitor with USB interface

This grid-connect solar power monitor measures the power being produced by your solar array, and gives you a "balance" of the power you are consuming versus what your solar array is producing. It also displays the costs, with 3 tariffs for your electricity pulled from the grid, and a feed-in tariff for your solar production. Of course you also get a "net cost" that deducts the solar feed-in tariff amount from the electricity you pulled from the grid.



NOTE: Only works with NET-METER grid-connect solar systems.

Also available: Extra sensors to suit MS-6165 and MS-6167 for 3 phase system MS-6166 \$29.95

**\$179<sup>00</sup>**  
MS-6167

## Renewable Energy Book - Design, Installation and Use

Explains renewable energy in an easy to read format and covers everything from basic electrical concepts through to system design.

- Softcover, 201 pages, 280 x 200mm

**\$38<sup>95</sup>**  
BE-1538



## 516 page 2012 JAYCAR CATALOGUE

Buy in store or online \$3.95.



## Sine Wave Inverter Generators

These inverter generator units are petrol powered and differ from cheaper units, in that the engine drives a DC alternator. A pure sine wave inverter then converts the DC to a stable pure sine wave 230VAC, suitable for appliances including sensitive electronics. No matter what the load is on the generator or the speed of the engine, the output remains very well regulated. The added benefit is that the petrol motor is far better matched to the load, reducing overall size, keeping engine speed in line with the load, reducing noise and increasing fuel efficiency. Additional features include electric key start, electric remote start\*, low oil cut-out, and overload circuit breaker. See website for full specifications.

\*Remote start on 2kW and 3kW models only.

Three models available:  
1kW MG-4501 \$599.00  
2kW MG-4502 \$899.00  
3kW MG-4504 \$1,499.00

Note: Not stocked in all stores but can be ordered.

**FROM \$599<sup>00</sup>**



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# Contents

## Issue 121, October – December 2012

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## The future tech issue: what's here now, what's coming

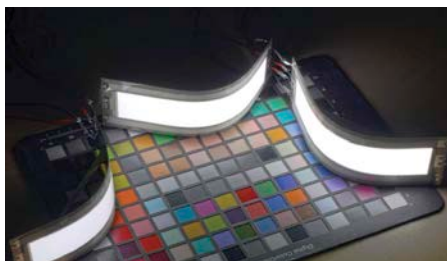
24 ↓

### Looking into the technology crystal ball

What's in the future for sustainable technology, and who decides? Michael O'Connell explores the opportunities and challenges.



↑ Future tech—a pedal-powered washing machine. Page 24.



↑ OLEDs lighting the way forward. Page 62.

### Future tech: sustainable building

29 ↓

#### The challenge is building

We have the knowledge, so why aren't we using it? Chris Reardon considers where to next for our built environments.

32 ↓

#### Building with SIPs

Sid Thoo describes the design and construction decisions when building with new product SIPs—structural insulated panels.

36 ↓

#### An evolution of materials and methods

Prefab, cross-laminated timber and materials reuse are all part of the cutting edge of sustainable building, writes Jack Nicholls.

38 ↓

#### Houses of the future

Inspiring and practical houses of the future: Meg Warren's build-in-progress, sustainable building standards and competitions + eco-village developments.

### Future tech: community-scale renewables

42 ↓

#### The future generation?

60 community-owned solar, wind and hydro projects are in the pipeline, writes Robyn Deed.

44 ↓

#### Built for and by the community: a wind farm in WA

Australia's second community wind farm is about to come online. Project chair Craig Chappelle describes the long, but ultimately rewarding, process.

48 ↓

#### The value of solar

The value of medium-scale solar has been realised in this Carnarvon power station, writes project engineer Toby Price.

↓ Page 42.  
Community wind farm at Hepburn Springs. Image: Hepburn Wind.







← Cover image by Jim Tetro, US Department of Energy Solar Decathlon. Silo House was Cornell University's entry in the 2009 decathlon. The house is three interconnected cylinders powered by electricity from 40 photovoltaic panels. Silo House features an 8 kW photovoltaic system, evacuated tube collectors providing space and water heating, and a home control system accessible through the internet, allowing residents to monitor power use and turn circuits on and off remotely. Page 39.

## Future tech: technology directions

52 ↓

### Electric vehicles are coming—slowly!

Lance Turner looks at what we can expect to see on our roads in the near future.

56 ↓

### Alternatives to old battery technology

Just how close are we to replacing lead-acid batteries for renewable energy storage?

58 ↓

### Solar PV: new pieces in the energy puzzle

Stephen Tansing looks at solar technology, current and future.

60 ↓

### Meter smarts

You can even monitor your energy use when you're not home: Richard Keech puts Jemena's new online portal to the test.

62 ↓

### LED to OLED: lighting the way forward

John Knox rounds up the latest lighting developments.

64 ↓

### Water harvest

Could stormwater solve the problem of water shortages in our impermeable cityscapes?

66 ↓

### Renewables research

Research into waves, intermittency and living labs. By Beth Askham.

## Member projects

79 ↓

### Hybrid solar hot water

It's not easy making hot water during the winter months in Dunedin, NZ, so Michael Laba has done it in an unusual way.

82 ↓

### Green on the water—an update

Stef Palmer gives a 'liveaboard' report on the low carbon footprint catamaran project initiated earlier this year.



↑ Energy matters on a catamaran. Page 82.

## Buyers guides

68 ↓

### Renewable energy courses guide

Enrolment time is approaching for many courses. Find the right course in our guide.

70 ↓

### Taking care of your batteries: a regulator buyers guide

Using the right regulator in an independent power system is very important if you want your batteries to live a long and healthy life. We take a look at the types available, what they cost and where to get them.

## Regulars

06 ↓

About ATA

08 ↓

Editorial

10 ↓

Up front

16 ↓

Letters

20 ↓

Products

28 ↓

WIN! *ReNew* subscriber prize

84 ↓

Shop with the ATA

85 ↓

Browser

86 ↓

NEW! Member profile

88 ↓

Pears Report

90 ↓

Q&A

92 ↓

Classifieds

94 ↓

Salvage It!

96 ↓

Travel with the ATA

# About ReNew and the Alternative Technology Association



## ReNew magazine

ReNew has been published by the Alternative Technology Association (ATA), a not-for-profit organisation that promotes energy saving and conservation to households, since 1980. Each issue features renewable technologies such as wind and solar power, along with ways to make our homes more energy efficient. ReNew also includes practical examples of water conservation and reuse, recycling of materials and alternative modes of transport such as electric vehicles. It provides practical information for people who already use sustainable technologies and practices, and demonstrates real-life applications for those who would like to.

ReNew is available from newsagencies, by subscription and as part of ATA membership. ATA membership starts at \$75 and offers a range of benefits; see centre spread for details.

## Sanctuary magazine

In addition to ReNew, the ATA publishes *Sanctuary: modern green homes* magazine, profiling beautiful houses in Australia and around the world. *Sanctuary* provides inspiration and practical solutions for a sustainable home.  
[www.sanctuarymagazine.org.au](http://www.sanctuarymagazine.org.au)

## ATA branches

Located around Australia and in New Zealand, ATA branches are involved in activities such as running monthly seminars, visits to sustainable homes and projects, and attending community events.  
[www.ata.org.au/branches](http://www.ata.org.au/branches)

## Webinars

With the support of bankmecu, the ATA has recently run a series of free online webinars to share practical knowledge about sustainable living. The webinar recordings are available for playback on demand via the ATA website:  
[www.ata.org.au](http://www.ata.org.au)

## Alternative Technology Association

The Alternative Technology Association is Australia's leading not-for-profit organisation promoting sustainable technology and practice. The ATA provides services to members who are actively walking the talk in their own homes by using good building design, conserving water and using renewable energy. The ATA advocates in government and industry arenas for easy access to these technologies as well as continual improvement of the technology, information and products needed to change the way we live.

With branches and members around Australia and New Zealand, the ATA provides practical information and expertise based on our members' hands-on experience. It also offers advice on conserving energy; building with natural materials; and reusing, recycling and reducing the use of natural resources.  
[www.ata.org.au](http://www.ata.org.au)

## Advocacy and projects

As well as advocating to government and industry, the ATA also conducts research projects with partners from the government, industry and community sectors.  
[www.ata.org.au/projects-and-advocacy](http://www.ata.org.au/projects-and-advocacy)

## International projects

Since 2005, volunteers from the ATA have travelled the length and breadth of East Timor installing hundreds of solar power systems and providing lighting for over 4000 East Timorese. ATA has also installed solar power in hundreds of community buildings such as schools and health clinics.

ATA has trained technicians to install and maintain solar lighting systems. Over 20 technicians have received accredited training and the project is a template for training development in East Timor.

For more information and to make a donation to give the gift of light in East Timor, go to [www.ata.org.au/jpg](http://www.ata.org.au/jpg)

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[www.renew.org.au](http://www.renew.org.au)

Contributions are welcome; guidelines available at [www.renew.org.au](http://www.renew.org.au) or on request. Next editorial copy deadline: 19 October 2012.

## Advertising in ReNew

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## Next advertising deadlines:

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Advertising copy: 9 November 2012

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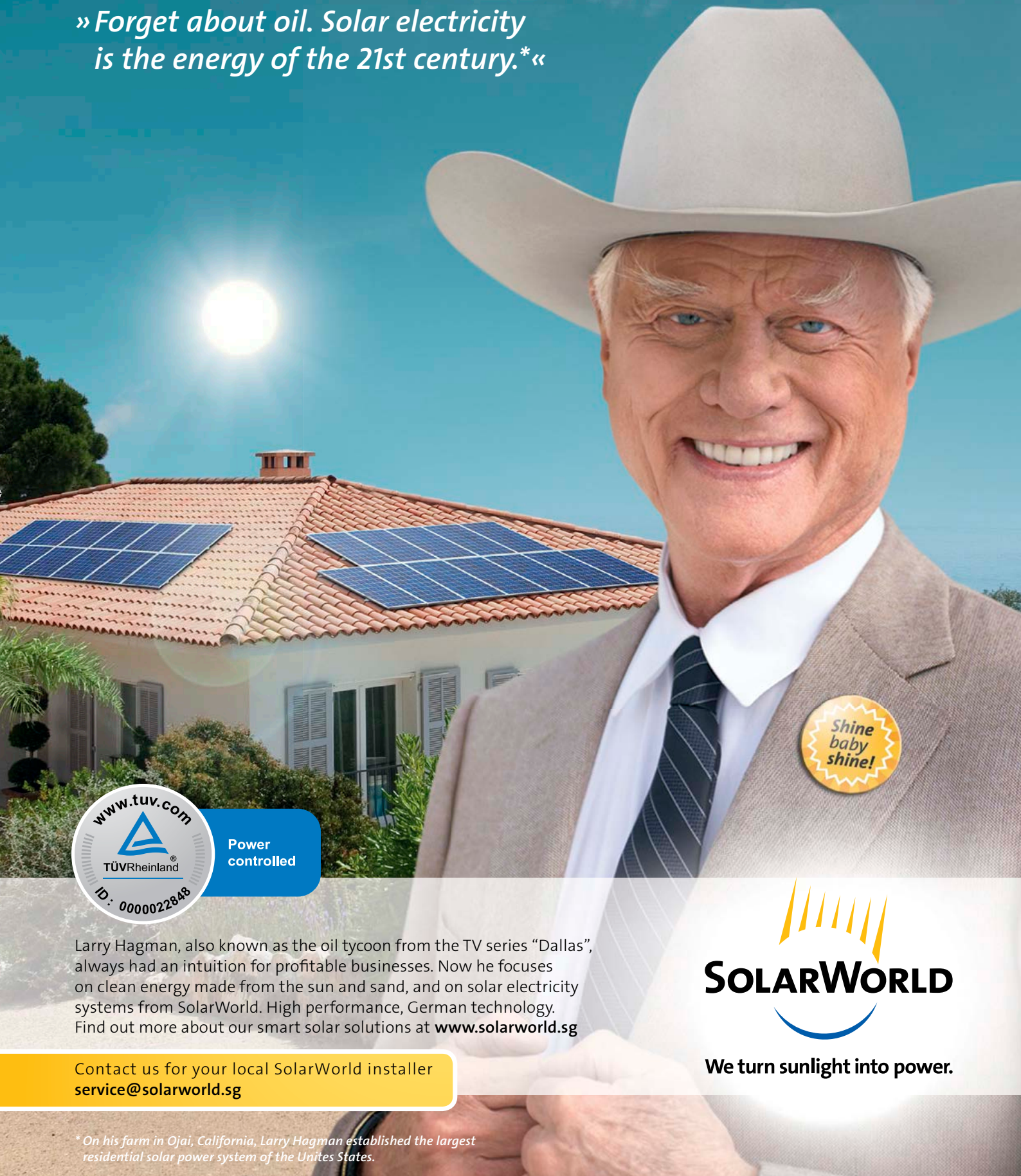
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# Shine baby shine!

*» Forget about oil. Solar electricity  
is the energy of the 21st century.\* «*



Power  
controlled

Larry Hagman, also known as the oil tycoon from the TV series "Dallas", always had an intuition for profitable businesses. Now he focuses on clean energy made from the sun and sand, and on solar electricity systems from SolarWorld. High performance, German technology. Find out more about our smart solar solutions at [www.solarworld.sg](http://www.solarworld.sg)



Contact us for your local SolarWorld installer  
[service@solarworld.sg](mailto:service@solarworld.sg)

\* On his farm in Ojai, California, Larry Hagman established the largest residential solar power system of the United States.

# Editorial

## Future tech: challenges + opportunities



SOMETHING that one of our contributors said has stayed with me while working on this issue of *ReNew*. Explaining why he was investing in the long hard slog of getting the Cape Paterson eco-village off the ground, Brendan Condon said he'd decided there wasn't time to muck around anymore. He said, "We're really under-prepared for the challenges coming at us in the next decades, like peak oil, climate change, and food and water security. We should have been doing this sort of thing 20 years ago. Let's get on with it."

Again and again this issue, it's been amazing to witness that the frustration of wanting to be part of a sustainable future, but living with the present reality, hasn't spilt over into apathy but rather into action. From people like Brendan through to the people who've spent five or even ten years working to get their community wind farms off the ground, the overriding thing that comes across is undiminished passion and good humour.

Another highlight for me this issue is the challenge put forward in Chris Reardon's thoughtful response to the question of the

future of sustainable building. The Living Building Challenge poses the question of sustainability not in terms of abatement but in terms of contribution—what if everything we built or produced could have a positive effect, rather than just not a negative one? On first reading, it sounds a bit optimistic; nice, but not necessarily helpful. But, then again, why not strive for a positive result when it is possible? It's not new to *ReNew* readers to seek positive effects in their homes and energy use, but perhaps it pushes it just a little further to state it so clearly.

The focus in this issue is on 'future tech': the question of where we're heading with sustainable technology. We've taken that to mean where we're heading pretty soon—so we've looked at emerging technologies, materials and approaches, in building, solar PV, batteries, electric vehicles, lighting and more, rather than pie-in-the-sky stuff.

But beyond that, Michael O'Connell takes us a couple of steps further into the world of nano-materials and gene technology. He puts the challenge out there for us all to debate and have our say about the opportunities and

issues posed by technology. We look forward to hearing your thoughts on that question, and anything else that strikes you in this issue.

In fact, we'd like to get your feedback more generally in our online survey. There's a great prize of an Aquamonitor on offer, along with the chance to let us know what you'd like to see more of, or less of, in *ReNew*. It only takes 10 minutes and we'd love to hear your opinion. Go to [www.renew.org.au/readersurvey](http://www.renew.org.au/readersurvey).

**Robyn Deed**  
*ReNew* Editor



HELLO, readers, and welcome to *ReNew* 121, an issue with a theme very dear to my heart, and to the hearts of many of our readers—future technology.

A question which often comes up when introducing the ATA is the meaning of that first 'A' ... what do we mean when we talk about 'Alternative' Technology? The ATA, through *ReNew* and *Sanctuary* magazines, and through our advocacy work to governments, often promotes and argues for technologies that were alternative 20 years ago, but are heading into the mainstream now. These are technologies that are crucial now if we are to meet the challenges of climate change and sustainability: solar power, wind power, energy efficiency and grey water.

In this issue of *ReNew*, though, we cast our gaze further forward and look at some of the next wave of technologies, the technologies which will in some cases even further disrupt our existing energy systems for the better. We look at new batteries, at the sprawling field of electric vehicles, at new building products and approaches. Going beyond the household fence we take a look at the exciting field of community-scale power generation, and at how our electricity companies can help lead change.

We will need many if not all of these technologies over the next 15 years, as we grapple with moving to a sustainable future.

Not quite the jet packs and regular shuttles to the moon that my childhood science fiction

books promised me (although we do mention space elevators), but none the less inspiring, exciting and important.

Enjoy.

**Ian Porter**  
CEO, ATA







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## Vale Frank Fisher

The winter of 2012 has indeed been a sad one for Australia's sustainability community. As well as the loss of the wonderful Deni Greene (reflected upon in Alan Pears' column) we saw the passing of Frank Fisher in mid August. Frank, a former Australian Environmental Educator of the Year, was a tireless contributor to environmental thinking in Australia. From his tertiary teaching, through his books (his last being *Response Ability*), his engagement with a huge range of people across all sectors, his wry humour and his devoted and constant cycling, Frank will be greatly missed.

## Robots installing solar

As more large commercial solar arrays are installed, engineering companies have been looking for ways to speed up installations while reducing costs. As panel prices have fallen, installation costs have become a large proportion of the total system cost, so reducing these costs makes large-scale PVs even more attractive compared to other renewable generation such as wind.

Two companies, PV Kraftwerker and Gehrlicher in Germany, have designed robotic systems to greatly accelerate the installation of large PV arrays while also greatly reducing the number of workers required on site. The robots can install panels at any time of the day or night, in any weather.

According to PV Kraftwerker, installations that used to require 35 workers can now be done with just three, and in an eighth of the time. As an example of just how much costs can be reduced, PV Kraftwerker estimates

that for a 14-megawatt solar plant it might cost about \$2 million to install the panels manually. Using robots cuts the costs in half.

PV Kraftwerker built its \$900,000 robot from off-the-shelf Japanese components. It consists of a robotic arm mounted on a tracked all-terrain vehicle. Suction cups grip the glass surface of the solar panels and the arm swings them into position. The robot is controlled by a human operator and is guided by cameras that give it three-dimensional vision. [www.pv-kraftwerker.com](http://www.pv-kraftwerker.com) and [www.gehrlicher.com](http://www.gehrlicher.com) and a video of one of the robots at work <http://bit.ly/PydoXP>

## Styrene recycler gets recognition

Polystyrene recycling proponent Leo Sines was recently honoured with the Minister's Award for Leadership at the Queensland Premier's Sustainability Awards. Leo has spent the last

12 years campaigning to turn Queensland's expanded polystyrene (EPS) waste into useful products. Leo developed a prototype polystyrene foam chipper that has now been installed at five locations across Queensland. The foam is chipped and compressed into bricks, which reduces its volume by two-thirds.

So far, Leo's chippers have recycled 350 tonnes of polystyrene foam, amounting to 30,000 cubic metres of the space-wasting material—that's around 12 olympic-sized swimming pools of styrofoam!

Leo's plan is to have a chipper in every recycling centre in Queensland. However, Queensland is Australia's largest EPS manufacturer, producing 11,000 tonnes each year, so there's a long way to go yet. Perhaps the best solution would simply be to ban the material, as there are other more eco-friendly alternatives. [www.polyrecycleqld.com.au](http://www.polyrecycleqld.com.au)

## Big(ish) solar for NSW

Under the federal government's Solar Flagships Program, First Solar, one of the largest manufacturers of solar panels in the world, and AGL will install large-scale solar PV power projects totalling 159 MW at two locations in New South Wales.

AGL will develop a 106 MW project at Nyngan and a 53 MW project at Broken Hill. First Solar will provide engineering, procurement and construction services for both projects, which will use its thin-film PV modules.

The project will be funded through a



← Robots can install large solar arrays faster and cheaper than humans alone.



combination of \$129.7 million from the federal government and \$64.9 million from the NSW government, with the balance of the total \$450 million cost coming from AGL's cash reserves.

The projects are expected to produce enough electricity to meet the needs of over 30,000 average households in New South Wales, with electricity and large-scale generation certificates produced to be sold to AGL under a long-term arrangement to support its customer base and meet its renewable energy obligations under the Renewable Energy Target legislation.

The projects are expected to generate approximately 150 direct construction jobs in Broken Hill and up to 300 in Nyngan. [bit.ly/QYX7al](http://bit.ly/QYX7al)

### Wave energy projects funded

The federal government has recently approved funding for not one, but two, new wave energy projects.

The first grant of \$4 million is for a 1MW wave turbine system from Oceanlinx, to be installed in South Australia. This installation will be the largest wave turbine generator project in the world.

The federal government is also providing \$5.6 million, in addition to \$5 million from the Victorian government, to BioPower Systems for a full-scale pilot plant of its 250kW bioWAVE generator off the coast of Victoria.

Both grants are being made under the \$126 million Emerging Renewables program, and follow an earlier \$9 million grant to Carnegie Wave Energy for a 2MW grid-connected demonstration of its CETO technology near Fremantle in Western Australia. [s.tt/1gKZ5](http://s.tt/1gKZ5), [www.oceanlinx.com](http://www.oceanlinx.com) and [www.biopowersystems.com](http://www.biopowersystems.com)

### Help with your energy bills

In July this year, the Australian Energy Regulator launched a new website to help domestic and business energy users with their often confusing energy bills.

The Energy Made Easy site lets you put in your postcode and supplies you with information on energy companies and available contract types in your area, as well

### More wind power for SA

TrustPower, New Zealand's fifth largest electricity retailer/generator, has appointed Siemens as their turn-key supplier to construct South Australia's largest wind farm. It will be constructed at Snowtown and will consist of 90 of Siemens's 3MW direct-drive wind turbines, producing up to 270MW—enough energy for up to 180,000 South Australian homes.

This is the first time these gearless machines have been used in Australia.

The Snowtown II wind farm will make South Australia one of the leading generators of renewable energy, having already exceeded the nation's 20 per cent by 2020 renewable energy target, with



26 per cent of South Australia's electricity now generated by renewables. South Australia has now set a target of 33 per cent renewable energy by 2020. [www.siemens.com.au](http://www.siemens.com.au)

as the average energy use for homes in your area. There's explanations of fees and tariffs, info on how to switch energy companies, and solar generation contracts are also explained.

There's also an energy efficiency section and information on consumer law and your rights when dealing with energy companies.

While the site is not extremely detailed, it is bound to be useful for anyone who is confused by their energy contracts or bills. [www.energymadeeasy.gov.au](http://www.energymadeeasy.gov.au)

### Renewables to be cheapest

The federal government's chief energy forecasting body has predicted that onshore wind and solar PV will provide the cheapest electricity by 2030, with solar PV dramatically cheaper than all other energy forms by 2050.

The Australian Energy Technology Assessment (AETA) prepared by the government's Bureau of Resources and Energy Economics slashes its previous estimates of the cost of a whole range of renewable technologies, and in some cases doubles the predicted cost of coal-fired generation in the decades to come—with or without the addition of carbon capture and storage.

Its estimates of the cost of gas-fired generation are relatively unchanged at around

\$130/MWh. Its estimates for solar PV are a midpoint of around \$224/MWh now, around \$116/MWh by 2030 and a midpoint of \$86/MWh by 2050, with possible minimums of \$70/MWh by 2020 and \$30/MWh by 2050. Even brown coal, without a carbon price or carbon capture and storage (CCS), is costed at around \$100/MWh by 2020, nearly double that with a carbon price, and between \$150/MWh and \$200/MWh with CCS. [s.tt/1kGXz](http://s.tt/1kGXz)

### Bankmecu prize winners

The winners of the bankmecu \$5000 prize were Fran and Ray from San Remo, Victoria. The money could not have come at a better time as their hot water system recently turned into an "erupting geyser" while they were away from home. Thanks to an awesome neighbour who stepped in with some great tradies from Phillip Island—an electrician and a plumber—a solar-ready replacement was organised and installed. Fran and Ray think they will probably spend the money on adding solar to this system, possibly evacuated tubes, or maybe they will place themselves in some sun for a while outside of Victoria. Congratulations Fran and Ray.

# Up front



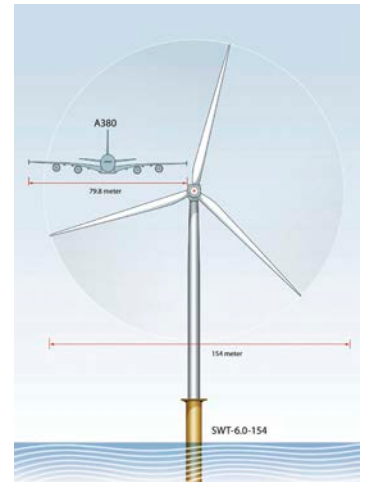
## How big can wind turbines get?

While Siemens is planning to install their 3MW turbines in Snowtown, SA (see article previous page), they have much larger turbines. Indeed, their largest unit is a huge 6MW prototype, and the sheer scale of such large turbines is hard to fathom unless you see one. Hopefully, the images here will give some idea of just how massive these monsters are.

The turbine has a rotor diameter of 154 metres, with blades measuring 75 metres in length. The swept area of the rotor covers 18,600 square metres, the area of two and a half soccer fields. The tips of the blades move at up to 80m/s, or 290km/h.

The entire blade is poured as a single length in giant moulds (see photo at right) and is made of glass fibre-reinforced epoxy resin and

balsa wood—much the same as ocean-going yachts. As a result, the blade has no seams or bonded joints and is extremely robust. This is important, as at a wind speed of 10m/s, the rotor is hit by 180 tonnes of air each second. [www.siemens.com](http://www.siemens.com)



Siemens press pictures

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## Solar's future

I can empathise with Arthur Zaicos (Letters *ReNew* 120) regarding retroactive rule changes for renewable energy systems. How could such a rule be put in place without exemptions or compensation applied for existing installations? The alternative energy industry is still sadly lacking cohesion and political voice.

Where I live, the only option is off-grid. When I installed my hybrid wind/solar/diesel system in 2004, the industry was an unregulated cottage industry requiring highly motivated and informed customers to make it work. Although short-lived government incentives have made a small difference, unless and until we see the sort of subsidies that the car industry enjoys, the renewable energy industry will remain where vested interests would like it to remain—unorganised, unfunded and fledgling.

The industry has an inevitable future. I wonder when our governments at local, state and federal levels will recognise the imperative of being ahead of the curve. A visionary government would get behind this industry as we lose more traditional manufacturing jobs.

Anne Tillig

## System upgrades and FiTs

In the Q&A section in *ReNew* 120, David Wakeham queried 'Solar Upgrades', which Lance replied to.

If David is located in South Australia, any adding of a second parallel solar system will result in losing the 44 or 16 cent FiT he would currently be receiving. ETSA

classes a later installed parallel system as a second generator, which if fitted results in a loss of the FiT. They only allow fitting of extra panels up to the capacity of the original system. Parallel systems can be installed but only if they are part of the original approved system. When you lose the FiT, you will only receive the retailer amount, which is currently 9.8 cents/kWh as of 1 July.

I personally have a 1.7kW system and wanted to also fit a second system in parallel as my power bills have gone from \$800 to \$1100 over the last few years.

I was speaking to ETSA regarding my options. If I lose the FiT, I will need to fit a 7kW system to generate enough energy to equalise my bill. I am currently paying around 30 cents per kWh for the energy I consume but would only receive 9.8 cents/kWh for what I would put back into the grid—so the system needs to be large to make up the difference.

Peter Simpfordorfer

## No wind farm issues

Ania Hampton, in *ReNew* 120, wrote from the point of view of someone who doesn't like wind farms. She wrote about being protected from wind farms, and of how genuine and well-founded communities' concerns about wind farms were. Interestingly she did not mention what there was in the wind farms that she needed to be protected from, nor what the well-founded concerns were.

About eight years ago I started looking into the facts of wind power for two reasons: I was convinced that society had to

move away from burning fossil fuels and I was hearing and reading a lot of claims about the disadvantages of wind power that were hard to believe.

Ms Hampton's letter was refreshing in that she didn't make specific and false claims, but she left me wondering why she was so set against wind turbines. My home is in Crystal Brook, 15km from the nearest turbines at Clements Gap. I have visited most of the wind farms in SA and Victoria and some of those in WA. I have even camped beneath working wind turbines five times (and had a peaceful night's sleep every time). I see wind turbines as beautiful, graceful, benign, optimistic heralds of what could be a much more ethical and sustainable future.

David Clarke

## Electric ceiling heating

Further to Lance Turner's comments on electric ceiling heating in *ReNew* 120, electric ceiling heating may be relevant in a small number of applications. Because of the radiant component of the heating it is generally as effective as a convective heater of twice the capacity.

Its main advantage over heated floors is that it has lower thermal storage than in-floor heating which makes it more responsive to changing conditions. This also means the energy use would be lower for an intermittently heated building than in-floor heating, as you only need to heat when the building is occupied. However, you won't be able to operate this on a night tariff so it will generally

be more expensive than in-floor heating to operate. It is also more readily installed in an existing house than in-floor heating.

It is best suited to areas where you have normal 2.4m or 2.7m ceilings to minimise the stratification effect referred to by Lance, and needs to be used with well-insulated windows for the same reason. The walls should also be insulated, preferably with more than just a layer of foil.

If you live in an area with low-cost green energy and you don't need cooling (or evaporative cooling is suitable), it could be an option. Lance pointed out that the COP of reverse-cycle heating ranges from around two to five. Because radiant ceiling heating is twice as effective as convection heating, the energy use for a given comfort level is similar to a reverse-cycle heater with a COP of two. In other words, any reasonably efficient reverse-cycle air conditioner will be more efficient and a preferable option. If, however, there is a problem putting reverse-cycle in, and the other requirements apply, it could be considered.

Clive Blanchard

## Earth-covered library

In response to John Herman's letter re the earth-covered library at the school in the Macedon Ranges, I would like to point out that while \$500,000 should get you a very large and fancy house within cooee of the city, to build a school building or other building of a similar size will take substantially more money, for a variety of factors including



## Cycling in Europe

In *ReNew 119* a reader wrote a very complimentary letter about the number of bikes in Europe. I am afraid that the true picture is a bit more greyish than that.

While there are more bike users in Europe than in Australia and North America, their numbers have decreased a lot compared to the 50s and early 60s, when large numbers of factory workers, school teachers and their students, along with priests, housewives, farmers and rural cops used bikes all the time. One has to understand that Europe was still rebuilding towns badly damaged during WWII, wages were low and few cars were being built.

In the 60s, car ownership became possible for most workers and freeways started to sprout all over. As the number of cars increased there was less and less safe space for bikes, so the use of bikes plummeted. In Southern Europe younger people preferred either a scooter (the famous Vespa) or a contraption with a small motor that sort of looked like a bike.

It is only relatively recently that bikes have become popular in Europe again, starting in the 80s and 90s in Holland, Denmark and Germany, and a while later in France and other southern European countries. There are also differences in the number of bike users in various towns within a country, and even in a given town, between the downtown area (more bike users) and the suburbs (fewer users).

Australians and North Americans see Europe as a bike paradise, yet the true paradise is Japan. Many Japanese use their car on weekends only (fuel is even more expensive than in Europe and motorway tolls are high—so is parking). During the week they ride their bike to the nearest suburban train station for their daily commute. Once at the station at the other end they will either walk or use their other bike.

The streets near most train or subway stations are full of bikes—so much so that in some places there is automated bike parking that stores hundreds of bikes in an underground vertical tube.

But even in Japan there are more bike riders (per head of population) in big towns and their suburbs than in rural communities.



I just read a report by a French expert about bikes in Europe. One of his findings is that the only way to increase the use of bikes is by making it much safer than it is now. Separated bike lanes are a must. At the same time he feels that there is still a reluctance for many Europeans to use a bike for cultural reasons.

There too, Japan follows a different pied piper. There are few, if any, bike lanes. People use the wide footpaths of big avenues. Residential streets go from narrow to very narrow and don't have footpaths. A painted line on one side of the street is a footpath of sorts, also used by bikes and even cars stopping by a store for five minutes. It works well, but then these streets are a maze only known to locals (they have no names), so cars proceed slowly.

The majority of Japanese bike riders, like Europeans, only use bikes for relatively short trips and wear normal street clothes and no helmets. A far cry from North America, where even office workers will commute long distance by bike. I can't remember seeing older people on bikes in my Canadian home town, whereas in Japan especially, but also in Europe, people in their 80s and older bike routinely.

J L Brussac

the higher costs of a commercial builder, building regulations, and project managers' and other consultants' fees.

As part of the \$16 bn 'Building the Education Revolution' economic stimulus, schools throughout the country received grants, many of them for \$2 million or more, and got standard 'template' designs, much of which received quite a bit of negative media coverage for various problematic aspects of the program. As a 'Building the Education Revolution' project, it appears this school has got great benefit, value and uniqueness out of a comparatively smaller amount of money than many other schools. Well done to the architect and the school.

The application of the same building design features for residential purposes could be done for a few hundred thousand dollars (John, you have done very well by today's standards with your building cost), but I'd say we shouldn't quibble about the cost of this project, when over 18,000 times this amount has been spent throughout the nation on designs with much less thought, time, skilled design and delight instilled in them than this project.

Tim Brooks

### PV panel orientation

In a letter in *ReNew 118*, I gave preliminary figures for comparing PV outputs of east and north facing panels on a property at Coonabarabran in

NSW (latitude 31 degrees S).

Now I have figures for a complete year: north facing panels: 1211kWh; east facing panels: 1040kWh (14.1% less).

Both systems have six monocrystalline panels mounted 15 degrees from horizontal. The east facing panels get a small amount of shading from a narrow flue, but this is late in the day

when the output is low anyway.

14.1% does not sound much but if the difference of 171kWh was exported at 60c/kWh, the loss from the east facing panels would be about \$103 for the year.

Ashley Campbell

### Write to us

We welcome letters on any subject, whether it be something you have read in *ReNew*, a problem you have experienced or a great idea you have had.

Please limit letters to 350 words. Due to space restrictions we can't guarantee to publish all letters received, and letters published may be edited for clarity and length.

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# Products



## 01 PV and hot water combined

Usually, if you want both photovoltaic panels and solar water heating collectors, you need two sets of panels. For homes with limited roof space, this often means compromising on the size of the PV array or even going without one altogether.

The PV-T hybrid panels from Solimpeks combine a PV panel with a solar water heater collector. The PV component produces electricity while the water heating component removes waste heat from the PV module to improve its efficiency, producing hot water in the process.

The PV component uses monocrystalline cells while the water heating component is all copper for longevity. The panels are available in 170 and 190 watt versions which weigh 24.4 and 34.4kg respectively. The panels come with a 10-year warranty and a productivity warranty of 90% after 10 years and 80% after 20 years.

Mounting options include on-roof, roof-integrated and on tilted frames for flat roofs.

For more information, contact Solimpeks Australia, PO Box H365, Australia Square, NSW 1215, ph: (02) 9338 6000, [contact@solimpeks.com.au](mailto:contact@solimpeks.com.au), [www.solimpeks.com.au](http://www.solimpeks.com.au)



## 02 Beating bike thieves

There's no doubt that cycling will play a big part in reducing greenhouse gas emissions from the transport sector, but one of the negatives about cycling is that bikes are easy to steal. Sure, you can use a bike lock, but most won't stand up to a hacksaw or bolt cutters.

GPS tracking devices have been fitted to cars for some years now, but until recently it was not possible to fit them to bikes. The SpyBike, from Integrated Trackers in the UK, fixes that, with a complete SMS-controlled GPS tracker that fits inside the steerer tube and looks like a standard headset cap. It uses a rechargeable lithium ion battery to power the unit and is motion activated. Provided you remember to turn the unit off when you're riding the bike, the battery will run for several months.

When the unit is turned on by the discrete remote, it starts uploading its location to the free online tracking service as soon as it is moved. If the unit loses GPS lock, it will use GSM signals to provide an approximate location until it can get a GPS lock.

The SpyBike is a quad-band GSM device and works anywhere in the world. All you need to do is install an active SIM card, fit the tracker to your bike, turn it on and configure it via SMS. The tracker comes complete with battery and charger and has a 12-month warranty.

RRP: UK£97.35. For more information or to buy direct, go to [www.integratedtrackers.com](http://www.integratedtrackers.com)



## 03 Simple solar lighting

Sometimes all you want is a simple solar lighting system without the hassle of wiring up batteries, regulators and the like.

Sundaya is known for its plug-and-play solar lighting kits, and the Ulitium 200 kits fit in that range.

The kits consist of an LED-based lamp that has an inbuilt lithium battery and charge controller, so no external battery or controller is needed. You just connect any DC voltage source of 18 to 24 volts and the system is complete. This makes them perfect for use with standard 12 volt nominal solar panels.

Because the lights use LEDs, they are very efficient and only a small solar panel is needed. For example, a 3-watt panel will provide up to six hours of light per day on the high setting. The lamps have three brightness settings—240, 120 and 25 lumens—making them a lot brighter than many similar small LED lights. The Ulitium system is almost infinitely expandable, with extra cables and connection hubs available.

If you wish to use an external battery instead, you can buy the Ulitium lamps without the internal battery—they are called Ulita lamps and have the same light output specifications and use the same cabling system.

RRP: \$33 for the Ulita lamps, \$77 for the Ulitium lamps. Available from Rainbow Power Company, PO Box 20240, Nimbin, NSW 2480, ph: (02) 6689 1430, [www.rpc.com.au](http://www.rpc.com.au)





#### 04 Grid interactive wind turbines

Soma wind turbines are a bit of an icon in the Australian renewable energy industry, being the only Australian-made small wind turbine available.

While they are usually used to charge battery banks, Soma also makes a grid-interactive version of both their 400 and 1000 watt turbines for people with grid connections and a good wind resource.

The SOMA 400GC and 1000GC turbines feature a higher output voltage (192V and 165V respectively) than the battery charging versions. Their rated outputs of 400 and 1000 watts respectively come at 10m/s, lower than many other turbines, and they have maximum outputs of 600 and 1400 watts. Maximum rated wind speed is 50m/s for both turbines.

Both come complete with controller and rectifier and they are compatible with several brands of grid-interactive inverter, including the SMA Sunny Boy and Windy Boy units. Soma can also supply 13m and 19.5m tower kits to suit their turbines.

For more information, contact Soma Power Pty Ltd, 18/13 Gibbens Rd, West Gosford, NSW 2250, ph: (02) 4323 1113, [sales@somapower.com.au](mailto:sales@somapower.com.au), [www.somapower.com.au](http://www.somapower.com.au)



#### 05 Australian EV motor controller

With commercially available electric vehicles in Australia still costing two arms and a leg, there are plenty of reasons to consider converting your current vehicle to electric power.

Traditionally, conversion components have had to be imported from overseas, mainly the USA, where conversions are much more popular.

To address this issue, Zero Emission Vehicles Australia has commenced production of its MC600S DC motor controller, an economical and Australian-made alternative to similar controllers from Curtis, Logisystems and Kelly.

The controller is microprocessor-controlled for smooth performance and reliable operation and features a compact case (240 x 150 x 100mm) with in-built heatsink for convection cooling. An optional cooling fan which attaches to the heatsink for higher sustained power is also included.

Specifications of the controller include a nominal input voltage range of 72 to 144V, 200A continuous and 600A maximum motor current, and a multi-colour status LED with remote option. The controller requires a four-pin throttle (three wire 0-5V plus enable pin) and works with most three-wire potboxes (with microswitch), including the ZEVA Hall effect potbox.

RRP: \$1295. Available through ZEVA, [www.zeva.com.au](http://www.zeva.com.au)



#### 06 The thermostat that thinks for you

With energy costs soaring around the country, everyone is looking for ways to save energy and reduce their bills.

Former Apple designer Tony Fadell decided to put his experience to good use and came up with the Nest thermostat.

Unlike other thermostats, the Nest is a smart device that learns your habits. It keeps an eye open using its inbuilt activity sensors to see if anyone is home, and if the house is empty it reduces or shuts off the heating or cooling to reduce energy use.

As you would expect from a smart device, the Nest features a secure wi-fi connection that not only lets you control it from a smart phone, tablet or PC, but also allows Nest to check weather forecasts and so learn how the outdoor conditions affect your energy use.

The Nest takes about a week to learn your usage habits and will then control your home's climate control system while constantly adapting to any changes in behaviour.

Other features include a clever display to provide easy to understand feedback, three temperature and one humidity sensor, the ability to store energy use data, automatic software updates and a host of other features.

The only downside at the moment is it is not yet available in Australia, but you can easily purchase it via a freight forwarding service.

RRP: US\$249. For more information, go to [www.nest.com](http://www.nest.com)

# Products



## 07 Keep your downlights cosy

Air leakage through ventilated downlight fittings results in a considerable loss of heat during winter. There are a number of downlight covers on the market but they are all passive designs.

The Cosydome is designed to be used on all downlight fittings rated up to 100 watts. It completely covers the fitting, allowing ceiling insulation up to 210mm thick to be placed right up to the dome, eliminating holes in the insulation that an uncovered fitting requires for safety.

The unique feature of the Cosydome is that it has an active vent in the top. This vent is normally closed, but opens up to 5mm to allow some ventilation when the temperature inside the dome exceeds 40°C. This reduces the chances of a fitting overheating, thus protecting your expensive LED downlights.

The Cosydome is rated as a fire-resistant enclosure and is made from high heat resistant polypropylene with a glass-reinforced polyester valve. It meets the appropriate AS/NZS standards for such enclosures.

For more information, contact Cosy Dome Limited, PO Box 30095, St Martins, Christchurch 8246, New Zealand, sales@cosydome.co.nz, www.cosydome.co.nz



## 08 Heat storage in your ceiling and walls

Maintaining a stable temperature inside your home can be difficult. Insulation is one important component of a thermally efficient home, but thermal mass is also important. Unfortunately, many building materials contain very little thermal mass. And what if you already own a home that doesn't perform as well as it could?

Phase change materials are a potential solution in many cases. These materials work by absorbing energy while maintaining a fixed temperature until they have completely transitioned from one phase to the other (solid to liquid, for instance), the same way ice stays at 0°C while it is melting.

Phase Change Energy Solutions supplies a range of phase change materials (called BioPCM) in sheet form that can be added to new or existing buildings. They can be simply laid on top of a ceiling under the bulk insulation, or installed under floors or in walls during construction.

According to the supplier, BioPCM is made from sustainable renewable materials. It is available in a range of energy storage densities and phase change temperature ranges for different requirements and applications. It comes in packs that cover from 1 to 5m<sup>2</sup>, depending on the material type.

For more information and to buy online, contact Phase Change Energy Solutions Australia Pty Ltd, 11/23 Cook Rd, Mitcham, VIC 3132, ph: (03) 9837 1010, www.phasechange.com.au



## 09 Protect your batteries

Lead-acid batteries can be damaged if too deeply discharged. While most inverters have a low-battery disconnect built in, most other loads, such as pumps and motors, do not.

The OzCharge 50 amp battery protector is designed to disconnect a load from the battery if the battery voltage drops below 10.5 volts for more than 10 seconds. The time delay eliminates accidental disconnection during heavy start-up currents, such as those caused by motors starting under load.

Once disconnected, the load remains disconnected until the battery voltage exceeds 12.5 volts, which usually means the battery will be on charge before that occurs.

The unit also features a manual switch, allowing you to turn the load on and off at will, and there is also a remote-control option via the trigger wire included with the kit.

While not a complete solution to preventing excessive battery discharge (a battery showing a 10.5 volt terminal voltage under a light load is effectively flat), this unit should extend the life of batteries used in smaller remote power supply systems as well as power systems in caravans and RVs.

RRP: \$99. Available from OzCharge retailers or directly from the OzCharge online store at [www.ozcharge.com.au](http://www.ozcharge.com.au)





## 10 Use the summer sun

We get a lot of sun in Australia, but most of us don't use it to best effect. Solar cooking is greatly overlooked by the average Australian, but with a little effort you can become a solar cooking whiz, reducing your energy bills and keeping your home a lot cooler in the hotter months.

One of the most popular solar cookers is the Global Sun Oven from Sun Ovens International in the USA. It consists of an insulated cooking box, surrounded by adjustable mirrors that concentrate solar heat into the cooking box.

The Global Sun Oven is able to cook pretty much anything that a regular oven can, in a similar amount of time, including roast vegies, bread, cakes, soups, and almost any other cooked food. All you need is a reasonably sunny day. And like most solar box cookers, it won't burn food or dry it out excessively.

The Global Sun Oven is available in Australia for \$539 from BonzaBuy. A range of accessories, including various pans and fly nets, are also available. For more information and to buy, contact BonzaBuy, PO Box 1111, Hillarys, WA 6025, [info@bonzabuy.com](mailto:info@bonzabuy.com), [www.bonzabuy.com.au](http://www.bonzabuy.com.au). Also see the manufacturer's website at [www.sunoven.com](http://www.sunoven.com). Also available from [www.sunoven.com.au](http://www.sunoven.com.au)



## 11 Double pole DC breakers

Circuit breakers are an often overlooked part of many smaller or DIY renewable energy systems, but they are very important to prevent fires or damage to electrical devices in case of a fault.

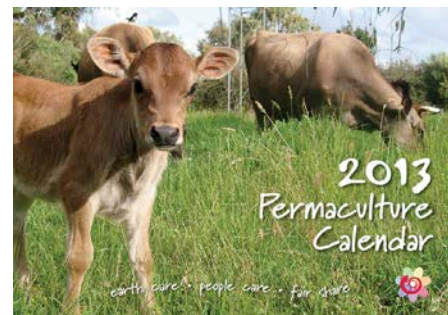
Many DIYers end up using AC-rated circuit breakers as they are cheap and readily available, but they are not rated to break DC currents and will often fail during a fault due to their inability to prevent arcing.

Jaycar Electronics has recently released two new DC-rated circuit breakers in 16 and 20 amp models. They are rated for DC voltages up to 500 volts and are electrical safety authority approved.

The breakers are standard DIN mount devices and so will fit in any standard electrical breaker box. They are ideal for solar, marine and caravan installations.

Part numbers are SF-4155 for the 16 A unit and SF-4156 for the 20 A model.

RRP: \$24.95 for either model. Available from Jaycar Electronics stores and their website. For more information, contact Jaycar Electronics, ph: 1800 022 888, [techstore@jaycar.com.au](mailto:techstore@jaycar.com.au), [www.jaycar.com.au](http://www.jaycar.com.au)



## 12 Permaculture calendar

With the rising cost of food, there's a growing global movement towards growing your own produce, and generally living more sustainably.

Permaculture is a branch of ecological design which develops sustainable human settlements and self-maintained agricultural systems modelled on natural ecosystems.

The photos in the 2013 Permaculture Calendar illustrate the 12 permaculture design principles, and are all examples of locally appropriate sustainable living and design.

In keeping with permaculture principles, the calendar is printed on Australian-manufactured 100% post-consumer recycled paper that is certified carbon neutral and supports the restoration and replanting of landfill sites around Australia. The paper is manufactured and printed using 100% renewable energy.

The calendar's size and light weight take advantage of standardised postage and reduced freight. Printing plates and paper waste are all recycled. Vegetable-based inks are used which don't release unnecessary volatile organic compounds (VOCs) into the atmosphere. Once the calendar has reached the end of its life, it can be composted.

RRP: \$12. Available from Permaculture Principles, [www.permacultureprinciples.com](http://www.permacultureprinciples.com)

# Future tech for sustainability

## Looking into the technology crystal ball

Where can technology take us, sustainability-wise? And who decides on the direction? Michael O'Connell explores the opportunities and challenges.

FUTURE tech for sustainability! Sounds impressive, but what does it mean? Does it mean technology that can sustain itself? Or is it technology that allows us to live sustainably? For that matter, what does sustainability mean?

From a pedal-powered washer/spin dryer to an edible coffee cup; from the latest PV innovation to algae that produces biodiesel. High-tech, low-tech, recyclable, reusable, old-school, new-wave, green: there are a myriad ways in which people push the latest in sustainable technology.

There are so many technologies, gadgets and ideas out there that it's easy to get overwhelmed. You could create any number of lists and categories. Just to give you an idea of one arbitrary way of categorising that will seem familiar to our readers, here's a short list.

### The short list

#### The usual suspects

- wind
- solar PV
- solar hot water
- solar thermal
- hydro

#### The new kids on the block

- geothermal
- thermal/chemical storage
- compressed air storage
- hybrid technology
- LED lighting
- fuel cells
- smart grid
- tidal
- wave
- hydrogen
- exotic battery chemistry

#### Way out there

- nanotechnology
- human-powered devices
- ... and the list goes on, and on, and on.

### So what can we expect in the future for sustainable technology?

We looked deeper into our multicoloured LED crystal ball for an answer.

All of the innovations seem to fall into two broad categories:

- new materials and
- new ways of doing things or thinking about things.

Almost all of the clever new devices that are powering the future of sustainability are the result of clever new materials and substances. From the latest in solar technology to new

types of building materials such as super insulators, they rely on being able to control and create new types of substances. And the most exciting and rapidly expanding of these new technologies is nanotechnology.

### Super-strong, ultra-smooth materials

Nanotechnology—the building of structures at the atomic and molecular level—has opened up whole new fields in engineering and manufacturing, and revitalised many existing fields. From superconductors through ultra-efficient filters to super-strong structures, the potential roles for nano-materials just keep expanding. Most of the current advances have been using carbon atoms in conjunction with other substances such as silicon and many metals. Here is just a sample of the new materials being developed.

**Room-temperature superconductors:** These are set to revolutionise electricity generation and transmission by drastically reducing losses: very important for wind turbines and PV devices, for example. This will have a flow-on effect for other developments such as the smart grid that will enable the integration of multiple renewable energy sources.

**Super-strong carbon nanotube cables:** These are so strong that they, theoretically, could enable the construction of the sci-fi space elevator. At a more practical level they enable the construction of buildings, bridges, etc. with less material and less energy.

**Ultra-smooth surfaces:** These are surfaces so smooth that dirt and even bacteria can't stick to them, which means no chemicals are required for cleaning. Some companies are already selling nano-coatings for glass to reduce the need for washing and cleaning.



Photo: Stephen Swintek, swintekphotography.com

↑ Recognised by both the Dell Social Innovation Challenge and the International Design Excellence Awards 2012, the GiraDora pedal-powered washer/spin dryer needs no electricity and is intended to cost just \$40. It is currently being field-tested in Peru with commercial production planned for 2013. [www.facebook.com/GiraDora](http://www.facebook.com/GiraDora).



The latest in the series of ongoing announcements of new materials is from a team of scientists from Hamburg University of Technology and Kiel University who have created a new material using zinc oxide particles and carbon nanotubes. Weighing in at only 0.2 milligrams per cubic centimetre, this new material is called Aerographite. What makes this material so promising is that it is also electrically conductive and highly compressible. It shows great promise as a material for lightweight and powerful batteries for electric vehicles.

### Just press print

But this is just the start. Nanotechnology can now also be used to build moving parts and nano-machines, and that really opens up a whole new world which we're only just starting to glimpse. For example, some people have proposed manufacturing systems that could sit on your desk just like a printer and print a working copy of almost any device you want including complex electronic devices such as computers, smartphones or even PV panels. Theoretically they could even build copies of themselves!

Existing 3D printer technology is already giving us a tantalising taste of what similar nanotechnology-based devices could provide. Devices such as the MakerBot Replicator and the Solidoodle SD1001-A are capable of printing almost any object you can think of, provided it is made of one or two basic materials such as plastic, silicone rubber, or, in the case of the Fab@Home machine, even foodstuffs such as cheese.

This could be truly disruptive technology

→ 3D printing is set to have a big impact on manufacturing industries.

3D printers now start at only \$300 and even quite advanced units like the MakerBot Replicator, which can print in two materials at once, are less than \$2000.



but would it be sustainable? That's really up to us.

### Sustainable gene technology

Another big player in the future of sustainable technology is gene technology

With the controversy surrounding GMO foods and the highly questionable patenting of plants and live organisms, it might seem odd to include gene technology here. But, as with most technologies, there are good aspects and not so good aspects.

Gene technology allows us to understand and predict the characteristics of plants and organisms based on their genes. It also allows us to manipulate those genes. It is what we do with this understanding and control that is important. One way in which this is being used sustainably is to enhance selective-breeding programs to achieve desired traits such as resistance to disease, or flavour or vigour. This can be done without introducing foreign genes into organisms. There is more and more research being done in this area.

At a much more basic level, gene technology is helping develop materials and organic substances which, while not alive, have some characteristics of living organisms that can be used to create useful and beneficial materials.

### The need for public debate

The manner in which both nanotechnology and gene technology develop into the future

“Made using zinc oxide particles and carbon nanotubes, Aerographite is electrically conductive and highly compressible, and shows great promise as a material for lightweight and powerful batteries for electric vehicles.”

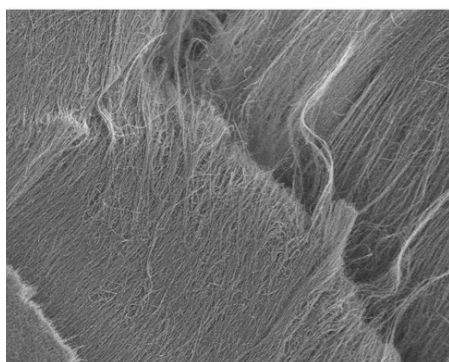
is fraught with risk. Unquestionably gene technology can be used inappropriately as we have already seen, and there have been questions raised as to the potential health dangers of nano particles and the need for a national register of nano-materials. The key to addressing all these issues is public awareness, discussion and decision making.

This is where the real future of sustainable technology lies, with us. What is a future technology that could ensure a sustainable future?—the communications revolution that is the internet and social media.

### Have your say!

Our sustainable future relies on us having a say in its development. Everybody needs to be involved in finding new and better ways to do things. This relies on people having access to information and to each other. Increasingly, as the world has become more industrialised, people have become less connected and fragmented.

Decisions which used to be taken at community levels, where everybody had the



↑ These multi-walled carbon nanotubes, seen here under magnification, would look like black soot to the eye. The walls of these nanotubes are thicker than one atom and they are adhering together in mats.

"Whether it is turning down your thermostat in response to a message from your smart meter, raising your voice against a developing environmental issue across the other side of the world, or sharing the latest techniques for urban permaculture, modern communications technologies and social media will play an increasingly important role in our sustainable future."

knowledge and a voice, have effectively been delegated to fewer and fewer individuals with less and less true accountability.

Recently we have seen the beginnings of a reversal in this trend. A new form of dialogue and participation through the internet and particularly social media is occurring and becoming stronger.

As technology allows us to become reconnected with our communities locally and around the world, the opportunities to participate in the decision-making process increase. Individuals and grassroots online organisations are using social media tools to provide information on issues and events that affect all of us. Online communities are bringing people together to share ideas, thoughts and improved ways of doing things.

### Better decisions

More importantly this new technology is allowing people to have a say and voice their opinion, as many of the successful online campaigns in recent times have shown, such as the successful campaign against new coal-fired power stations in Victoria.

Although some may find this process and the use of the technology frustrating and painful, the result should be better decisions that will have a positive impact for all of us.

Access to real-time information, coupled with the ability to take action or raise your voice in concern or support, is the key to achieving sustainability. Whether it is turning down your thermostat in response to a message from your smart meter, raising your voice against a developing environmental issue

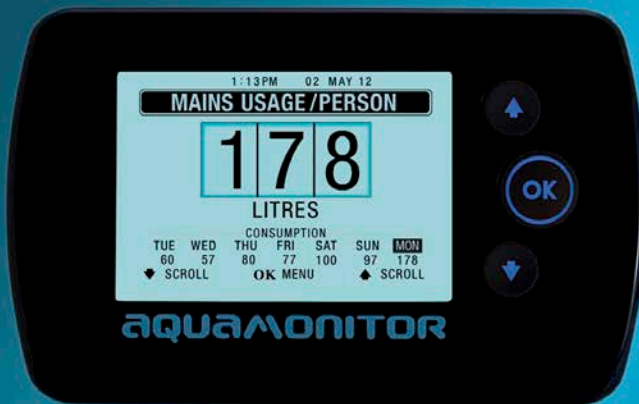
across the other side of the world, or sharing the latest techniques for urban permaculture, modern communications technologies and social media will play an increasingly important role in our sustainable future.

So, in that spirit, have your say, make a comment and tell us what you think by visiting the *ReNew* Facebook page or the ATA forums. You could even write a letter to the editor. What is the future for sustainable technology? ✨

Michael O'Connell is an electronics engineer, project manager and trainer. He runs a design and energy management consultancy with a focus on sustainable development, and is an immediate past president and board member of the Alternative Technology Association.

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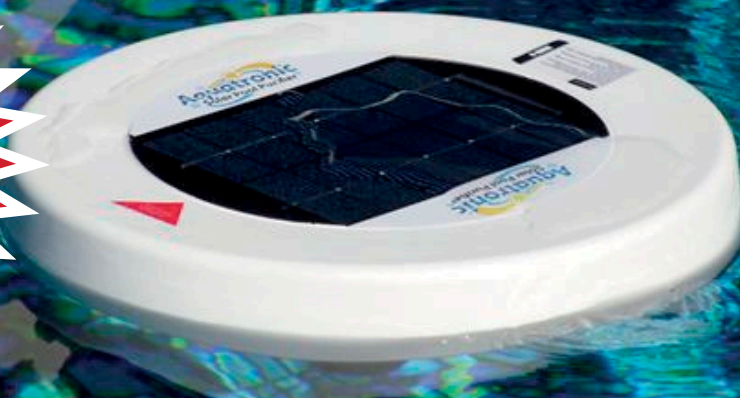
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# Housing futures

## The challenge is building



We have the knowledge, so why aren't we using it? Chris Reardon considers where to next for our built environments.

*RENEW* does a wonderful job connecting sustainable innovators, problem solvers and opinion leaders, and facilitating their exchange of ideas and inspiration. However, while we've been beaver away walking our talk, has anyone noticed that the broader community doesn't seem to have walked very far with us?

Indeed, while human population growth and lifestyle demands continue to weaken the ecological systems that sustain life, it has become increasingly apparent that our strategies to counter these threats have been ineffective at best. On our watch, the collective demands of humanity have managed to exceed the ecological carrying capacity of the earth, and this trend shows few signs of abatement.

This article steps back from the usual *ReNew* focus on technological innovation and applied solutions to briefly examine some new ways of thinking that might influence the way we approach our goals. To achieve truly sustainable futures, we require a quantum shift in the way we think about and interact with the biosphere in meeting our needs.

The concept of 'positive development' introduced by Janis Birkeland in her 2008 book, *Positive Development: From Vicious Circles to Virtuous Cycles Through Built Environment Design*, defines just such a shift and provides an analytical framework within which we can understand, plan and implement that change.

"While we've been beaver away walking our talk, has anyone noticed that the broader community doesn't seem to have walked very far with us?"

Birkeland envisages a future in which urban areas are retrofitted to deliver net positive ecological and social outcomes. This requires radical re-thinking of the ways we plan, design, engineer and manage our built environment and a shift in the way we benchmark our progress.

### Living Building Challenge

The International Living Building Institute (ILBI) follows a similar philosophy, and has developed a standard, the Living Building Challenge 2.0, to assess performance. The ILBI philosophy is captured in their challenge to the creators of the built environment:

What if every single act of design and construction made the world a better place? (ILBI, 2010)

Positive development embodies a radical shift from our current focus on impact reduction and improved resource efficiency to the creation of ecologically positive outcomes from every development. It challenges current assumptions that human development can have only negative environmental outcomes and suggests that this 'defeatist' approach is limiting our thinking about ways forward.

Most importantly, it addresses humanity's fundamentally unsustainable assumption that the biosphere can continue to meet growing human demands, and outlines strategies to resolve this conflict.

Positive developments will be required to deliver a net increase in the ecological carrying capacity of a site such that it is capable of contributing more to the biosphere (which includes human populations) than if it were left undeveloped.

"It challenges current assumptions that human development can have only negative environmental outcomes."

Such developments will include closed loop or 'reversible' materials flows (i.e. be highly adaptable, reuseable, recyclable and even compostable). On- and off-site renewable energy generation to over-compensate for energy and ecological resources consumed during production and operation of a development will be a standard requirement.

As this change occurs, our measurement and rating systems will need to move from measuring negative impacts (environmental emissions and depletions) to measuring positive contributions and restoration.

### An interim response

While essential for a truly sustainable future, the transition to positive development or something approaching it will likely not be rapid. Our interim challenge is to avert or postpone catastrophic changes to the biosphere (especially global warming) while we develop permanent solutions that work with and enhance natural systems rather than working against them.

To succeed, we will need to aim much higher than we currently are and find ways to engage the vast majority of the human population.

Three interim levels of response will be required if the housing sector is to maximise its contribution to sustainable futures:

- **Mitigation:** a rapid acceleration of current strategies to limit human demands to ecologically sustainable levels, as currently outcomes are barely measurable

- **Adaptation:** alteration of our homes to better cope with the consequences of changes that are already inevitable, such as hotter summers, warmer winters and extreme weather events
- **Restoration:** urgent repair of existing environmental damage and replenishing of the ecological integrity of acutely threatened bio-regions.

## Finding a way forward

While it is imperative that humanity solve this problem quickly, the way forward is anything but clear or agreed.

A flip back through my treasured *ReNew* library tells me that the necessary technology and know-how already exist in abundance, but a skim through any housing magazine (except *Sanctuary* of course!) makes it clear that these solutions are not being adopted at any meaningful level by the broader community. Why? We have led the horse to water but the damned thing won't drink!

Perhaps the best solution is to deem the situation life threatening and put the horse on a drip? Our electricity grid can provide that drip and the visionary Zero Carbon Australia Stationary Energy Plan (ZCA) has a recipe for the life-extending flow the grid can deliver.

This ambitious plan outlines a viable 10-year roadmap for 100% renewable energy supply in Australia by 2020. Published by Beyond Zero Emissions and the University of Melbourne Energy Institute in 2010, it is yet to receive

the widespread support it deserves from our governments and sustainable change agencies.

The Zero Carbon Australia Buildings Plan (a soon-to-be released component of ZCA) will frame the role of buildings in delivering ZCA's goals. Important elements include:

- all buildings to be required to have zero operational emissions within 10 years
- a focus on upgrading the worst performing existing building stock
- a shift to 100% electricity as the energy source for buildings (i.e. no gas) to fully capitalise on ZCA's zero carbon, 100% renewable target
- deep cuts in both total and peak energy demand
- on-site and decentralised energy generation within a smart grid.

## Limit electricity demand

What is the role of housing? Simple. To limit demand (particularly peak demand) and delay the need for new baseload generation capacity until ZCA becomes a reality.

Housing is the principal driver of peak electricity demand and has a critical role in limiting it. It also has a key role in the uptake of decentralised energy generation and distribution.

Both thermal and electrical storage are critical components of demand reduction and deferment. Current advances in both fields are very encouraging.

**"What is the role of housing? Simple. To limit demand and delay the need for new baseload generation capacity until ZCA becomes a reality."**

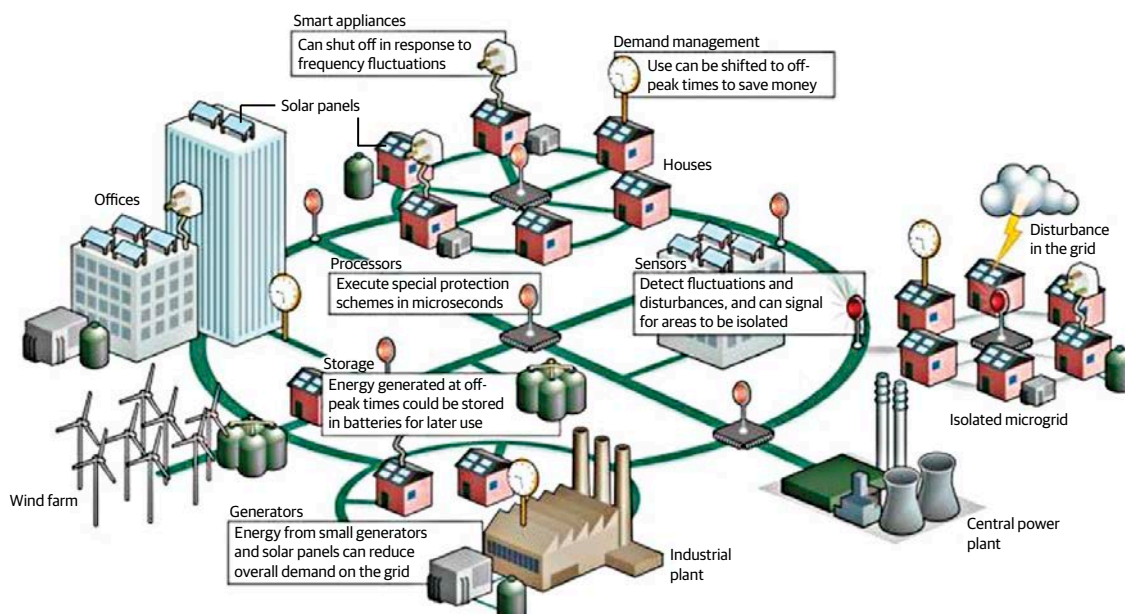
## A decentralised smart grid

While current national inconsistencies in prices paid for grid-feed renewable electricity are frustrating and counter-productive, rapid developments are occurring in home energy management systems and battery technology. These developments are set to revolutionise the way we interact with a decentralised smart grid.

A combination of time-of-use metering, on-site storage and energy management systems will allow corporate, community and individual household renewable energy generators to choose when they use their electricity and when they sell any excess produced back to the grid. This will enable them to maximise their returns while at the same time reducing peak demand and potentially eliminating it.

Technological improvement in both plug-in hybrid electric vehicles and stand-alone battery storage systems (see *ReNew 118*) are increasing the affordability and viability of both off-grid and grid-connect systems.

← A smart grid includes mechanisms to make the grid more efficient, including greater use of technology, such as smart meters and technologies to manage appliance loads at peak times, and economic strategies, such as time-of-use tariff structures.





## The importance of thermal storage

Thermal storage of winter solar warmth and summer 'coolth' from night purging reduces total household heating and cooling energy use and can delay or eliminate peak demand.

While the use of high thermal mass in cool and cold climate housing is effective today, it is likely this approach will need to be adapted as warming increases. Such solutions generally have higher embodied energy and can be slow to respond to heating or cooling input.

Thermal storage solutions using water or phase-change materials (PCMs) are emerging as viable alternatives. These generally have lower embodied energy and are highly suitable for retrofitting existing lightweight (low thermal mass) homes to provide thermal storage. These mass systems are flexible, relatively low cost and work well with the high-efficiency active heating and cooling systems that will likely be required as climate change occurs.

You can just move or drain your thermal mass if it gets too hot in summer or becomes a heating liability due to inadequate solar gains in winter. Imagine a mobile footrest filled with PCMs that can be placed in a sunny spot in the day and then moved to your TV area or bed to keep you warm at night.

*"While the use of high thermal mass in cool and cold climate housing is effective today, it is likely this approach will need to be adapted as warming increases."*

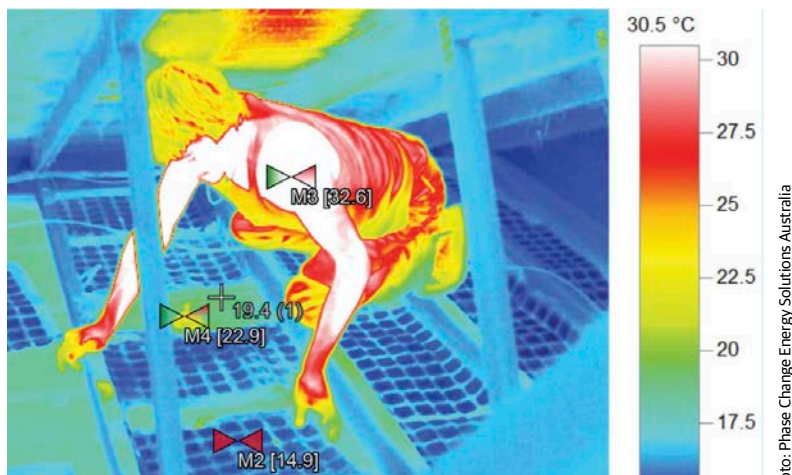


Photo: Phase Change Energy Solutions Australia

↑ Phase-change materials are emerging as a viable alternative for thermal storage. Here, a thermal image of phase-change material (PCM) mats being installed in a ceiling shows the temperature differentials with/without the mats. See Products, p.22, for more info on bioPCMs.

## A closing note of optimism

There are many encouraging signs that sustainable change in Australia is about to receive a big boost from a brewing 'perfect storm' of economic and market forces.

These include: rising energy costs; carbon pricing; mandatory disclosure; increasing economies of scale for renewables; engagement of the property marketing sector and increasing recognition of sustainable performance in property values.

The net outcome is a rapidly increasing financial incentive to improve the

environmental performance of our existing housing stock.

Put a buck in it and they will come! \*

Chris is a building design practitioner and former builder who currently provides sustainable design and construction consultancy and training throughout Australia through his multi-award winning practice, Suntech Design. His PhD research addressed sustainable change creation in the housing sector and he is the principal author of the award-winning *Your Home* sustainable housing guide.



## Nationwide retrofit: Zero Carbon Australia Buildings Plan

To be released early November 2012 by Beyond Zero Emissions.

The Zero Carbon Australia Buildings Plan, to be released in early November 2012 by Beyond Zero Emissions, is the first comprehensive nationwide retrofit plan for Australia's building sector.

With technologies and strategies to 'decarbonise' Australia's existing building stock, the report shows that over 10 years, if the plan is adopted, residential energy use could be reduced from 385 PJ/annum to 184 PJ/annum, a 52% reduction.

The measures include improving the thermal performance of buildings, replacing inefficient appliances and switching to on-site renewable energy generation using solar PV or micro-wind. For example, the plan recommends replacing all gas-fired appliances and services with efficient electric

alternatives (heat pump hot water systems, reverse-cycle air conditioners, and induction cooktops), fully insulating buildings, reducing solar heat gain by using window coatings and awnings, draught proofing, installing LED lights and using in-home displays to enable consumers to understand and adjust energy usage.

These may be measures that are familiar to *ReNew* readers, but the report backs up these suggestions with modelling and analysis to show just how effective they can be.

With residential and non-residential buildings accounting for 20% of Australia's energy use and around 25% of Australia's emissions, such reductions are significant and important.

More info: [beyondzeroemissions.org/buildings](http://beyondzeroemissions.org/buildings)

# Under construction

## Building with structural insulated panels



Architect Sid Thoo takes us through the decisions along the way from design to construction of this house built using SIPs—structural insulated panels.

STACY and Phillip Gardoll first contacted my practice in mid-2009 for assistance with designing a new home for them and their young family in Swan View, a suburb approximately 24km east of the Perth CBD. Having recently moved back to Perth from Melbourne, they were keen to build a contemporary home that was energy efficient and made best use of their 804m<sup>2</sup> block and its generous northern aspect.

We came up with a floor plan that featured the trademarks of a passive solar dwelling—elongated along the east-west axis, living spaces orientated to the north with appropriate glazing ratios, bedrooms to the south, and minimal glazing to the east and west. Thanks to Stacy's training in interior design, their home featured a spacious open-plan kitchen, dining and living area, an adjoining area for the kids, and a separate study that also took advantage of the northern aspect.

The challenge we faced was selecting appropriate materials for the building. To start with, Stacy and Phillip weren't keen on building the usual double-brick and tile home so commonly found throughout suburban Perth. Also, the soil in the Swan View area is classified as reactive due to a high clay content (whereas most of metropolitan Perth is sand), meaning expensive structural piling and footings would be necessary to support this kind of heavy mass construction.

### Structural insulated panels

I had recently learnt about a new construction technology known generically as SIPs—structural insulated panels. They've been in use in both the UK and North America for a



↑ North elevation of the dwelling built from SIPs, prior to the water vapour membrane being added.

Photo: Stacy Gardoll

number of years, and a company trading as SIPs Industries had opened a factory in Perth about six months prior.

As their name suggests, each SIP is a load-bearing panel that is integrated with an insulated core made from polystyrene, sandwiched between two panels of oriented strand board (OSB). The polystyrene core is available in a variety of thicknesses depending on the R-value required, and the entire assembly is glued under pressure to form a complete unit.

You'd be surprised at just how strong a SIP can be—extensive testing to ensure compliance with the National Construction Code has demonstrated that a SIP can withstand significant structural loads. If you

were like me, you wouldn't have thought that polystyrene could be a load-bearing material, but when combined with the OSB panels it has impressive structural performance.

Unlike some other types of panelised construction, SIPs can be used not just for walls, but also floors and roofs, making it a particularly versatile construction material. This was of particular interest with Stacy and Phillip's house, as the relatively lightweight structure that could be built using SIPs would be advantageous given the reactive soil found on their site.

Also, SIPs can be used for fire-rated construction, as the polystyrene is never exposed. Each SIP has the sill, head and sides of the polystyrene core rebated, and this



rebated section then slides over a horizontal or vertical timber stud for fixing into the adjacent panel. Additionally, a SIP wall is then externally clad with weatherboard, metal sheet or fibre-cement, providing further protection from the risk of fire.

### Ease of assembly

Speed of construction is another advantage to building with SIPs—panels are made to size in the factory, numbered, loaded and transported to site in a logical sequence to facilitate ease of assembly on-site. Windows and openings are pre-cut into each panel, and vertical conduits can be included in each panel for electrical and plumbing pre-lays.

And because there are almost no wet trades involved with SIP construction, the main shell of the building can be rapidly assembled. In the case of Stacy and Phillip's house, the walls were assembled in less than two weeks, while the roof was in place in just four hours—Stacy tells me she almost missed taking photos of the roof going on because she turned up late to site!

### Environmentally friendly?

For all the benefits of building using SIPs, there are some downsides to be aware of. As an architect I'm interested in all aspects of eco-effectiveness, not just operational energy efficiency, and polystyrene is not generally a material I would consider as 'environmentally friendly', as it contains benzene and is a petroleum-based product. It also has a relatively high embodied energy, and while it is theoretically possible to disassemble a SIP building to its constituent components, I am not aware of any buildings where this has been done yet.

However, as with most building and construction practices, it is sometimes about choosing between materials that all have some downsides. For example, some other types of sandwich panel construction use a polyurethane foam core, which can give off hydrogen cyanide gas when ignited, and can cause skin and respiratory sensitivity.

Also, more traditional forms of construction such as brick also have a high level of embodied energy, result in a greater amount of construction waste and are potentially difficult to salvage at the end of a building's life.

Many things considered, SIPs seemed like the most appropriate building material given

Stacy and Phillip's design brief and budget.

On the subject of embodied energy, the OSB panels are not currently manufactured in Australia, and so the ones we used were shipped from Germany. While this may appear to be a contributing factor towards the higher embodied energy of SIPs, it is interesting to note that the carbon emissions per kilometre of sea transport are substantially lower than those of road transport.

SIPS Industries has also indicated they intend to start fabricating OSB in Australia once there is sufficient demand to justify investing in such a manufacturing facility.

### The importance of thermal mass

With regards to energy efficiency, you might think that a super-insulated 'box' made from SIPs would perform extremely well with regards to thermal control. However, when I completed the Nationwide House Energy Rating Scheme (NatHERS) assessment



Photo: architecture.collective

↑ Each SIP is a load-bearing panel that is integrated with an insulated core made from polystyrene, sandwiched between two panels of oriented strand board (OSB).

"You'd be surprised at just how strong a SIP can be."

### Installing unplanned services

Each SIP comes manufactured with vertical conduits for electrical and plumbing services, but it seems almost inevitable that another power point or light fitting will need to be added during construction, despite the best planning.

While this is easy to accommodate on the outside of the building by running a conduit between the outside face of the SIP and the external cladding, internal walls require the use of a 'hotballing' technique, whereby a small section of OSB is removed at the top and bottom of a panel, a ball-bearing is heated up with a blowtorch, then inserted and "dropped" through the polystyrene core to create a conduit.

This worked perfectly every time during my last site visit, but I was told by one tradesperson that occasionally a stray screw may be embedded in the panel, and can cause the ball-bearing to stray off-course.

Also, this technique only really works for flexible services such as electrical wiring; plumbing variations are difficult to adjust on-site, and in the instance of Stacy and Phillip's house, an additional timber stud wall had to be built in the ensuite to enclose the plumbing services.



Photos: architecture.collective

↑ Hotballing technique. 1. Cutting a hole in the OSB. 2. Heating the ball-bearing. 3. Angle and cut-out to allow the heated ball bearing to exit at the required point in the wall.

"While a SIPs building will lose and gain heat very slowly due to its high R-values, at some point it will require heat to be added or removed from a space artificially in order to achieve thermal comfort."

for this design, I was surprised to discover the building struggled to achieve 5 Star compliance (the building was submitted for a building licence prior to the introduction of 6 Star in WA).

The only way we could achieve the minimum requirement was to include in the design a couple of layers of fibre-cement sheeting on the internal face of the floors and walls of the building.

This highlights the importance of thermal mass inside the building envelope to achieve optimal thermal control—thermal mass is able to store and release heat energy, which is beneficial both in summer and winter. While a SIPs building will lose and gain heat very slowly due to its high R-values, at some point it will require heat to be added or removed from a space artificially in order to achieve thermal comfort.

Somewhat fortuitously, it turned out that concrete slab on-ground construction was the most cost-effective way to build the floor, with Stacy and Phillip opting for a bare concrete finish to the floors. I recently re-ran the NatHERS analysis taking into account this design change, and the design now rates at 6 Stars without the fibre-cement internal lining.

### Are SIPs cheaper?

Another important consideration when evaluating an alternative form of construction

such as SIPs is, of course, cost. Although there are considerable reductions in labour, time and materials wastage when using SIPs, it would appear that building in SIPs isn't necessarily cheaper than more conventional forms of construction.

This is partly due to the nature of SIPs construction. Unlike traditional building methods such as cavity brick or brick veneer, there are additional costs and labour associated with constructing the internal (SIPs) 'shell' of the building independent of the external 'skin'.

It is important to remember that a SIP must be protected from the elements and cannot be exposed externally. While there are some types of SIPs that use fibre-cement or magnesium-oxide board instead of OSB as their outer layer and can therefore be used as the external skin (and be directly rendered), I would argue that the separated 'shell' and 'skin' approach actually provides more design flexibility and potentially better protection from moisture and condensation.

In my experience as an architect, it's also worth noting that there appears to be no inherent logic as to why one form of construction is cheaper than another.

For example, cavity brick is the most economical form of construction throughout most of metropolitan Perth, while on the east coast it tends to be brick veneer; they are different but equally practical methods of construction, yet it will cost more to build brick veneer in Perth for a variety of reasons.

More often than not, cost of construction tends to be dictated by economy of scale, so as SIP construction increases in popularity, no doubt it will become a more cost-effective alternative.



Photo: architecture.collective

↑ SIPs covered with water vapour membrane and battens ready for attaching the outer 'skin'. A SIP must be protected from the elements and cannot be exposed externally.

In summary, I believe Stacy and Phillip are very happy with their decision to build using SIPs and are looking forward to the completion of their new home just before Christmas. As an architect, there are advantages and disadvantages to be found with every type of construction. However, I would certainly consider using SIPs again on a project where it's appropriate for the client's design brief and budget. The team at SIPs Industries has been incredibly professional, knowledgeable and helpful throughout the design and construction process for Stacy and Phillip's home, and is definitely committed to raising awareness of SIPs as a viable, cost-effective construction alternative.

In an industry that is generally very conservative, I genuinely look forward to seeing innovative systems such as SIPs receive greater acceptance. This will ultimately provide greater choice for people when building their next home. \*

Sid Thoo is an architect and HERS assessor with architecture.collective in Perth, WA. He is also a director of eTool.

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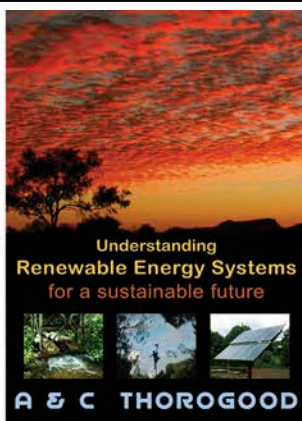
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# Building innovations

## An evolution of materials and methods



It's not just about new products: old tricks and materials are also being reworked in an evolution of sustainable building in Australia, writes Jack Nicholls.

AUSTRALIA'S building sector is responsible for almost a quarter of our country's greenhouse gas emissions, and yet our homes are so often ignored in national environmental debates. After all, everyone needs somewhere to live, so we can't stop building. But while our construction sector may be a long way from becoming carbon neutral, architects and builders across the country are looking at ways in which they can reduce their buildings' footprints.

Next generation building materials offer some hope, and preliminary tests have shown that structural insulated panels (SIPs)—insulating polymer foam sandwiched between boards—can offer insulation values far in advance of traditional bricks and mortar. Yet the embodied energy in these materials

can be a drawback from a sustainability perspective. In the meantime, innovative designers are looking to the past for inspiration—rammed earth walls for thermal mass, wood as a lightweight construction material, and hydronic heating evolved from the Roman's ancient practice of pumping hot air beneath their floors.

### Old trick: prefab

One old trick that is getting a 21st century dust-off is prefabricated housing. Many people associate prefab with cheap and flimsy, but Craig Riddle, managing director of the Living Green Designer Homes (LGDH) construction company, sees things differently.

"The three main sources of pollution in the housing sector are concrete, steel and

transport to and from site," he explains. "By preferencing natural materials like certified pine, and by doing the bulk of construction in-house, we minimise that pollution."

Assembly-line housing might seem the antithesis of the sustainability ethos, but in Living Green's case the prefabrication label is somewhat misleading. Rather than building the entire shell, the company's crews build and undercoat customised components that can then be snapped together like Lego blocks. This allows for a fully customised house each time—one that utilises passive solar design to maximise winter sun exposure, while making the most of local wind patterns to provide natural air conditioning in summer.

Why bother prefabricating at all? Riddle says that it is all to maximise efficiency and minimise the carbon footprint of a project. The factory setting increases efficiency, as all the necessary materials are close at hand and any waste or offcuts are immediately recycled. Once the construction phase is complete, components are trucked to the site. With only a single semi-trailer and a small cement mixer, Riddle's team are able to assemble a complete house to lock-up in seven to ten days.

"The factory setting increases efficiency, as all the necessary materials are close at hand and any waste or offcuts are immediately recycled."



Photo: Living Green Designer Homes

↑ Prefab construction can increase efficiency, with the bulk of the construction done off-site.





↑ A CLT panel being winched into position in the Forté apartments construction in Melbourne 2012.

### New product: cross-laminated timber

One new material that shows promise is cross-laminated timber (CLT). Essentially, CLT is a form of super plywood. Panels of timber are glued together in a 'criss-cross' pattern where the grain of each panel sits perpendicular to its neighbours. Alternating the grain of the wood allows load-stresses to be transferred in more than one direction, while making the timber resistant to swelling or shrinkage. Up to 11 sheets are laid, then hydraulically pressed and cut to shape. When finished, the CLT forms a solid slab that, in its thermal and structural properties, behaves more like a lightweight concrete than a traditional wood, with a fraction of the embodied energy.

This material has been in use in Europe for 20 years, but is only now reaching our shores. Three years after a nine-storey wooden high-rise sprang up in East London, Australia's Lend Lease Group has begun constructing a cross-laminated timber apartment block in Melbourne's Docklands. The project has been christened Forté, meaning strength, and when complete will stand ten storeys tall. The tallest commercial timber structure in the world—until the next developer goes one better.

You might think that a wooden apartment block is a towering inferno waiting to happen, but proponents of CLT say quite the reverse. In a fire, the outer layer of a CLT panel is designed to quickly char, while leaving

the load-bearing core intact. The charcoal layer delays the transfer of heat and oxygen through the wood, buying time for emergency crews to douse the flames.

Lend Lease's website makes the claim that "it is only a matter of time before everyone is building like this." Perhaps; the mid-height towers CLT is suited to would offer a relatively palatable alternative to urban sprawl, with the added benefit of locking up carbon in our cities. But turning to CLT as a primary building material would necessitate a dramatic expansion of our plantation industries, and without knowing how well these structures will hold up over time it is difficult to judge exactly how well they compare against more traditional buildings across the complete carbon life-cycle.

### Salvaged materials

From the perspective of embodied energy, wood is more sustainable than steel, but it still has to be grown and harvested, with the issue of certification of those forestry processes to be considered. Perhaps the greenest building is the one that uses no new materials at all. That's the thinking behind Greening Australia's Sustainability Learning Centre, currently under construction in Hobart.

The materials for the learning centre were salvaged from an old warehouse in Hobart, painstakingly dismantled by hand over the course of three months. 98% of the warehouse's materials were saved from landfill, and the bulk of these have gone into the learning centre—including 80% of its steel and timber, and half of its minimal concrete.

"The materials for the learning centre were salvaged from an old warehouse in Hobart, painstakingly dismantled by hand over the course of three months."

Using old materials doesn't mean the architects have restricted themselves to old ideas. A furnace fuelled by recycled cooking oil heats water that is then pumped through a hydronic piping system beneath the floor for heating. Solar walls release trapped afternoon heat throughout the evening, and wind and solar power are used to provide the building's energy. When complete, the learning centre will be used to educate students of all ages in sustainability and ecology programs.

The learning centre's greenest innovation will have to wait for its death, rather than its birth, to see fruition. The structure has been designed for easy dismantling, so that its bricks and cladding may be used in turn in yet another structure. We've been recycling our drink bottles for years, but Greening Australia is looking to a future where we recycle our homes.

These projects and others like them offer no magic super-brick or paradigm shift in design, but rather a series of simple improvements that combine to a new ethos of construction. It may be more evolution than revolution, but structures like these offer hope that the dream of a carbon-neutral building sector will be realised sooner rather than later. \*

Jack Nicholls is a climate change campaigner and a science-fiction author, giving him a dual interest in the cutting edge of sustainability technology.



↑ Northern exterior of the new Sustainability Learning Centre in Hobart, Tasmania, showing the glass trombe (solar) walls, and the black perforated steel walls that duct heated air into the building. The building has been assessed by eTool as having 1% of a benchmark building's carbon footprint over its design life.

# Houses of the future

## Under construction in Beechworth



Is it possible to build a residential house in Australia to meet PassivHaus standards?

Meg Warren and Fraser Rowe are working on it now.

IN the cool of Victoria's Beechworth, construction is in full swing building a house with a thermal performance rating of 8.3 Stars, as rated by FirstRate5. The house owners, *ReNew* readers Meg and Fraser, believe their new house may come very close to meeting the international PassivHaus thermal performance standard, although they did not set out with this as a specific design aim.

The finished design incorporates insulation layers with several internal thermal mass walls. Meg states: "We opted for more insulation layers to achieve a higher R rating, and a well-sealed envelope to lessen draughts and cold air penetration." Since the selection of the block four years ago, Meg and Fraser have worked with the designer and builder to create a climate-zone-specific passive solar design. The building is a modest 2 to 3 bedroom home. The designer and builder were selected on experience and their commitment to energy efficiency details.

They are looking to finish the build by the end of 2012. Keep your eye on *ReNew* for updates as building progresses. \*

"We placed extra roof battens in anticipation of up to 18 solar PV panels"

→ Installing the middle layer of the sealed three-layered insulation envelope.



Photo: Meg Warren

### Features included to meet the PassivHaus standard:

- double glazing throughout
- window area matched to the north-facing internal area and volume of thermal mass; minimal windows to east and west
- well-positioned Solatubes rather than clerestory or overhead windows
- above BCA-standard insulated walls, 140mm thick with total rating of R3.5+, achieved with three layers of specific 'house wraps', two battened-out air gaps and 90mm bulk R2 insulation
- roof with total R5+ insulation
- roof space ventilated with Solarstar units, thermostatically controlled and independently powered by PV panels
- Venmar heat-recovery ventilation system for fresh air exchange and distribution of warm air throughout
- small, efficient, low-emission wood heater with cooktop, centrally located and with a dedicated fresh air supply and closeable vent
- 3.5kW grid-interactive solar PV system
- evacuated-tube solar hot water system with instantaneous LPG inline booster
- LED light bulbs where possible, compact fluores elsewhere
- 32 amp power point for charging future electric or plug-in hybrid vehicle
- wiring installed for possible future split-system heat pump for heating and cooling in extreme weather
- rainwater tank (27,500L) to potentially supply all house and garden needs
- greywater diversion system
- A small rain garden to make use of excess stormwater
- retractable shading to the north and planned 'living shade' on trellises.



Photo: Meg Warren

↑ Midday sun casting a shadow on framing, confirming orientation is within six degrees of solar north.



# Setting the standard

A round-up of some of the building standards and competitions that are leading the way in sustainable design.

## PassivHaus standard

PassivHaus is an energy performance standard developed in Germany in 1990 and now practised throughout the world. In this building standard, heating and cooling systems are not considered essential and thermal comfort is achieved by design. PassivHaus buildings are slightly more expensive to build than conventional houses but have very low heating and cooling costs once constructed.

Houses built to this standard are quite air tight with a sealed and well-insulated building envelope. Heat recovery ventilation systems allow fresh air into the building without losing warmth in the process. This standard can be applied to residential and commercial buildings.

[www.passivhaustrust.org.uk](http://www.passivhaustrust.org.uk)

## Living Building Challenge

Buildings around Australia are beginning to aim for Living Building Challenge certification. This global challenge is a set of principles and a philosophy that can be used as a tool for sustainable living. Certification for this challenge is based on a building's environmental performance in regards to the site, water, energy, health, materials, equity and beauty. The challenge could be an important step in creating living cities that give energy back to the environment and its inhabitants. This standard is assessed based on the completed building, 12 months after construction, rather than on the design.

[www.ilbi.org/lbc](http://www.ilbi.org/lbc)

## Zero Carbon Challenge

The winners of the 2012 Zero Carbon Challenge competition, run by the Urban Renewal Authority and the Integrated Design Commission SA, have started to build their zero carbon house in South Australia. Team Collaborative Future designed a 7.5 Star house with net zero operational energy, a projected 16-week construction time and a price of \$335,000. Their design took into account the embodied energy of a building, future emissions, liveability, affordability

and adaptability. The house is due to be completed by the end of the year.

[www.integrateddesign.sa.gov.au](http://www.integrateddesign.sa.gov.au)

## 10 Star Challenge

The annual Building Designers Association of Victoria (BDAV) awards allow designers to showcase 10 Star energy efficient home designs. Multiple dwellings were given their own category in this year's challenge, with one of the winning designs from EME Design/Greensphere Consulting including a consolidated garden, a community building with a commercial kitchen and play area, shared rainwater collection and a water treatment plant.

[www.bdav.org.au/10-Star-Challenge](http://www.bdav.org.au/10-Star-Challenge)

## Solar Decathlon

This international challenge, run by the US Department of Energy, sets student teams competing against each other to build a house powered by the sun. These houses produce more energy than they use and are judged on affordability, optimal energy production and energy efficiency. Their design and how lovely they are to look at are also important competition elements. Past competition winners have been from Germany, New Zealand and the USA. This year, the Solar Decathlon heads to Europe, with Spain running the competition in September.

[www.solardecathlon.gov](http://www.solardecathlon.gov); [www.sdeurope.org](http://www.sdeurope.org)



↑ 150 students from Cornell University helped to build this Silo House entry in the 2009 Solar Decathlon. This house produces more energy than it uses.

# Multiple dwelling developments

## BEND, New South Wales

Bega Eco-Neighbourhood Developers (BEND) is a town-based community housing solution. Building is well on the way, with finished households enjoying the shared community house (including a laundry and composting toilet) and a water treatment system.

From the outset BEND members wanted the project to be outward looking and represent the town of Bega, where around one-third of houses are rental. A community housing group came on board, Community Housing Limited (CHL), and built 10 houses in the development. These houses have since placed CHL as a finalist in this year's United Nations World Environment Day awards in the community category.

[www.bend.org.au](http://www.bend.org.au)



↑ A multiple-dwelling design from the BDAV 10 Star Challenge, EME Design.

## Cape Paterson, Victoria

Affordable 7.5 Star houses are in the pipeline at the Cape Paterson development in Gippsland, Victoria. This multi-dwelling development on degraded farmland at Cape Paterson has the environment in mind. Revegetation and habitat restoration of the surrounding land is all part of the plan and houses are set to contribute more energy than they take to build and run, thanks to the solar panels on each roof. You can find the development's zero carbon study on their website: [www.capepatersononecovillage.com.au/sustainability/zerocarbonstudy](http://www.capepatersononecovillage.com.au/sustainability/zerocarbonstudy)

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# The future generation?

## Community-based energy comes of age



With more than 60 projects in the pipeline, momentum may finally be building for community energy in Australia. By Robyn Deed.

COMMUNITY-OWNED projects have been a part of the renewable energy landscape in Europe for decades. In Germany, thanks to favourable policy, 51% of the renewables are community-owned; in Denmark, 2100 community-owned wind farms have come online since the mid 1970s.

In Australia, the genesis has been slower: the Renewable Energy Target turns 11 this year and the renewables revolution is really just starting. As such, community energy is in its infancy, with projects facing significant planning, financial and regulatory hurdles.

But there have been successes. The turbines at the community wind farm in Hepburn in Victoria have been turning for a year now, and in the town of Denmark in WA, they're about to start (see p. 44 for the full story of Denmark community wind farm).

These projects have taken a while: six years for Hepburn and ten for Denmark, from idea to generation. But the lessons they've learnt are making it easier for the projects that follow.

To assist other projects to get off the ground, in 2010 Hepburn Wind's founding chair (and ATA member) Simon Holmes à Court set up not-for-profit group Embark. Its website provides free how-to info for those wanting to establish community renewable energy projects, based on the experiences of Hepburn Wind and other projects. He says, "During the development of Hepburn Wind, we were contacted by many people wanting to set up a project in their own communities."

### The community response

The benefits can be many. Community energy projects provide local control over energy generation, and a large part of the community's



Photo: City of Port Phillip

↑ Artist's impression of the 'sawtooth roof' over the South Melbourne Market showing the planned 37kW of solar panels. Community group LIVE is proposing extending this to 600kW, funded by community shares.

'energy dollars' stay in the community, paid to local employees and suppliers, a community fund and profits to shareholders. For many, the satisfaction at being a part of creating a sustainable future is also an important factor.

Most commercial wind farms do support a local community fund, but Simon notes: "Hepburn is one of the smallest wind farms in the country but runs one of the largest community funds."

Not all in the community support these projects though. Hepburn Wind actually grew out of strong community objection to a proposed large commercial wind farm in Hepburn shire. Out of frustration, a small group from Daylesford started talking about their own local farm. Led by Danish-born

Per Bernard, with passion and tenacity they were able to turn the dynamic around to one of a community pitching in together.

There are still some in the community not happy about the project, but with 2000 members, mostly local, the community is overwhelmingly behind it. The response to a recent survey of members was positive with 84% saying they would be keen to invest in another such project.

### A solar majority

It's not all wind: in fact the majority of community projects underway are solar (about 45 out of the 60). Simon notes this is because solar projects are simpler and cheaper.

Developing a wind farm requires hundreds



of thousands of dollars to monitor the wind resource and commission the 10 or more detailed studies required to secure a planning permit. In contrast, a solar farm needs only a few simple reports and a basic planning permit. And, although the per unit cost of energy generated is much higher for solar, projects can be of a smaller scale than wind farms, and thus cheaper.

For example, at 4.1 MW, the \$13m Hepburn Wind project is considered tiny for a wind farm, whereas community group Yarra Climate Action Now is hoping to build a 100kW solar farm for less than \$300,000.

These community-scale solar projects stack up particularly well in an urban setting. There are many people renting or living in apartments without access to roof space for solar panels and, conversely, there are large buildings with available roofs.

The South Melbourne Market project in Melbourne is one example. The Port Phillip council is building a new 'saw tooth' roof over the markets, designed to provide an optimal surface for solar panels. Local community group LIVE has put forward a proposal to cover the entire roof with 600kW of panels (extending the 37kW the council has planned initially), to be funded by the community buying shares in the panels.

## Hydro in Warburton

In Warburton in Victoria, a project is starting up which combines a bit of history and community spirit.

Early last century, a number of micro-hydro systems powered the town's industry and streetlights. One of those, located on what is now the golf course, powered a timber mill by day and the streetlights by night, before then powering a guest home until the early 1940s when the town became connected to the grid.

In late 2009 a team of locals started investigating the potential of the creek to

→ From just two turbines, Hepburn Wind's energy is enough to power 2000 homes (more than the whole town of Daylesford).



Photo: Hepburn Wind

provide renewable energy and were amazed to find that the original turbine was still there—and that it could be refurbished.

Two and a half years later, they are well on their way to gaining the necessary approvals and permits. Calculations show a sustainable water diversion sufficient for around 90kW of power. The energy generated will be used on-site and sold to the grid. The local community bank has funded the expenses thus far, and expects to fully own the project, with profits distributed through the community.

The lessons learnt from all these projects—the need for broad community engagement, the technical and financial realities of grid-connection, the economic case for 'behind-the-meter' energy use (see box below), and more—have all made it easier for projects that follow.

We do need the big commercial or government-funded projects—the 10 MW solar farm coming to Geraldton in WA and the 420 MW Macarthur wind farm in Victoria—but it's interesting to note just how much the energy mix in Australia is changing due to grassroots initiatives. As recently widely reported, almost 10% of Australian houses now have solar panels, so the appetite for change is there.

Rather than waiting for the wheels of government policy and funding to turn, community-scale renewable energy projects are taking the lead and demonstrating just what can happen when groups of like-minded individuals work together. \*

More info: Embark, [www.embark.com.au](http://www.embark.com.au).

## 'Behind-the-meter' vs export

Is it viable to sell the energy from these community-scale projects into the energy market in Australia?

Currently, given the lack of certainty regarding grid connection costs and feed-in tariff rates for systems larger than household scale, community solar projects are generally only viable 'behind-the-meter'. In this model, the generated electricity is consumed on-site rather than being fed into the grid. This way, the value of the energy is based on the retail price (as high as 30c/kWh or more), rather than whatever price for feed-in a project may get from an electricity retailer (which is more likely to reflect the wholesale price of between 5-10c/kWh). For example, in the South Melbourne Market proposal, the stallholders would buy all their daytime electricity directly from the panels with only minor excess amounts exported to the grid.

Community wind farms, on the other hand, typically do not have large on-site

loads and need to export most of the electricity they generate. The two-turbine Hepburn wind farm generates more energy than the largest solar plant currently operating in Australia—around 10 GWh/year for Hepburn compared to the 1.2 MW University of Queensland solar plant, generating perhaps 2 GWh/year. Hepburn Wind's energy is enough to power 2000 homes (more than the town of Daylesford).

Lower equipment costs for wind relative to the amount of electricity generated makes export into the grid possible. For example, Hepburn Wind sells its electricity to the retailer 'Red Energy' who then on-sells to consumers in Victoria.

Hepburn Wind was able to negotiate this arrangement with Red Energy, a smaller retailer. Simon says, "One of the bigger players told us that our energy represented something like four hours of their annual needs and it would be hard to justify the costs of even writing the contract."



Photo: Luke Whiteside

↑ Team members in Warburton removing the 1930s-era turbine runner for refurbishing.

# Built for and by the community

## A wind farm in WA



The switch is about to be turned on for Australia's second community wind farm—ten years from when the idea was first mooted. Project chair Craig Chappelle describes the long, but ultimately rewarding, process.

TOUCH wood, all the major hurdles (and there have been many!) are now behind us, and the remaining few months will be smooth sailing—notwithstanding the occasional minor emergency which is bound to crop up in a project of this complexity. The turbine foundations are scheduled to be excavated as *ReNew* goes to print, ahead of the turbines arriving in early December. The wind farm should be operational by late December, and commissioned a few weeks later.

Since we began in 2003 there have been three federal elections, four federal environment ministers and two state elections, so it's little wonder that some of our approvals have taken longer than expected. The biggest single holdup was waiting for confirmation of our federal grant—that took two years, almost to the day, and was undoubtedly our lowest point: we were hog-tied, unable to move; people were starting to lose touch, and energy was starting to drain away. It was only the vision that kept us going, and a determination to see our community achieve what it wanted.

In the same period the makeup of our local council changed five times—with about as many changes of attitude towards the wind farm. The twists and turns that have occurred dealing with that would make a book!

Most of the founding people are still directly involved and we have also been fortunate to have skilled people appear on the scene at critical times. Denmark is a diverse community, with a wide range of skills and interests, and it's uncanny how often, just when you're ready to throw in the towel, someone will turn up and say, "I'm a retired engineer/project manager/accountant/PR guru, do you need any help?"



Photo: Denmark Community Wind Ltd

↑ Aerial view of the coastline near Denmark, WA, showing the position of the soon-to-be-installed turbines.

**"Just when you're ready to throw in the towel, someone will turn up and say, 'I'm a retired engineer/project manager/accountant/PR guru, do you need any help?'"**

Our inspiration and quite a lot of knowledge came via a couple of visionary individuals who saw an energy future which could be sustainably realised only by growing the renewable energy industry to supplement—and eventually replace—the anachronistic, increasingly expensive and inherently inefficient centralised-generation model based on fossil fuels.

These two, who have qualifications in economics and engineering, did the groundwork without reference to similar

projects in Australia (there weren't any at the time) and concluded that a small, community-scale renewable energy project was doable here—in theory at least.

A wind farm was proposed because the district has a very high-energy coastline, because wind power is the most cost-competitive form of renewable energy generation, and because that's what our community said it wanted, at a series of well-attended public workshops way back at the beginning.

Hepburn community wind farm floated a year or two after us, and we had regular contact during its early days, swapping ideas and experiences. While there are many similarities between the two projects, we adopted a different organisational model—a



→ Construction begins: preparing the site for installation of the turbines in December 2012.



Photo: Peter Auer, Skyfarming

public company versus a cooperative—mainly due to state differences at the time in the way cooperatives could operate.

Like Hepburn we are using Enercon turbines because (a) they are superior machines, (b) they best suit our site conditions, and (c) there is a resident Enercon maintenance crew at Albany, 60km east of Denmark, which services the Albany wind farm and the more recent Mt Barker wind farm 55km to the north.

### Connecting to the grid

It was always intended to connect to the South West Interconnected System (SWIS), the connection and distribution infrastructure owned by the state (through Western Power). It made financial and operational sense to plug in to what's already there; equally, it made sense to sell our energy to Synergy, the state-owned SWIS retailer.

Given the small size of the project (1.6MW), economies of scale, and the complexity of the electricity market in WA it was clear that we would have our hands full just being a generator, never mind trying to be a distributor and retailer as well.

Consumers can buy 'our' energy by subscribing to Western Power's Green Power program. Otherwise, dividends paid to shareholders could be considered a kind of rebate on the power they consume. Beyond that there is no way to discriminate between 'green' and 'brown' electrons, although people living near the wind farm will probably get our power (when the wind's blowing) on its way to the main feeder.

### The financial equation

Funding has come from three primary sources:

the federal government's now-defunct Renewable Remote Power Generation Program (RRPGP); 116 private investors, the vast majority of whom are locals; and \$1.7m in bank and private loans, which together cover the total project cost of \$6.1m.

In dollar terms this is the biggest single project ever undertaken in Denmark.

It is financially viable—we knew it had to be. We know our upfront costs and we can predict our maintenance costs, conservatively of course. We also can predict our income based on estimates of energy generation and the fixed rate (increasing annually) that we are being paid for the energy via a power purchase agreement. Shareholders should get back better than bank interest over the life of the project; returns start low to cover the upfront costs but grow after just a few years.

The level of local support is best illustrated by the fact that we raised the bulk of the private investment funds (approximately \$800,000) in less than two months. Thus in December last year we were able to declare financial closure, allowing us to enter into contracts to purchase the turbines, sell our power, and undertake civil and electrical works.

### A bit of project history

The local community embraced the project concept from the beginning—had it been otherwise, and had that support not continued, we wouldn't be here today.

To get the ball rolling, we ran three public workshops over a period of some months, for people to get a handle on what renewable energy is, which forms were financially and technically feasible for Denmark, and how it could benefit them, directly and indirectly.

**"The level of local support is best illustrated by the fact that we raised the bulk of the private investment funds (about \$800,000) in less than 2 months."**

Once people had a clear idea of what they wanted we registered a not-for-profit group, Denmark Community Windfarm Inc, which soon had 100 plus members, and started putting out occasional newsletters, published updates in the local media, ran more seminars and workshops, gave talks to local groups, and generally kept people abreast of progress.

Despite some early sensationalist media, opposition actually comprised only a few individuals—but they were very noisy and for a while grabbed the headlines (and hoodwinked then federal environment minister Ian Campbell, who threatened to reject our funding application). Over time we were able to demonstrate that most of their objections were ill-founded, and mostly inaccurate.

In retrospect they probably did us more good than harm, in one sense (though it didn't feel like it at the time!) because their personal attacks and hyperbole created distrust and people eventually saw through them.

A timely survey in 2008 by the shire council, which at the time opposed the project, quantified community support—at 70% in favour.

### Built on volunteers

"Sweat equity" is a measure we adopted from day one to quantify voluntary input. Up to the time the project was transferred to the operating company, Denmark Community Windfarm Ltd, the original group contributed around 13,500 hours of voluntary time,



↑ L to R: DCW directors Paul Llewellyn, Murray Thornton and Craig Chappelle at the site of the road-making program.

which, at a nominal rate of \$15 an hour, represents around \$200,000 in sweat equity. That was recognised by the group receiving shares in the company, with the dividend payments from those shares to be ploughed back into community projects.

Volunteer burnout is a very real possibility in a complex and protracted community project, so it's really important to do succession planning and/or rotate tasks which don't require specialised knowledge or skills. And unless they flatly refuse, people should be rewarded in some way which recognises the level of their contribution; altruism is a wonderful concept, but a tangible reward almost never fails to reinforce most people's sense of worth.

### The need for professionals

We certainly needed to employ professionals, though: the energy industry is complex and full of traps for young players, and there are some things that even the most enthusiastic

layperson just cannot manage—like having 'street cred'. There we were, a group of amateur renewable energy enthusiasts wanting to play with the big boys—no street cred at all. The technical area alone is an arcane and mysterious place where only specialists dare to tread; likewise the intricacies of high-end finance, project management, grant administration, and some other areas of expertise are beyond the capabilities of most laypeople. Without professional input we would have crashed and burned long ago.

That is not to diminish in any way the absolute necessity of having committed, energetic volunteers to coordinate, enthuse, compile, join the dots, make cups of tea—to drive the vision and do the legwork.

The greatest challenges have been elapsed time and dealing with bureaucratic inertia; the biggest reward is that we succeeded, with the community behind us. That success is due primarily to the commitment of a core group

"The original group contributed around 13,500 hours of voluntary time, which, at a nominal rate of \$15 an hour, represents around \$200,000 in sweat equity."

of people over such an extended period.

It is only because of the then-federal government's support for renewable energy projects that we even got to first base: in 2003 we proposed the first community wind farm project in Australia, and that was something the bureaucracy didn't know how to deal with. So I guess you could count as another of our successes the fact that we've helped to put distributed generation/community-based energy production on the national agenda, and inspired others to have a go.

Another reward has been the Green Town project, in conjunction with Western Power, which grew out of this project (see [www.bit.ly/MqUyBL](http://www.bit.ly/MqUyBL)).

Probably the biggest lessons for others wanting to follow this path are to have patience, involve the community from day one, explain everything you're doing, be transparent, and employ professionals wherever you can—and in WA, avoid building a wind farm on public land! The Mt Barker wind farm, which also received RPPGP funding, went from whoa to go in only about three years, thanks largely to being on private land. \*

Craig Chappelle is one of the directors of Denmark Community Windfarm and has been involved in the project since the outset. More info: [www.dcw.org.au](http://www.dcw.org.au)

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# Commercial-scale renewables

## The value of solar



The value of medium-scale solar has been realised in this 290kW solar power station in Carnarvon, writes project engineer Toby Price.

MEDIUM- and large-scale solar projects face many challenges in Australia. Technically the design is relatively straightforward, using commercially available components. The difficulty lies in maintaining the momentum of the project while waiting on approval for grid connection and undertaking complex power purchase agreement negotiations.

EMC, a clean energy company based in Perth, has secured 12 sites around Western Australia for a rollout of 53MW of solar PV power stations. The first of these is a 290kW solar power station in Carnarvon, northwest of Perth. Completed in 2011, this solar plant is the first off-grid power station supported by a power purchase agreement with an electricity retailer, and the largest privately owned plant in WA. (Note that Carnarvon is classified as off-grid as it runs on a local grid rather than the main grid in WA.)

The project in Carnarvon is an interesting example of a financially viable market for solar power. Carnarvon is home to around 5300 people and has an excellent solar resource, averaging 211 sunny days per year, with an average solar exposure of 22MJ/m<sup>2</sup>/day. The local grid has a summer peak load of 11.56 MW, which represents 72% of the available generation capacity.

### The case for PV

Even prior to the EMC solar power station, Carnarvon had a high penetration of solar PV, with over 1MWp installed across a range of commercial and residential sites. Additional generating capacity is supplied by an ageing suite of diesel and gas-diesel hybrid generators. The high cost of diesel made an excellent case for solar, so in 2007 EMC made



↑ Like giant sails in an open field: 1160 panels are grouped on 7 tracking and 48 fixed frames.

the first enquiries into adding a solar power station to the town.

The high levels of existing distributed PV and the cautious nature of the local grid operator, Horizon Power, meant the project progressed slowly. For four years EMC and Horizon Power negotiated over the proposed input from the solar power station to the grid. Central to these negotiations was establishing a control mechanism to enable Horizon Power to manage this extra input into the town. Finally, in 2011, a power purchase agreement was signed and EMC was able to commence construction.

EMC's solar power station received funding from the Australian Government through the now-defunct Renewable Remote Power Generation Program. This funding enabled

the system to be run as a commercially viable 'build-own-operate' installation and to use state of the art technology for both generation and remote control of the station. The project was initially budgeted at \$2.4 million. However, falling panel prices and a hands-on attitude towards the project brought the project to completion \$500,000 under budget.

### Following the sun

The station itself is situated a stone's throw from the town, with 1160 panels facing the town from the south. The panels are 250W panels from Chinese company LDK, currently the largest cell manufacturer in the world. The station uses two different panel framing and mounting systems. The first, an in-house designed fixed frame, can be





↑ Installing the tracking frames.



↑ The EMC team and locals all pitched in for the installation.

manually positioned for pitch, on a seasonal basis. These fixed frames in total support 768 panels, for a total of 192kW, with groups of 48 panels across three frames each feeding into an SMA Tripower 12kW inverter.

The remaining 392 panels are supported on single-axis tracking frames sourced from innovative Spanish company Mecasolar. Each of these tracking frames supports 56 solar panels, with the frames tracking the sun from sunrise to sunset. Not reliant on battery power, these high efficiency trackers are driven by power from the grid, giving reliable tracking.

**"The power station was fully installed in just six weeks."**

The harsh conditions of Australia—heat, wind, soil and rain—all require careful consideration in installations of this scale. Located in a designated D2 cyclone region, the solar power station had to be designed to meet the 255km/h winds which can descend on the area during the cyclone season.

The trackers, effectively giant sails in an open field, needed to be re-engineered to cope with these extreme conditions. During normal operation, the trackers are controlled by a master tracker, fitted with a weather station that constantly monitors wind speed and direction. High winds set off an alarm which propagates from master to the other trackers and causes them to all align and present their side profiles to the wind. During cyclones, the trackers are set down in the horizontal position to minimise their exposure to the wind.

### Remote control from Perth

The successful operation of the plant relies

on an advanced Supervisory Control and Data Acquisition (SCADA) system. This provides Horizon Power with the ability to monitor and control the plant and site from their Perth and Bentley offices. The control system enables remote adjustment of the total output (active power and power factor) of the farm, with adjustments applied almost instantaneously to all 23 inverters in the field. Remote control extends to a remote 'off' switch, to allow emergency dropout of the PV system.

The combination of this level of control, along with weather instrument analysis, allows Horizon Power to tailor the operation of the power station to best supplement the solar in the town—a crucial requirement for successful long-term operation of the farm. Horizon Power is also able to track the impact of this solar power station on their high-penetration grid, information that will provide valuable lessons when designing systems for other sites.

In many ways, the construction process was the simplest part of the project. The power station was fully installed in just six weeks, with many of the EMC office team from Perth making the long drive north to install panels and bolt together frames. This hands-on attitude extended to the town community, with input from many of the town's residents and solar fanatics! The completed solar farm now neighbours Carnarvon and is a highly visible statement of the value of solar to the town.

EMC sees the Carnarvon PV power station as the first of a rollout of 53MW of solar PV across 12 sites. These sites have been secured and were chosen close to substations with high-voltage links to the grid. The next project

**"Remote control extends to a remote 'off' switch, to allow emergency dropout of the PV system."**

is a 2MW installation at Moora, for which EMC is currently awaiting connection approval from Western Power.

### Other solar ways

Connection applications are a barrier to medium-scale systems connecting to the mains grid. The current regulations treat systems above 30kW in the same bracket as gas-fired power stations. The approval process is designed for much larger installations and brings significant financial and time costs.

To avoid these issues, EMC also installs commercial 30kW PV systems for contestable electricity customers (those using over 50,000kWh annually) and sells them the electricity generated: all electricity generated is consumed on-site, thus reducing the amount of grid-supplied electricity the customer requires. The customer avoids any up front capital costs as the system is owned and operated by EMC, and sees a reduction in their bills as EMC's power tariff is lower.

EMC continues to search for these openings in the market, as panel prices continue to fall and energy prices rise. This is truly an exciting time to be in the clean energy industry. ✨

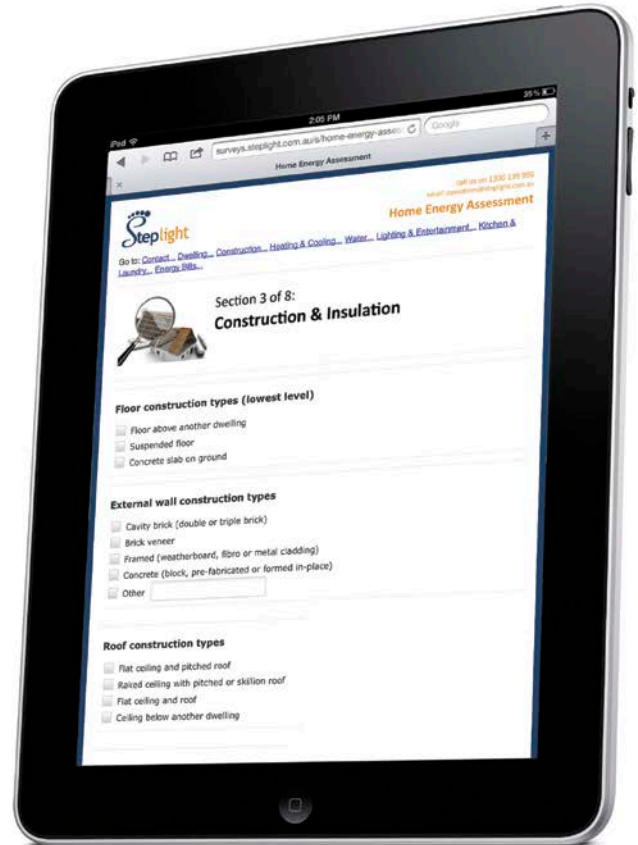
Dr Toby Price is a project engineer at EMC with a background in post-doctoral research in the area of hydrogen storage. His focus at EMC is developing heat storage solutions for concentrating solar thermal projects. More info: [energymadeclean.com](http://energymadeclean.com)

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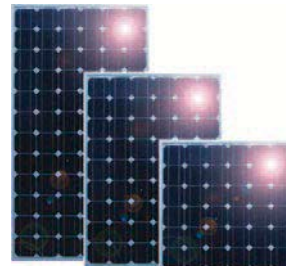
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# EVs are coming—slowly!

## Where the EV industry is headed



We've looked at electric vehicles a number of times in recent years, but progress towards getting them on the road has been slow, at least in Australia. Lance Turner looks at what we can expect to see on our roads in the near future.

IT seems the car industry has been promising electric vehicles for quite a while now, but in Australia very little is happening. We have seen the Nissan Leaf and Mitsubishi iMiEV enter the Australian market a little while ago, but uptake has been slow.

This is mainly due to the high price tags on what are effectively small cars. \$50,000 plus is likely to be more than most people will want to pay for a small limited-range vehicle, especially when you look at what's on offer in other countries.

Other potential causes of a slower than wished for uptake are the perceived issues of limited range, lack of charging infrastructure and lack of incentives to switch to electric vehicles. The rapidly escalating price of electricity in many parts of Australia is also reducing one of the potential advantages of owning an EV—reduced running costs.

However, it should be noted that other advanced technologies were also slow to get started. Hybrid vehicles were initially very slow to interest the consumer, and in fact, at the same point of their introduction, they were far less popular than EVs already are. Yet the Toyota Prius is now one of the biggest selling cars in the world. Toyota has also extended the Prius range and the hybrid drive system is appearing in other models. But, hybrids are still fossil fuel powered cars.

This is where Toyota's plans get interesting. They are not only going to offer plug-in hybrid versions of the Prius, but are also planning to release pure EVs in the near future. Interestingly, one of those is a rehash of their first original EV from the 90s—the Rav4. Given Toyota's global distribution network, it's only a matter of time before the Rav4



↑ Called a long-range electric vehicle (LREV), the Volt combines a liquid-cooled 288 cell 16.5kWh lithium ion battery pack (pictured at right) and 111kW/370 Nm electric motor to provide up to 87km battery range. If you need to go further before recharging, a 1.4 litre petrol engine generator kicks in to provide electricity to the electric motor and to recharge the battery, giving unlimited range. The Volt allows you to use it as either a pure EV or as a hybrid when needed. The standard charging system can use any regular power point and can charge the car in under 10 hours while the fast charge system can charge the car in under four hours.



arrives on our shores. How it will be priced is another matter entirely.

### Pricing

While on the subject of pricing, we have noticed that electric cars sold here are far more expensive than the same model sold in other countries.

For instance, the Holden Volt will be priced starting at \$59,990 here, but starts from US\$39,145 in the USA. We're not sure how Holden can justify adding \$20,000 to the price. The same thing applies to the Nissan Leaf.

In the USA the Leaf starts at US\$27,700, whereas here the cheapest version of the Leaf will set you back \$51,500—that's almost twice the US price.

The Mitsubishi iMiEV also suffers from a price increase. The base price for the iMiEV is \$48,800 for what is essentially a micro car. Admittedly it has a rated range of up to 150km from its 16kWh battery pack, but at 1110kg empty and with a 49kW motor, it is not likely to have performance to match the price tag.

So what is going on here? Are Australian buyers being charged a premium by car



→ The Ford C-MAX Energi is another plug-in hybrid to be launched in the USA this year. While specifications are a bit thin on the ground, it's clear that the C-MAX is targeted as a direct competitor to the Toyota Prius plug-in hybrid. The electric drive system features a 7.5 kWh battery pack driving a 68 kW peak synchronous AC motor. Starting at US\$25,200, it's cheaper than a Prius and has a larger battery pack.

The C-MAX is not Ford's only electric offering. Indeed, they currently sell a fully electric version of the Focus and the Transit Connect light commercial, with a plug-in hybrid version of the Fusion to go on sale early next year. As of writing, there are no Ford electric vehicles available for sale in Australia, although we expect the Focus EV will be the first.



manufacturers for what is perceived as a new green technology, when in fact the vehicles have been sold in other countries for several years? This is not without precedent. Indeed, if you look at the pricing of most cutting edge technology in Australia it is considerably higher than buying the same device from elsewhere. But, of course, you can't just hop online and buy an EV from the USA or China—at least not yet!

But with a relatively small perceived market here in Australia, it is understandable that car makers are setting their prices higher initially to cover the costs of distributing the new technology, as well as training service personnel to work on EVs safely.

Really, it's a catch 22 situation. EV prices won't come down until sales increase considerably, convincing car manufacturers that there is a real market here, but sales are retarded by the high prices. While higher prices are partially offset by the lower running costs of EVs, it isn't enough to make it financially worthwhile purchasing an EV at current prices—especially with the improving fuel efficiency of internal combustion vehicles.

How electric vehicle suppliers will address this problem remains to be seen, but governments can step in and provide financial incentives to encourage new car buyers to consider EVs.

Incentives being used in other countries include reduced registration costs, tax rebates and partial offsetting of the upfront cost of the vehicle. Other, non-financial incentives include dedicated charging bays for EVs, so guaranteeing EV owners a park and charge while out and about, and the use of transit (priority) lanes on freeways, regardless of

the number of occupants. None of these incentives have been implemented to any great extent in Australia to date.

### Range anxiety

Range anxiety is perhaps one of the biggest disincentives for potential EV buyers—what do they do if the battery goes flat before they get home? This is a good question, and the answer is multi-faceted.

Firstly, most commercial EVs have very good battery meters that tell you what percentage of battery capacity remains and how far it is likely to take you before you run out. This alone should allow any sensible person to plan a trip without running flat.

Secondly, many EVs have a 'limp home' feature that will put the car into low power mode when the battery is almost exhausted. On the Nissan Leaf this is known, rather cutely, as Turtle Mode.

But another way in which some EVs solve this problem is rather novel—there's a spare internal combustion engine (ICE) that activates to charge the batteries and power

the car when the main battery pack goes flat.

The Holden Volt has this feature and is known as a long-range electric vehicle, or LREV. The car operates as a purely electric vehicle until you exceed its range and then operates as a type of high efficiency hybrid vehicle until either you stop and plug it in or the ICE has charged the battery pack.

For many people who are nervous about switching to a purely electric vehicle, cars such as the Volt and the plug-in versions of the Prius and Ford C-MAX (called the Energi) will be the ideal stepping stone—once they arrive on our shores, that is. And there are many more models to come. Mitsubishi has openly stated that it will be offering either an electric-only or plug-in hybrid version of every vehicle in its model range within four years. Expect most other manufacturers to follow suit.

Arguably the best solution to range anxiety is the ability to recharge quickly when you are out and about. This can be done in two ways—fast charging at dedicated fast charging stations, or battery swapping.

→ Toyota's Rav4 is returning as an electric vehicle in the near future. For those with the need for a larger vehicle for use around town, it should prove ideal.





↑ The Nissan Leaf features a 360 volt, 24kWh lithium ion battery feeding an 80kW/280Nm electric motor. For a small car, it weighs in at a hefty 1795 kg, although range is an optimistic 170km, according to Nissan.

The first method is available on some EVs, which have battery packs capable of being charged to 80% capacity in 30 minutes. Finding the closest charging point is becoming easier too, with various apps appearing for smart phones, as well as charging points being listed on satnav maps in the EVs themselves. However, fast charging points are still few and far between in Australia and the infrastructure needs to be put into place before drivers will be willing to switch to EVs en masse.

Fast charging requires a high-power grid connection. Commercial premises such as service stations already have suitable connections to allow at least two or three cars to charge simultaneously, so it's really only a matter of standardising a charging system and getting them installed. Hopefully, enterprising owners of shopping centres and service stations will see the writing on the wall and start installing fast charging bays sooner rather than later.

But even standard charging equipment can extend the range of EVs. Imaging being able to plug your EV in when you go to the shopping centre—you park, plug it in and wander around the shops for a few hours. By the time you get back, the battery is close to full, even at standard charging rates.

Charging units are becoming quite easy to source and install nowadays, with companies like Delta Energy Systems ([www.delta.com.tw](http://www.delta.com.tw)) providing standard and fast charging systems suitable for domestic and commercial installations. With the availability of such chargers, there's no reason why we shouldn't see en masse installation of charging infrastructure in the next few years.

While governments can lead in encouraging implementation of charging infrastructure via rebates and the like, one car company, Renault, has decided that uptake of its EVs was too slow in France so they plan to install about 1000 fast charging stations around the country (with a few in other countries as well), which EV owners can use to recharge their cars for free. That's pretty clever thinking on their part. BMW is also helping their EV owners. The US arm of the company has recently announced that it has partnered with Green Mountain Energy Company to offer drivers of the BMW ActiveE the choice to support renewable energy for their cars by purchasing RECs to offset their charging emissions.

### A really fast charge

The other method of increasing range is battery swapping. This sounds complex, but

one company, Better Place ([www.betterplace.com.au](http://www.betterplace.com.au)), has been working with car makers around the world to implement fast battery swapping systems to give EV owners virtually unlimited range.

It works like this: you drive your car into the battery swap station, the flat battery drops out the bottom of the car and a charged one is fitted in its place, all in a matter of minutes. It takes no longer than filling an ICE vehicle with fuel.

Better Place has already partnered with Renault to provide battery swapping and charging facilities in Denmark for the Renault Fluence ZE. Even here in Australia there are some public charging stations, such as the solar-powered unit in Brunswick, Victoria, as mentioned in *ReNew 120*.

Another big advantage with the battery swap system is that Better Place provides an option where they own the batteries, so when you buy an EV you are paying far less up front, as the battery pack is a large proportion of the total cost of an EV. All the car owner pays is a fixed monthly membership fee that covers the battery rental and energy use.

Ultimately, range anxiety for pure EVs will be solved by a combination of fast charging stations, battery swapping and much longer range batteries. There are many companies working on the last of these, and proposed technologies include lithium-air batteries, lithium batteries with nanotube electrodes to massively increase surface area and hence energy density, and many others. It's fair to say that many companies are now seeing that



↑ There are many small and micro sized EVs already on the market or in development. This little beast, the QBEAK, can be fitted with up to six 4.7kWh battery packs for a rated range of up to 300km.

→ Another tiny EV, the electric version of the Smart Fortwo will be available in the third quarter of this year in parts of Europe and the USA. A 16.5kWh lithium-ion battery will power a 30kW motor.





there will be a lot of money to be made in new battery technology in the next decade or so. Competition will ultimately see just a few technologies win out, but the real winners will be EV owners and those needing large storage batteries for renewable energy systems.

### Current battery technology

Batteries have been the biggest stumbling block for electric vehicles. You can use either relatively low cost but low capacity and heavy lead-acid batteries, or lighter, higher capacity but much more expensive units such as lithium batteries.

Commercial EV manufacturers have all but ruled out the use of lead chemistry batteries due to the above-mentioned limitations. This means they are virtually all using lithium batteries, mostly lithium iron phosphate (LiFePO<sub>4</sub>) chemistry, due to the high capacity, ruggedness and resistance to fire compared to other lithium batteries.

One manufacturer, Tesla, has taken a novel approach and made their battery packs not from a relatively small number of large cells, but rather using many thousands of smaller cells that were designed for use in power tools. The advantage of this approach is that the cells are readily available and have a proven track record of being used and abused. The disadvantages include greater complexity of pack design and the need for very well designed active cooling systems.

Regardless of cell type and design, lithium battery prices have dropped somewhat in the last few years, and with car manufacturers themselves going into the lithium battery business, prices can only keep falling.

### Big isn't beautiful

Making EVs more viable for the masses isn't just a matter of cramming more kWh into battery banks. Making cars that need less energy to push them around makes a lot of sense as far as not only reducing overall energy usage, but also materials usage and the overall environmental footprint of cars.

Sure, some people with large families will need larger vehicles like the Tesla Model S (arguably the most advanced, and sexiest, EV available), but for commuters who almost never have more than one person in their car, why would they want a hulking two-tonne vehicle to get them to and from work?

There will always be people who just have to have a giant SUV or Hummer for their daily

commute, but for most of us, using a smaller, lighter, more efficient car is more sensible and should be encouraged. In the last 20 years we have seen a huge proliferation of small and micro cars, and in some countries these are the norm rather than the exception. As cars transition to electric power, it makes even more sense to make them smaller and as light as possible, and many car makers have realised this. If you look at the current crop of already or soon-to-be available EVs, many of them are in the small car class, and some are absolutely tiny.

### Home grown EVs

So with all these imported vehicles arriving in the next year or two, are there any Australian made options available? Blade Electric Vehicles, which was converting Hyundai Getz cars into EVs, has ceased their conversions due to Azure Dynamics, the manufacturer of the Electron's drive system, filing for bankruptcy protection on 26 March 2012.

While it is not a commercially manufactured EV yet, EV Engineering—a collaborative venture between Air International, Bosch, Continental, Futuris, GE and electric car infrastructure provider Better Place—has converted seven Holden Commodores as proof-of-concept large Australian electric vehicles. The Commodores will be used as fleet vehicles during the testing phase.

### Conversions

The cheapest and arguably the most environmentally friendly EV is one that was previously an ICE vehicle. Converting an old vehicle is not for everyone, but there's a good range of components and services available from a number of Australian suppliers.

→ Cooperation between car manufacturers will speed the uptake of EVs by allowing all EVs to charge at any charging point. A great example of this is an agreement between Audi, BMW, Chrysler, Daimler, Ford, General Motors, Porsche and Volkswagen which supports a standardised charging system for use on electric vehicles in Europe and the USA called the 'DC Fast Charging with a Combined Charging System'. Each charging outlet has no less than four charging options: single and 3 phase AC, low power DC (for home charging) and ultra-fast DC charging at public charge stations. All of these options are combined into a single outlet. The International Society of Automotive Engineers has adopted the system as part of their soon to be released EV charging standard.

In some states there are even conversion services available, so if you can't do it yourself, you can have your favourite ICE car converted to something a lot cleaner.

### Ramping up

There's no doubt that the range of EVs available in Australia is set to jump dramatically within the next few years. With almost every car maker on the planet planning to or already adding EVs to their line-ups, it's inevitable that more EV choices will start appearing here.

Interestingly, it's some of the least likely players who are now looking at getting into EVs on a grand scale. For example, Ford has recently announced that it is repurposing its massive Advanced Engineering Center in Dearborn, Michigan, to focus on EV technology under the name Advanced Electrification Center.

According to Ford, the 26,500m<sup>2</sup> building already houses hundreds of engineers working on EV and hybrid research and development. Ford also recently employed 60 new engineers for its electrification team and plans to hire several dozen more this year. It seems that the big car makers are finally realising that the future of the vehicle is electric! \*

### Resources

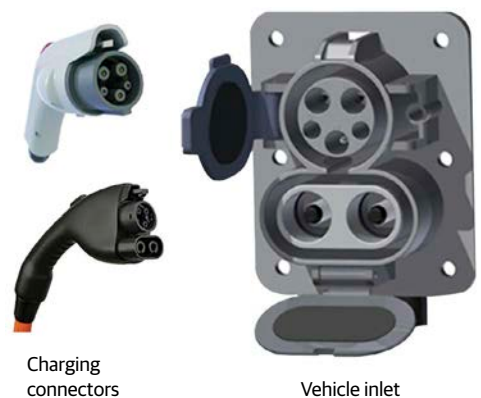
EV Engineering: [www.evengineering.com.au](http://www.evengineering.com.au)

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# Getting the lead out

## Alternatives to old battery technology



There have been lots of promises of new battery technologies in recent years, but just how close are we to replacing lead-acid batteries for renewable energy storage? Lance Turner looks at a few advances.

WITH many countries looking to increase the amount of renewable energy generation, it is generally recognised that a certain amount of high-capacity energy storage will eventually be needed to flatten out load and generation profiles.

To some degree, the coming proliferation of electric vehicles with bi-directional charging systems will provide much of this capacity, but EVs will not achieve a good penetration into the vehicle market until battery prices have fallen considerably.

As mentioned in the EV update article in this issue, leasing batteries instead of buying them can be one solution, but ultimately someone has to pay for the cost of those batteries. What we really need is a low cost battery technology with high energy and power densities, using abundant and environmentally friendly materials. But does such a thing exist?

Until now, large-scale storage has been the domain of lead-acid batteries due to their relatively low cost. But they have a low energy density (around 35 Wh/kg at best) and only medium energy density. This means they are not really suitable for electric vehicles, except for short-range vehicles, and the materials in them are quite toxic, despite being fully recyclable.

There have been a number of attempts to improve lead-acid battery capabilities, such as the CSIRO ultra-battery, but the key problem is that you are dealing with a very dense and therefore heavy material, so any energy density gains are going to be limited.

With the popularity of portable electronics there has been an explosion in lithium chemistry battery developments, with improvements in energy and power density



↑ Cut-away of the Nissan Leaf showing the lithium battery pack at the 2009 Tokyo Motor Show.

Photo: H. Kashioka

as well as safety. The lithium iron phosphate (LiFePO<sub>4</sub>) chemistry has shown the most promise, and most current commercial electric vehicles are now using these batteries due to their long cycle life, deep discharge capabilities and high resistance to fire, even when badly damaged.

However, while prices for these batteries have dropped in recent years as demand, and hence production levels have ramped up, a set of LiFePO<sub>4</sub> batteries suitable to run the average EV or off-grid renewable energy system is still a considerable upfront cost, even if the long term cost is lower than lead-acid due to higher reliability and longer lifespans.

Indeed, LiFePO<sub>4</sub> batteries cost around \$500 per kilowatt-hour here in Australia at current prices, not including the battery management system (BMS). This is around twice the price of lead-acid batteries.

While lithium batteries will take over as the

main storage chemistry in the near future, what other options are likely to appear, and are there likely to be technologies with higher energy densities and lower costs?

While electric vehicles need energy storage that is light, strong and preferably low cost, not all of the same criteria are necessarily required for stationary storage systems. The main requirements for such systems are reliability, long cycle life and low cost per unit energy stored, but battery weight is generally not an issue.

### What's on the horizon?

One battery chemistry that has been around for over 100 years is that based on iron—a cheap and plentiful material. Nickel-iron batteries are the most commonly known iron-based batteries, but they have several disadvantages including low charge efficiency and high self-discharge.



However, the University of Southern California has taken a different approach to iron-based batteries and has developed an iron-air battery chemistry that eliminates the key problem—low charge efficiency due to excessive electrolysis while charging. They found that adding a small amount of bismuth sulfide to the battery stopped the electrolysis and reduced the energy wasted from 50% down to just 4%. They also developed a new low-cost method of producing the battery plates. The researchers' goal is to produce a battery for just \$100 per kilowatt-hour of storage, with a target life of 5000 charge-discharge cycles. If they can attain these goals, iron-air batteries could be set to displace all other chemistries for stationary energy storage. ([www.bit.ly/RYLXbo](http://www.bit.ly/RYLXbo)).

While talking air batteries, there is a fair bit of work being done on lithium-air, or more accurately, lithium-oxygen batteries. The problem of oxidation of the battery electrolyte has been overcome by at least one research team, as reported in *Nature* ([www.bit.ly/RZdUhZ](http://www.bit.ly/RZdUhZ) and [www.bit.ly/NH4u83](http://www.bit.ly/NH4u83)). The researchers estimate that a commercially made battery using this technology would have an energy density around 10 times that of current lithium batteries. That would mean electric vehicles that could travel 1000km on a single charge!

However, this technology is in its infancy and it will be some years before lithium-air batteries become available, but they have the potential to solve the last perceived problem of electric vehicles—range anxiety. See [en.wikipedia.org/wiki/Lithium-air\\_battery](http://en.wikipedia.org/wiki/Lithium-air_battery) for more information.

### Salty batteries

Sodium is a material that has been used for batteries in the past but hasn't achieved large-scale implementation. The main chemistry, sodium-sulphur, requires a sealed battery that runs at a continuous temperature of 300 to 350°C, making them suitable only for large-scale industrial and grid-levelling applications.

Researchers at Murdoch University have taken another look at sodium-based batteries and have developed a battery chemistry that works at room temperatures. They developed a battery that uses manganese dioxide as the cathode grid material and a novel olivine sodium phosphate as the anode material. These materials have larger 'holes' than those

used in lithium batteries, allowing sodium ions to pass through them. The end result is a relatively low cost battery with a high energy density. The researchers state that they have now reached the stage where they're ready to move beyond the lab towards larger-scale commercialisation.

Whether we will see these batteries manufactured in Australia remains to be seen, but with large-scale manufacturing, this sodium-based chemistry is another contender for stationary energy storage at both domestic and on-grid scales. ([www.bit.ly/PmBAvB](http://www.bit.ly/PmBAvB)).

### The immediate future

But what about current lithium battery technology? Surely it can be improved, or have we reached the limits of this chemistry? The answer is that there are many companies working to squeeze a lot more energy into (and out of) lithium batteries. The main method of doing this is by modifying electrode materials to provide a greater surface area for the active lithium material, hence increasing energy density, and often power density as well.

As you might expect, nano-materials are playing a key role in these advances. From silicon and tin nano-wires and whiskers, through to fibres derived from natural sources such as wood, there are many researchers working on increasing lithium battery energy storage without increasing the amount of lithium the batteries require, thus increasing energy density while keeping costs relatively constant. This means that price per kilowatt-hour stored decreases.

However, most of these advances are in early or intermediate stages of development. Most, but not all: Envia Systems ([www.enviasystems.com](http://www.enviasystems.com)) has recently demonstrated prototype 45 Ah cells with energy densities of 400 Wh/kg—around twice that of current lithium batteries.

They have achieved this capacity using



a number of advances. Their cathode is a proprietary design, described as "high capacity, manganese rich, with a unique crystal structure", and their anode is a silicon-carbon matrix. They have improved the electrolyte so that it is stable at cell voltages up to 5.2V, making the cells more resistant to overcharging.

The end result of all this is a battery with double the energy density of regular lithium units and a rated cycle life of over 1000 cycles at a 100% depth of discharge. Projected cost for production cells is \$150 per kilowatt-hour.

### What about right now?

If you are looking for a high capacity battery for renewable energy storage or electric vehicle use, you really only have three options.

For electric vehicle use you should invest in lithium iron phosphate batteries as they provide the greatest storage density in a relatively safe battery. With their long cycle life and high depth-of-discharge capabilities, they are cheaper per kilometre travelled than lead-acid and, of course, give you greater range and a lighter EV.

For renewable energy storage, you can stick with the tried and trusted lead-acid or pay more up front for nickel-iron cells, which are still available. Either option will work, but their charge efficiency is lower than lithium batteries, while requiring more maintenance.

Again, lithium iron phosphate batteries are probably the best option if you can afford the initial expense. Given the longer lifespan and less maintenance, they should be considered for all new systems.

As for where the future of batteries is headed, only time will tell. But with the proliferation of electric vehicles and a trend towards off-grid or battery-backed renewable energy systems, expect to see a number of new battery technologies being fast-tracked within the next decade. The choice in battery options is only going to get better! \*



↑ On the left is a regular lithium ion cell after a nail penetration test. Obviously, it didn't cope well. On the right is a similar cell using the Envia electrodes. No potentially catastrophic fire occurred this time.

# Solar tech

## New pieces in the energy puzzle



What should I look for? How do solar panels work? Stephen Tansing looks at solar technology, current and future.

FIRST let's look at the broad solar picture, and then zoom in on households. In 2011, human activity worldwide consumed approximately 515 exajoules of energy, excluding dietary needs<sup>[1]</sup>. This is equivalent to the energy in 23 billion tonnes of chocolate! Australia receives at least 60 exajoules of solar energy in a single day—on the darkest day of winter<sup>[2]</sup>. With so much potential, particularly through the rest of the year, could the sun become a more substantial source of energy for us? I believe we can do much more with solar energy.

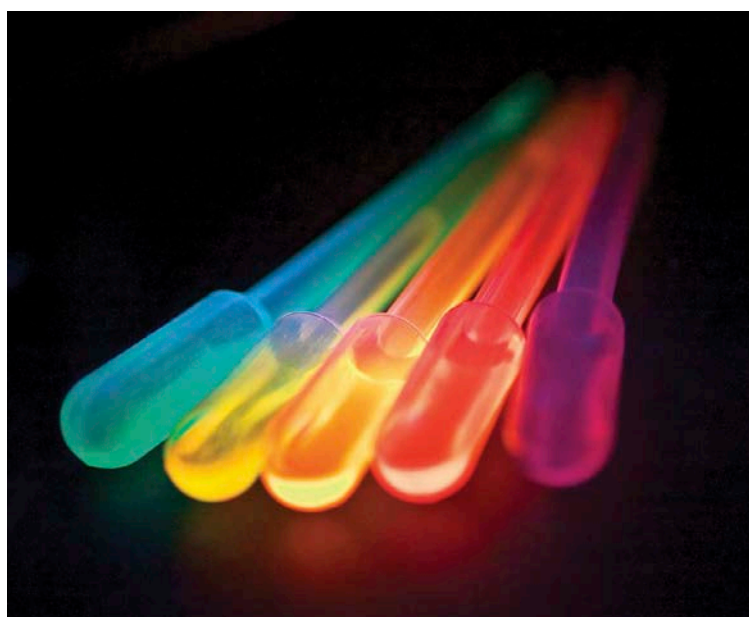
In this article, I by no means wish to over-emphasise the role of solar photovoltaic (PV) technology as the only solar technology. My intention is to inspire you to make a reasonable investment in solar PV as a worthy part of your future energy mix. Other ways to invest in solar include supporting Alinta Energy with their community-scale solar thermal power station proposed for Port Augusta, South Australia, or investing in a solar hot water system. A healthy mix of renewables could help stabilise the price of energy.

But read on and I'll tell you more about the humble electric solar panel.

Solar energy has been used throughout history. In 776 BC, a solar parabolic mirror was used to ignite the first Olympic flame in Ancient Greece. The first solar PV cell was made in 1839 by Edmond Becquerel. The first silicon solar PV cell was made in 1953 by Chapin, Fuller and Pearson of Bell Laboratories. It was 4% efficient. Today, regular silicon solar PV cells are about 13% to 16% efficient.

For those of you who are interested in the technical aspects of how a solar cell works, here is my take on it. Let's start with what sunlight actually is—a complex spectrum of

→ Test tubes with quantum dots of different sizes under UV light at Argonne National Labs.



electromagnetic energy. As an example, the three different cone cells in our eyes are most sensitive to blue, green and yellow-green. Solar cells are sensitive substances tuned to a specific colour to 'see' energy.

There are four solar cell technologies to discuss. Two are used now and two are in the innovation pipeline. The sensitive substance that responds to sunlight is silicon, with two types used to create a solar cell. The first type is silicon mixed with either phosphorous or arsenic, which acts like a negative terminal on a battery. The other type is silicon mixed with boron, aluminium or gallium, which acts like a positive terminal on a battery. Joined together they form a galvanic, but isolated, battery cell. When (and only when) sunlight hits the junction between the two terminals, electricity

is generated (see Figure 1), but not stored.

### Current technologies

This explains the workings of the most common solar cell sold today:

**Current technology 1:** Crystalline silicon solar cell technology. Variants of this technology attempt to reduce manufacturing costs by using many small silicon crystals (polycrystalline), which are cheaper to make than one big silicon crystal (monocrystalline) but yield a slightly lower performance.

**Current technology 2:** Multi-junction solar cell technology. In this more advanced solar cell technology, the basic structure of the solar cell is identical to crystalline solar cell technology, but it takes advantage of more colours on the spectrum to generate more electricity at



the one time. The cell contains several layers made of different sensitive substances, with each layer of this solar cell 'sandwich' reactive to a different spectrum colour. Top quality multi-junction solar cells, called concentrated solar photovoltaic cells, are fitted with lenses that concentrate a large amount of sunlight into a smaller area. All types of these cells are more expensive as the materials are rarer, but the buyer effectively gets more solar cells per square metre. This is useful for homes with less roof space, e.g. in cities, and for use on satellites, where this technology provides maximum energy for minimum weight and so the premium price can be justified.

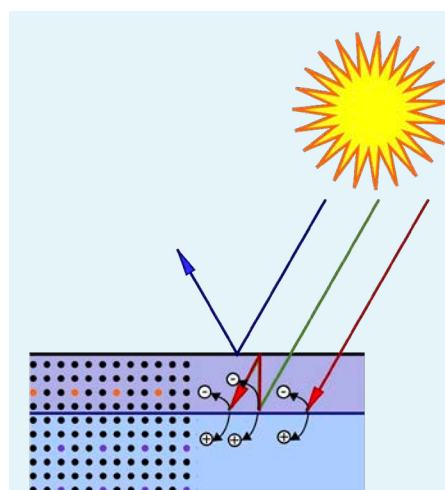
Somewhat cheaper models of multi-junction solar cells can be fabricated using thin films of amorphous (randomly structured) silicon, which is sensitive to different spectrum colours than crystalline silicon. Amorphous and crystalline silicon can be integrated to deliver a multi-junction solar cell which is more efficient than a cell using either silicon type alone.

## Emerging technologies

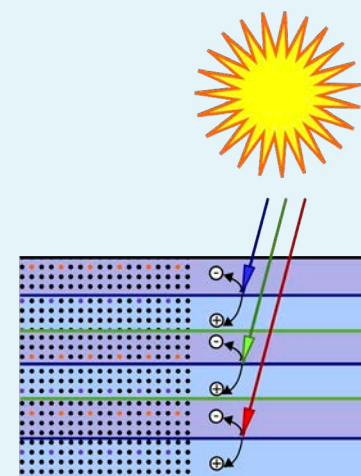
We have looked at two current technologies. Now let's look at two emerging solar cell technologies. Neither of these technologies is in mass production yet.

**Emerging technology 1:** Quantum dot solar cell technology. This is an emerging technology being studied at the University of New South Wales, Melbourne University and Australian National University. These solar cells are made using layers of differently sized tiny silicon dots, where the dot size corresponds to a set of colours that it is sensitive to. They provide the potential of delivering higher efficiency than existing multi-junction solar cells using the same materials (silicon) as crystalline silicon solar cells. Future success is reliant on honing production methods to provide an affordable product per unit.

**Emerging technology 2:** Dye-sensitised solar cell technology. This is an emerging technology being studied in many locations worldwide.



↑ Figure 1: A crystalline silicon solar cell 'sees' only infrared, although some visible colours are indirectly received.



↑ Figure 2: Multi-junction solar cell with three junctions sensitive to red, green and blue light respectively.

Organic dyes mixed with a photocatalyst such as titanium dioxide are applied to a surface with a conductive layer such as oxides of tin. They are up to 12.3% efficient, and therefore require a larger area than crystalline silicon solar cells to produce the same energy. At the moment this kind of solar cell deteriorates and requires maintenance, but is relatively cheap up front compared with conventional solar cells.

I have concerns about the practicality of commercial dyes that use particularly rare substances, but emerging quantum-dot based dyes are an alternative that may make high performance dye-sensitised solar cells cheap. Putting these concerns aside, dye-sensitised solar cells can be made at home for fun/education/DIY using white sand with leaves or fruit juices<sup>[5]</sup>.

While research continues into various other solar PV technologies, many are constrained by their need for substances rarer than silver.

Stephen is an asset management specialist with Honeywell Process Solutions, providing predictive maintenance for renewable energy generators. He participates in not-for-profit Beyond Zero Emissions and is passionate about these issues.

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## What does this mean for consumers? A comment from the ATA

From a financial perspective, investing in solar technologies is all about the cost effectiveness of the technology over time—i.e. over the life of the asset. The question is: will more efficient panels, despite their higher upfront cost, pay for themselves sooner due to their increased electricity output?

This type of analysis will differ in different circumstances, and is based on factors including location and solar insolation levels, final installed costs, current tariff pricing and structure, and future electricity price rise scenarios. \*

Technology	Price trends		Typical module efficiency
Monocrystalline silicon	\$149-\$398 per m <sup>2</sup>	\$1.00-3.26/W	14.1%-15.6%
Polycrystalline silicon	\$229-\$301 per m <sup>2</sup>	\$1.59-2.11/W	13.9%-14.4%
Silicon multi-junction	About \$700 per m <sup>2</sup>	\$3.70-3.80/W	18.6%
CPV multi-junction with dual-axis tracking	\$500-\$615 per m <sup>2</sup>	\$2.00-2.05/W	25%-30% [37% <sup>[3]</sup> to 43.5% <sup>[4]</sup> per cell]

Table 1: Cost performance comparison of PV technologies.

"Will more efficient panels, despite their higher upfront cost, pay for themselves sooner due to their increased electricity output?"

# Meter smarts

## Track your energy use online



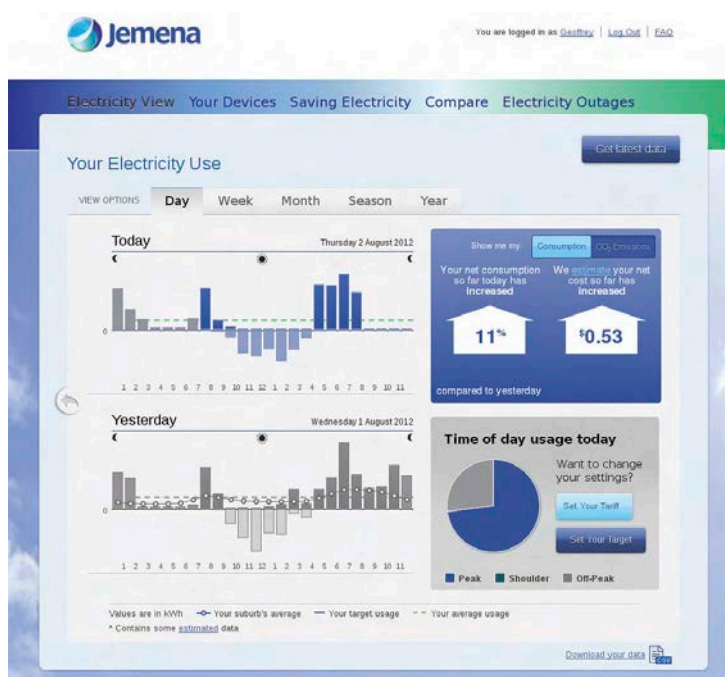
With Jemena's new online portal, you can even monitor your energy use when you're not home. Energy efficiency consultant Richard Keech puts the portal to the test.

AROUND Australia, and especially in Victoria, the deployment of smart meters and related devices is set to fundamentally change the way households track and manage their electricity use. Richard Keech tried out one distributor's smart meter web portal and gives us some insights about what he found.

Unless you've been hiding under a rock, you'll know that there's a push, around the country, to install so-called smart meters. You may already have one. There's been much reported in the media. There has also been some hysteria about time-of-use tariffs and alleged negative health effects of smart meters. I'm not going to look at the cost, health or policy dimensions of smart meters except to say that once they're fully deployed and working, I think we'll wonder what all the fuss was about.

This article takes a look at the smart meter web portal that has recently been deployed by Jemena Electricity Networks in Victoria. Smart meters were looked at in *ReNew* issues 111, 112 and 119. To start off, here's a recap of the basics.

→ The portal provides useful data for tracking energy use by time of day, day of week and month, and compared to previous periods.



### Why smart meters?

Your traditional electricity meter keeps track of energy imported from the grid to the house (minus any exports if you have solar), and needs to be read manually at the end of every billing period. And that's all it does. Applying communications and information technology to metering in smart meters can give rise to other useful things which potentially benefit both the energy company and the consumer:

**Interval metering.** Traditionally, at the end of the billing period, we know the total amount of energy used but we know nothing about the pattern of use during that period. Smart meters are interval meters which keep

track of energy use over time, usually with a sampling interval of 30 minutes. Interval metering also makes time-of-use tariffs possible (for better or worse) without needing a separate off-peak circuit and meter.

**Remote meter reading.** By transmitting meter readings back to the energy company over a communications network, the need for manual meter reading is removed. It becomes almost as easy to collect the data hundreds of times per billing period as it does for a one-time reading. This gives rise to the possibility of presenting the interval data to consumers to help them understand, track and manage their usage. The wireless technology for remote meter reading is called Advanced Metering

Infrastructure (AMI). Smart meters talk back to the energy company's AMI network using a built-in wireless modem. In my case, half-hourly data is communicated to my distributor (Jemena) via the AMI every four hours, starting at midnight daily. Other distribution businesses may vary on their timing.

**Home-area network.** Smart meters can talk to devices in the home via a wireless network technology called Zigbee. The most important type of device is called an in-home display (IHD) which can show real-time power and energy usage and tariff information. We will take a closer look at IHDs in the near future. Another important device type is the demand-response enabling device (DRED)



which provides the means to automatically turn off or cycle specific equipment if the power network is at risk of overload.

## Guinea pig time

Some energy companies (both distributors and retailers) have decided to offer their users web-based access to their interval meter data. My own experience here arose from responding to an ATA notice to members in Victoria. The distribution business Jemena was looking for guinea pigs in a trial of their new web portal. Since I'd had a smart meter installed in May, I was curious to find out what this web portal could do, so I signed up for the trial.

I registered on the Jemena portal (called Electricity Outlook) by giving my details and my meter identification number. After my electricity retailer gave their blessing (a delay of a couple of days), my web access was activated.

**Choose your screen.** Access to the Jemena portal requires a web browser on your internet device of choice—PC (Windows, Mac or Linux), tablet (iPad or Android), or smart phone. In my case I've tried it on Mac, Linux, Android tablet, Android phone and iPad. The mobile version of the portal is adapted to the smaller displays, but the experience is essentially the same.

**Electricity View.** The main mode of access, called 'Electricity View', lets me see my electricity use depicted as bar graphs by day, week, month, season and year (see figures opposite). The initial view shows data up to and including yesterday. However, the screens have a 'Get Latest Data' button which causes my most recent meter data to be fetched from Jemena and displayed. Since the data is uploaded from the meter to Jemena every four hours, you can see data which can be as stale as four hours or only a few minutes old, depending on when you hit the button.

**Clever graphs.** The graphs let me mouse over a bar to have it display the corresponding energy use in that period along with the estimated cost (assuming you have entered the tariffs). The graphs also show a line corresponding to the average value for your suburb. This gives me a basis for comparing my own use against other consumers in my area. The third feature on each graph is a horizontal dotted line representing my own average use.

**Solar generation.** When my solar panels export energy to the grid, this is represented 'below the line', i.e. as subtracting contributions to the net energy equation. Of

course, with import/export metering, this is exported energy only, and not the full amount of generation, so it doesn't coincide with what my inverter tells me.

**Tariffs.** The portal lets me enter my own tariffs, which allows the cost to be properly estimated. Time-based tariff schedules can be entered, as well as solar feed-in tariffs. One frustration here is that smart meters and the AMI could easily provide tariff information automatically from the retailer. Indeed the protocols and smart meter software have support for holding tariff information. This capability is going unused in Victoria.

**Fetching the data.** Energy geeks like me are always going to want to do more with the data than the portal can offer. So the designers have provided the means to download the raw interval data to be analysed as you see fit. I have been able to fetch this 'CSV' data and import it into a spreadsheet without a problem.

This overcomes a couple of limitations with the portal, namely:

- **sample period.** The portal shows, at its most fine-grained, data points every hour. However the smart meter interval data is at 30-minute resolution. Downloading the CSV data gives me access to the real 30-minute data.
- **graphical precision.** For all their cleverness, the portal's graphs make it hard to read off a numerical value because of the lack of a careful scale and grid lines. Plotting the CSV data on a spreadsheet lets me represent the data as I see fit.

## Insights from the data

After about three months using the portal it has been able to tell me some interesting things about my usage. First, it's been able to show me how much power I've been using overnight. This helps establish a baseline minimum continuous power, which in my case seems to be about 100 W, coming from the fridge and a couple of other essential items on standby.

The second insight is the ability to notice when an unexpected level of usage occurs. For example, I was showing some people at work the portal during the day. I noticed that the use was much higher than expected, and was able to infer that one of my split-system heater units had been left running when I left the house. Although unable to remotely switch off the device, it made me more conscious of the need to turn devices off.

"It's been able to show me how much power I've been using overnight. This helps establish a baseline minimum continuous power."

**The limits of peer comparison.** The portal's ability to compare my energy use with my neighbours seems less useful than at first glance, because different houses have a different mix of electricity and gas. In my case, being no longer a gas consumer, I compare poorly since, on average, my neighbours are getting a significant part of their energy from gas. In an ideal world the portal would integrate electricity and gas usage, allowing a fair comparison of energy use. In the absence of that, maybe there should be some scaling based on consumers nominating what they use their energy for.

**The test of time.** Another benefit of this system will really only become apparent after a couple of years of use: the ability to compare usage across years and perhaps correlate it with energy efficiency measures taken during that time. I can well imagine that this will assist people to properly quantify benefits from efficiency measures taken, especially if one uses electricity for all home energy.

Numerous studies have found that consumers armed with near-real-time feedback of their consumption can then reduce their usage by 10% to 15%. Having now tried it, I can well believe that these estimates are reasonable.

## What the future holds

As part of this exercise of getting to understand smart meters and web portals, I have been able to see how else smart meter technology might have an impact in the near future. Likely things in the offing are subsidised in-home displays, mandatory time-of-use tariffs, and even demand-response systems. These things build on smart meter technology. Look out for more on these coming up in future editions of *ReNew*.

Smart meters are here to stay. Courtesy of my own smart meter, I've been able to better understand and manage my own electricity use through access to the Jemena portal. After all, knowledge is power. ★

Richard Keech has over 25 years engineering experience in the military and in commercial IT. In 2010, he quit his job to study and last year graduated from Melbourne University with a Master of Environment. Today Richard works as an energy efficiency consultant and writer.

# LED to OLED

## Lighting the way forward



LEDs have made lighting much more efficient, but the revolution continues.

John Knox rounds up the latest lighting developments.

IN times gone by, lighting was a luxury, affordable only by the rich. Originally very much a product of combustion, be it from a bundle of sticks tied together to make a blazing torch, a candle, or a gas or oil lamp, the introduction of the electric lamp revolutionised lighting and heralded a new age for mankind. Nowadays, we in the western world take lighting very much for granted, although it is still a luxury in the developing world.

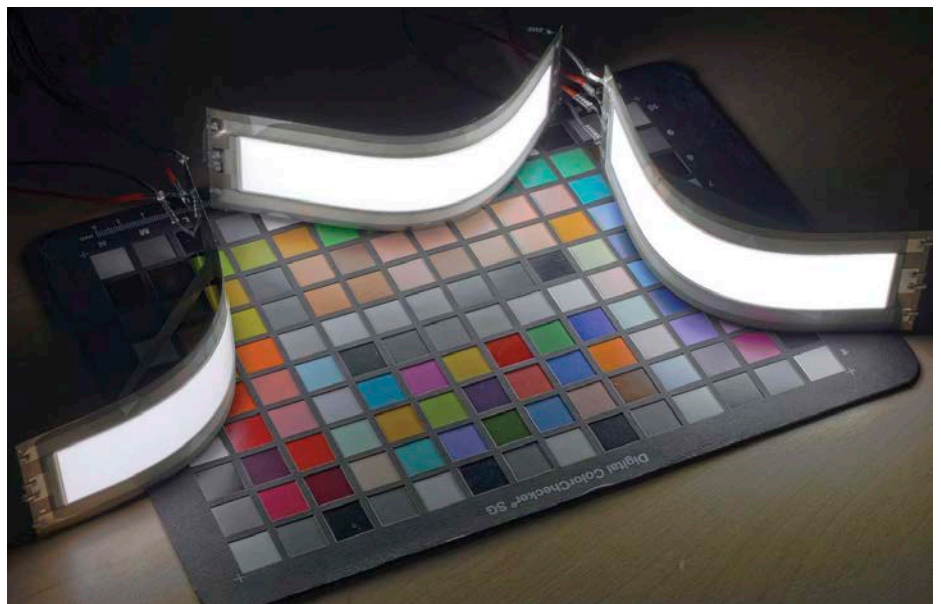
According to reports, lighting accounts for between 20% and 50% of all electricity consumed (source: [bit.ly/P7DvUB](http://bit.ly/P7DvUB)). If we were to improve the efficiency of our lighting, then it stands to reason we would be able to reduce our electricity use considerably. This can be done in a number of ways:

- We can use more efficient fixtures and lighting technologies.
- We can use lighting control systems to ensure we only use lights when necessary.

### More efficient (and smarter) bulbs

When compared with a typical incandescent bulb at about 2.2% efficient, using the best LED bulb, currently at more than 23% efficient, has the potential to save an enormous amount of energy, right now. Of course, the current LED efficiency is nowhere near the potential that this technology has to offer—at a theoretical maximum efficiency of almost 44%, 20 times more efficient than your typical incandescent lamp.

LED light bulbs are also set to revolutionise the way we do lighting, as can be seen by the new Insteon LED Bulb ([bit.ly/LinsUS](http://bit.ly/LinsUS)), which is a networked, remotely controlled, dimmable LED light bulb. It can even be controlled from



↑ These OLEDs from Osram, measuring 30 x 110mm, have set a new efficiency record of 32 lumens per watt.

a smart phone! Be aware, however, that not all LED bulbs are dimmable, though this is set to change as the technology matures.

### Lighting control systems

Of course, if you leave your efficient LED lights on all the time you will still be wasting energy and money, so there is also a push to make intelligent lighting control systems ubiquitous in the commercial environment and more available to domestic users. These systems will detect the presence or absence of people and turn on or off the lights appropriately.

Enlighted, a new smart lighting control technology startup, has saved its first corporate customers (the likes of Google, Turner Broadcasting, LinkedIn,

Interface Global, and 31 other Fortune 100 companies) 60% of their previous lighting electricity usage ([bit.ly/wETvWA](http://bit.ly/wETvWA)). Using an autonomous, adaptive sensor which measures ambient light, occupancy and temperature at each fixture and tailors light levels to each user's actual needs, these systems can minimise energy use while maximising user comfort. Gone will be the empty office block lit up like a Christmas tree, together with its unnecessary energy use and greenhouse gas emissions (not to mention the electricity bills).

### OLEDs are coming

A number of manufacturers are working on another technology that has the potential to change our relationship with lighting—the



Organic LED (OLED) display. An OLED is made by placing a series of organic thin films between two conductors. Initially intended for mobile phone, computer and TV displays, examples of OLED displays can be seen in Samsung Galaxy phones among others. These displays differ from LCDs as they don't require backlighting: when a current is applied to an OLED panel, they emit a bright light. This means they can also be used as a light source.

To check out a current evaluation model OLED, see [youtu.be/ZxOYOafRZvc](http://youtu.be/ZxOYOafRZvc). Some companies are already producing lighting panels, with mass production commencing this year, but it will be another few years before OLEDs start to compete in the general or professional lighting markets. Panels at present are very pricey but this can be expected to change as production matures.

### Changing colours

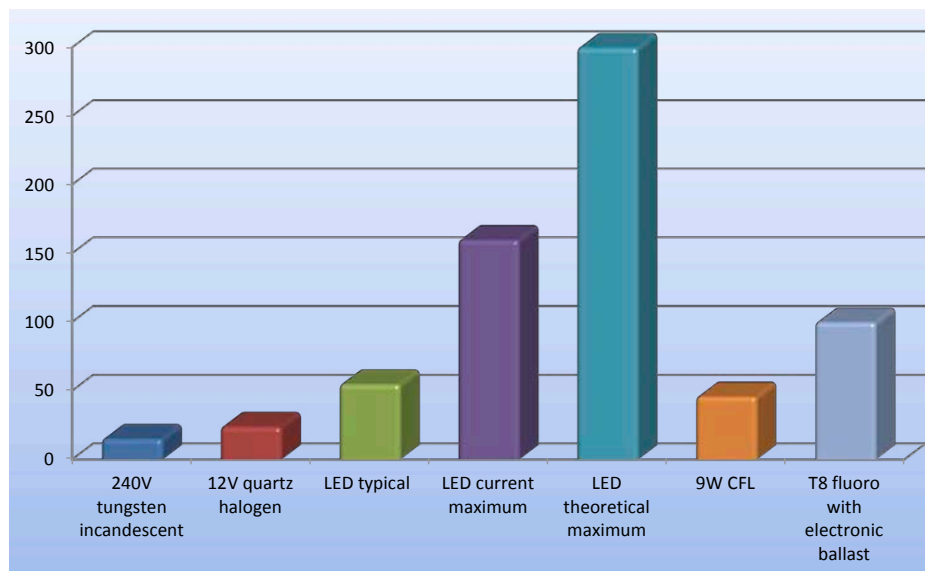
Philips believes that transparent and colour-tuneable OLEDs will be available within three to five years. Flexible ones may take a while longer, perhaps five to eight years. As a thin-film device, there are possibilities to use printing technologies to produce these panels which could dramatically reduce their

costs. Consider the possibilities of having a low-cost, high-efficiency light source that you can hang on your wall. Or how about one that is transparent until you turn it on, or another that changes colour!

We've come a long way from the candle and the kerosene lantern. The electric light from Edison transformed the world, and this is

set to continue with LEDs, OLEDs and smart lighting controls that will enable us to light up our world, without costing us the earth. \*

John Knox is the ATA's web shop manager. He has a Certificate IV in Renewable Energy and gives talks to diverse audiences on technology for a sustainable future and energy efficiency.



↑ Comparison of overall luminous efficacy (lumens per watt) of incandescent, halogen, LED, CFL and fluoro lights.



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# World-leading technology

## Water harvest



Smart design is leading the way in solving the problem of water shortages and pollution in our impermeable cityscapes. By Robyn Deed.

TUCKED away in the back streets of East Melbourne is a world-leading project, patent pending. There's not much to see—there's a nature strip planted with wetland grasses in the middle of Darling Street, and an intriguing-looking steelwork shed in the park across the road. If you peered into the shed, you might see a poster that describes what's going on. But most likely you'd walk on by, perhaps remarking that the grasses are thriving or the trees in the park look healthy. Which is exactly what's intended.

What's hidden beneath the bed of grasses is an innovative system for stormwater treatment and harvesting. With four years of research behind it, this City of Melbourne initiative uses existing technologies—water storage tanks, a natural biofiltration 'rain garden' and filters—but combines them in a smart way. The result is a system that's more robust than other systems, takes up a tenth of the space and costs less to both install and maintain.

### The problem

The system aims to solve two problems: contaminated stormwater flowing into our waterways and the shortage of water for irrigation in our warming climate.

Contaminated stormwater is a major problem in our impermeable cityscapes. In a natural landscape about 15% of rainwater runs off into waterways, with the remaining 85% soaking into the soil. In a built-up area that gets flipped: about 85% is now entering our waterways.

Ralf Pfleiderer from the City of Melbourne says it's getting worse. "We're improving our road surfaces but making them less permeable in the process, concreting over the bluestone

→ All that's visible of the system in Darling Street are the rain garden's biofiltration beds. Beneath the garden are two tanks—the 300kL primary tank and the smaller reuse tank. This photo shows the plants just two months after installation.



Images: City of Melbourne

gutters and replacing asphalt with bluestone over concrete," he says.

The water running off the streets into nearby rivers is contaminated by lots of things: by 'gross pollutants' (larger things such as plastic bags, other litter and leaves); by silts and sands washed out of the soil; and by oils from cars contributing toxic heavy metals.

The extent of water runoff into our waterways, combined with the extended drought and water restrictions, means that water for irrigation is at a premium. Many of our urban trees are struggling. Even after a recent year of good rain, soil moisture levels haven't returned to normal. So, as well as treating the water to remove pollutants, this project provides a source of water that can be harvested for irrigation.

### The solution

Central to the system is the separation of stormwater capture from treatment. Other

gravity-feed systems use rain gardens for both capture and treatment: the water from road gutters runs directly, by gravity, into the rain garden as it rains. This means the rain garden has to be below the level of the road—a design and safety issue in an urban streetscape (imagine a garden bed below the level of the road). In addition, the rain garden has to be much larger to enable it to capture and treat all the stormwater as it's flowing.

What the Darling Street system does instead is to first capture the stormwater into a large (300kL) underground tank, which allows the water to be slowly filtered through the garden bed after the rain event has passed. Using this approach, the system is able to treat the water from a 37 hectare catchment area—this would normally require 1200m<sup>2</sup> of rain garden, but this system needs just 120m<sup>2</sup> to do the same job. In addition, it's able to supply 21 million litres of water annually (or 18 Olympic swimming pools) for irrigation.



## Rain garden as filter

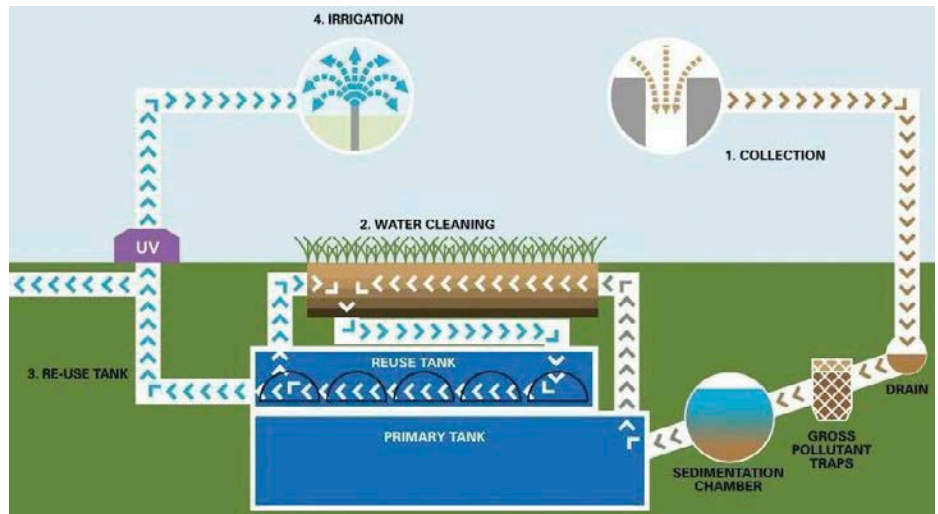
The rain garden itself is a natural biofiltration system, made of sand and grasses. Most of the filtering is performed by the bacteria coating the sand particles and plant roots—a natural biofilm, not by added bacteria. The plant stems help to break the surface tension and so maintain the flow of water through the filtering sand. They look great, too. Brendan Condon from Biofilta, one of the companies involved in the system's research and design, says that the plants in the Darling Street rain garden are already fully mature whereas ones planted at the same time in a typical gravity-feed rain garden would still be establishing.

The system has been robustly designed to avoid many of the problems that plague other rain garden systems. Although rain gardens are good at filtering out contaminants, they get clogged by litter, sediment and silts, requiring expensive manual maintenance. To avoid this issue, before capturing the water into the holding tank, there are two filters applied to the water—a gross pollutant trap, to remove leaves and litter, and a sedimentation chamber, to settle out a lot of the silts. Both these filters fill up too, of course, but they're easier to maintain as they can be vacuumed clean mechanically, rather than manually.

The cleaned water is either stored in a reuse tank (also beneath the ground) for irrigation use, or returned to the stormwater drains as cleaned stormwater—much better for our waterways than the original polluted stormwater. The final step is a UV filter to ensure that any residual bacteria are killed.

## Harvesting the water

Come summer, the system will switch to using water from the reuse tank for irrigation as needed. Irrigation could also be applied



↑ The Biofilta bioretention system separates collection of the water from treatment. Following the successful pilot at Darling Street, two larger systems are under construction in Melbourne, with one of these designed to provide sufficient stormwater to irrigate the Fitzroy Gardens.

in winter, but Ralf Pfeleiderer says that this is something for down the track. In winter the water needs to be applied below the surface as the surface layer is often already wet, leading to run off. But irrigation is still needed in winter: beneath the surface the soil moisture remains low, after so many years of drought.

Unlike gravity-feed systems, this system does require electricity to pump the water through the rain garden for filtering. But Ralf notes the pumps run just two hours out of 24, under low load, with a total electricity cost of about \$200/year, offset using carbon credits.

## Future water supply?

The most significant current application is to clean stormwater, thus reducing pollution in our waterways. When used for irrigation, such systems can also help keep parks and street plantings healthy, and so help alleviate the heat

**"Stormwater could even cover all our water needs. Melbourne currently uses 400 GL of water a year, compared to available stormwater of about 463 GL."**

island effect in cities as our climate warms. Brendan Condon notes that he's been involved with installing similar systems for apartments to provide irrigation for their gardens.

Looking further ahead, Ralf speculates that such systems could become part of a decentralised water storage approach. We could be using harvested stormwater on our gardens, and in our toilets and washing machines, while our reservoirs are used purely for drinking water.

Stormwater could even cover all our water needs. Melbourne currently uses 400 GL of water a year, compared to available stormwater of about 463 GL. We only use around 10 GL of that at the moment, so at the very least stormwater could be a much bigger part of our future water supply.

If we can switch to thinking of reservoirs as just one part of our storage system, rather than the full system—as super-sized rainwater tanks in effect—maybe we can start to reduce our dependence on them. \*



← Construction of the primary tank which sits beneath the rain garden. The pre-cast concrete culverts were craned in place within a day.

The system was researched and developed by Biofilta and Cardno, in conjunction with the City of Melbourne. A patent for the Biofilta™ bioretention system has been applied for. More info: [www.melbourne.vic.gov.au/ParksandActivities/Parks](http://www.melbourne.vic.gov.au/ParksandActivities/Parks), [www.biofilta.com.au](http://www.biofilta.com.au)

# Renewables research

## Waves, intermittency and living labs

Australian researchers are looking into the future of renewable and sustainable technologies, writes Beth Askham.

### CSIRO Energy Flagship: solar and wave power

CSIRO is laying down the foundation research for future solar and wave power generation.

The CSIRO Energy Flagship has recently published reports on the future of Australia's solar and wave energy generation.

Their report *Solar Intermittency: Australia's Clean Energy Challenge* takes a look at how we can overcome some of the solar intermittency barriers that are holding up large-scale solar photovoltaic energy in Australia.

CSIRO also believes that the ocean could supply about 10% of Australia's electricity by 2050. This energy would come from harnessing the abundant movement of ocean waves, tidal and non-tidal ocean flows and ocean thermal energy.

### SOLAR INTERMITTENCY

As the proportion of generation from solar increases, how will the grid manage the drop in power when a cloud passes across the sun?

Photovoltaic (PV) generation can drop by 60% when the amount of sun reaching the panels (insolation) falls. When large-scale solar power generation is affected by solar intermittency, the fluctuation in power generation makes it a network issue.

Intermittency, the variability and uncertainty of renewable energy, and not being able to switch electricity generation on and off on demand are problematic issues for the electricity network.

Intermittency can certainly be overcome, say CSIRO researchers. For a start, they have found that solar intermittency doesn't have to be unpredictable.

Accurate solar forecasting will provide information on the levels of power generation that can be expected from PV. These predictions can be short-term, predicting what might happen within seconds or minutes, or they can be long-term, forecasting what the next couple of days might bring.

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Photo: OPT

↑ An Ocean Power Technology PowerBuoy.

"CSIRO also believes that the ocean could supply about 10% of Australia's electricity by 2050."

into the electricity grid, in both management and infrastructure, will allow for greater input of renewable energy.

### WAVES ON TRIAL

Trial wave energy projects such as the federally funded wave energy project at Portland, Victoria, are in their beginning stages. Victorian Wave Partners are building a 19MW demonstration wave energy project that will use 28 PowerBuoys.

They plan to begin the project in 2013 with completion scheduled for 2017. These generators have a rated average output of 150kW that can go up to 870kW depending on the waves. And if you are worried about intermittency, wave strength can be predicted three days in advance.

More info: [www.csiro.au](http://www.csiro.au)



Photo: CSIRO

← A concentrating solar thermal tower at the CSIRO Energy Centre, Newcastle. This solar tower uses mirrors to concentrate the thermal energy of the sun. This thermal energy can be used to generate electricity.





"A key aim is for the building to be the first in Australia to achieve Living Building Challenge accreditation."

### University of Wollongong: living laboratory

The University of Wollongong is building a new Sustainable Buildings Research Centre that will showcase energy efficiency and sustainable building technologies.

"We are calling it a living laboratory because we will use the building itself as a research tool," says Professor Paul Cooper, director of the research centre.

A key aim is for the building to be the first in Australia to achieve Living Building Challenge accreditation. The building must be a net zero energy building to achieve this and Paul thinks that meeting this challenge requires the integration of a wide range of advanced technologies.

He says, "One key combination of technologies is our ground-source heat pump to supply baseload heating and cooling to our innovative heating, ventilation and air conditioning system, which in turn includes in-slab hydronic heating and cooling, displacement ventilation and PV-T (photovoltaic-thermal) solar air heating."

The building will have a renewable energy driven micro-grid that will generate and store electricity. This micro-grid will be continuously tested and developed in the research centre. Connected to the micro-grid will be a PV inverter fed by a significant fraction of the 150kWp rooftop solar PV array, a small-scale wind turbine generator inverter and an energy-exchange system using batteries as energy storage.

More info: [www.sbrc.uow.edu.au/index.html](http://www.sbrc.uow.edu.au/index.html)

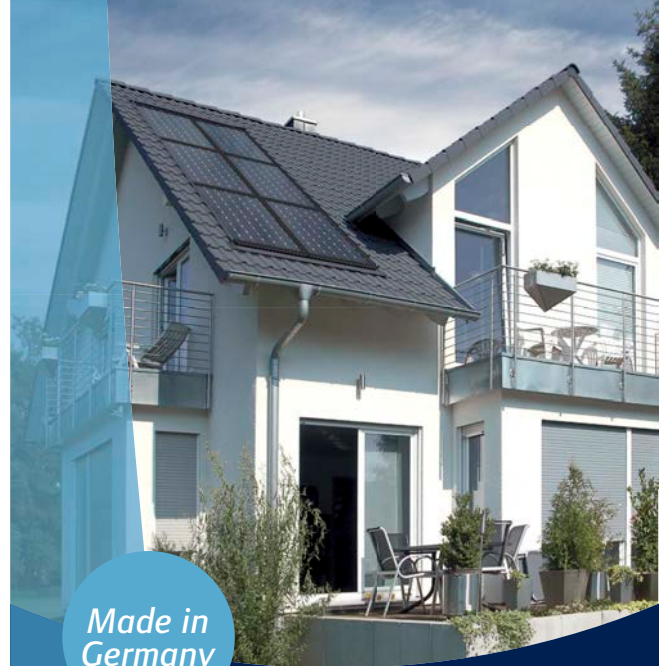


Photo: Paul Cooper

↑ The Sustainable Buildings Research Centre under construction.

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**SOLON** 

# Learning for the future

## Renewable energy courses guide



With enrolment time for next year approaching, we've updated our renewable energy courses guide. You'll find the guide on our website, but here Beth Askham gives a round-up of the types of courses and what to expect.

SHORT courses, TAFE and university courses can all provide skills and knowledge in renewable technologies.

Around Australia there are many options to choose from. In each state except Tasmania there's at least one TAFE offering accredited qualifications in renewable energy. There are also 11 universities providing coursework-based degrees in renewable or sustainable energy, and there are many short industry or TAFE courses providing specific industry accreditations.

Peter Averill teaches the Certificate III in Renewable Energy at the Northern Melbourne Institute of TAFE (NMIT) in Victoria.

He finds that students attracted to the course are generally mature aged, even though the course is available to school leavers. They range from people looking to change or broaden their careers to those who want to set up their own renewable energy systems at home.

In this course, learning is hands-on, with students taught how to install PV, wind generation and standalone systems. Peter makes the point that this type of study does not suit external learning: its hands-on nature means that it has to be face-to-face.

Peter Averill says the career paths of graduates of this Certificate III course tend to be broader than other equivalent trade qualifications. Graduates find work in areas ranging from PV installation for remote communities to home assessment for energy efficiency to solar water heating installation. As mature age students, they also often incorporate prior knowledge and skills with their newly learnt skills in renewable technology.



Photo: NMIT

↑ Students installing PV at the NMIT Green Skills Centre.

### Enough skilled workers?

In a report published in 2009, the Clean Energy Council found that the "current workforce demand is not being fully met, let alone projected demand."

The report, *Australian Renewable Energy Training and Workforce Strategy 2020*, found that the number of institutions offering renewable technology studies was too few to match the projected demand for these skills when looking forward to the year 2020.

At the moment, however, Peter Averill thinks the demand for renewable energy training is being met by TAFEs and universities. At the TAFE level "demand is driven and tied to government initiatives and directions," he says. Without government

incentives, interest in renewable education declines.

### TAFE qualifications mean business

Robbie Nichols completed the Certificate IV in Renewable Energy at the Gordon Institute in Geelong. Before completing this qualification he was an electrical contractor with his own business. His interest in renewable energy began during a short course in solar installation—he wanted to know more so he enrolled in the Certificate IV course.

The qualification took two years part time and he enjoyed the study. He says, "There was great teaching, with lots of hands-on learning, field trips and practical knowledge."

Not everyone made it to the end though.



"The career paths of graduates of the Certificate III in Renewable Energy tend to be broader than other equivalent trade qualifications."

His class size dropped from 14 to 5 over the two years, with only the dedicated staying until the end.

His current business, Green Earth Electrical, is kept busy designing and installing house-specific PV systems. He's also a solar inspector for the federal government.

### Short courses

Short courses can provide the bare minimum for accreditation, allowing tradespeople to design and install photovoltaic systems.

Other short courses, such as those provided by the University of Wollongong Sustainable Buildings Research Centre, help engineers develop skills in subjects including Smart Metering and Demand Side Management.

### University qualifications

Universities offer both technical skills and broader renewable energy policy and management courses.

For example, Murdoch University in Western Australia offers a Renewable Energy Engineering undergraduate course. They also offer a Bachelor of Sustainable Energy Management that focuses on electricity

generation systems as well as the social and environmental aspects of energy use across the areas of economics, policy and technology.

For engineering students, specialist online masters courses such as Advanced Renewable Energy, offered at the University of Sydney, look at renewable energy generation in terms of the principles of fluid mechanics, thermodynamics and heat transfer.

### Carbon management

And finally, if technical skills aren't your thing but you want to bring sustainability to your workplace, courses that offer carbon management can give you skills to reduce an organisation's carbon footprint. Training providers such as Carbon Trading International offer online units such as Evaluate Carbon Reduction and Renewable Energy Options in their Certificate II and IV courses in carbon management.

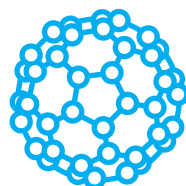
Find the renewable energy courses guide here: [www.renew.org.au/renewable-energy-courses-guide](http://www.renew.org.au/renewable-energy-courses-guide)

As a reader of Renew I don't think you buy any of the gimmicky advertising that you see in other publications. I think you are the discerning type that likes to learn as much about a subject from trusted and technically sound sources before making a purchasing decision. Therefore I'm not going to place any marketing slogans or stock images in this patch of your magazine. However I am going to let you know that if you are looking to further your knowledge and skills in **carbon management**, in case any of your work involves improving energy productivity - or you're just interested, that we have developed a series of 2-day courses which you might find interesting. There is the 2-day **cogeneration** course, the 2-day **carbon offsets** course, the 2-day **carbon accounting** course, and the 2-day **applied energy efficiency** course. Each full 2-day course costs \$895 and is also available entirely online if you prefer to study after work hours. If you'd like more information or just to have a chat about how you can learn more about carbon management please call 1300 073 410 or visit **www.co2ti.com** I'll include my personal mobile number here too ...

just in case you prefer not to talk with operators: 0425 788 654.

Kind regards

Richard Bolus  
Marketing Director  
Carbon Training International



**carbon training**  
international®

# Taking care of your batteries

## A regulator buyers guide



Using the right regulator in an independent power system is very important if you want your batteries to live a long and healthy life. We take a look at the types available, what they cost and where to get them.

WHILE most solar photovoltaic energy systems are grid-interactive, many people live away from the mains grid and need to generate their own electricity. Also, as energy companies shift more of their charges to fixed charges (such as the supply charge), thus making energy efficiency measures less cost-effective, more and more grid-connected homeowners are likely to disconnect from the grid and go it alone with energy generation.

All independent systems require a suitably large battery bank and other equipment. One of the most important, but often overlooked, components is the charge regulator, also called a charge controller.

The choice of regulator is an important one as the regulator can have a significant effect on the correct operation of your system and the lifespan of your batteries. In order to select the right regulator, you need to understand a bit about them and the choices that are available.

A charge regulator controls the amount of energy flowing from your solar panels, wind turbine or micro-hydro system into the batteries, in order to prevent the battery bank from being overcharged.

### Regulation methods

There are several ways in which energy flow to the batteries is controlled, including high-frequency series switching, open-circuit series switching, shunt power dissipation and the more recent DC to DC conversion employed by maximum power point tracking (MPPT) regulators. The method used varies between manufacturers and often depends on the energy source the regulator is designed for.

→ This maximum power point tracking regulator from Australia Energy Research Laboratories allows battery banks to be charged from solar arrays with much higher voltages, thus reducing cable losses.

### SERIES REGULATION

This involves controlling the energy going into a battery by partially or completely blocking the flow of current. This is done in one of several ways, including series switching and taper charging.



Open-circuit switching is usually referred to as 'series switching regulation'. The regulator monitors the state of charge of the batteries, and when sufficient energy has gone into the batteries, the regulator opens the switch and disconnects the charging source from the



batteries. When further charging is needed, the switch is closed again.

Two methods are employed to switch the power: relays, which are electrically operated mechanical switches; and solid-state switching, which uses transistors. Solid-state switching technology is more commonly used due to its relatively low cost and high reliability (there are no relay contacts to burn or wear out mechanically).

Open-circuit series switching is usually used with photovoltaic panels because they can be left open circuit (that is, not providing power to anything) without damage. This type of regulation is also quite cheap to implement, as no load dumps are required for the excess power.

However, potential generating capacity is wasted, which means that your investment in PV panels is not being fully realised.

Diversion series regulation, also called change-over regulation, is where the charging source is not just disconnected from the batteries, its energy is diverted to another load, such as a water pump, water heater element or a second set of batteries. Some series switching regulators may provide an additional feature for load diversion, which is actually diversion switching.

Change-over regulation is normally used with PV panels. However, if the change-over switching is done using fast electronic switches, the regulator could be used with other power sources such as wind turbines. This is achieved by rapidly switching back and forth between the two loads (the battery bank, and the other load) with an appropriate percentage of connection time for each load, providing an apparent smooth load without voltage ripple (small, rapid fluctuations in the output voltage which can affect the operation of electronic devices). If your regulator has a change-over facility, establish what it is capable of.

#### TAPER SERIES REGULATION

This type of regulation involves gradually reducing the amount of energy flowing into the battery as it approaches a full charge. This is nowadays usually done using pulse-width modulation (PWM) regulation, where the power source is rapidly disconnected and reconnected to the battery with a varying ratio which allows the regulator to maintain the desired battery voltage. It is similar to series switching regulation, except that it is

done rapidly to provide the voltage control.

PWM regulation is a form of switchmode power control, but you can also have regulators that are true DC to DC switchmode converters. These are generally known as maximum power point trackers or MPPTs, and are discussed later.

#### SHUNT REGULATION

With shunt regulation, the excess energy is diverted, or shunted, by the regulator into an alternative load which is connected in parallel with the batteries. The voltage across the alternative load is the same as the voltage across the batteries. Depending on the degree of control sophistication, either all the energy is diverted—that is 'on/off'—or an appropriate proportion of the energy is diverted through the dummy load.

The method of controlling and dissipating excess energy varies but is generally one of the following.

Low- and medium-power shunting is done using a transistor or similar electronic device. The excess energy is dissipated in the transistor.

High-power shunting is also done by a transistor or similar device, but the energy is dissipated in another load, usually a bank of resistive heating elements, water heating elements or, sometimes, incandescent light bulbs.

If you want to use the excess energy from your power source when using a shunt regulator, then regardless of power level, the last method is used.

Because the voltage is consistent across the system, shunt regulation is usually used with wind and hydro generators. As a result, the generator does not have any sudden loading or unloading which can cause undesirable structural stresses.

There is no reason why PV panels could not be operated using this type of regulation, but it is usually more expensive than series switching due to the cost of providing an alternative load.

#### MPPTS

These are a different type of device that use high-frequency switching to convert the varying input voltage and current from the solar panel array to the correct voltage for the battery bank. Because they are capable of maximum power point tracking, just like a grid-interactive inverter is, they can convert



↑ Another maximum power point tracking charge controller, this one from Morningstar. They have a number of advantages over series regulators and can increase PV array yield considerably, although their internal electronics are more complex.

any excess energy in the form of high panel voltages into usable current, thus increasing available current from the panels.

There are quite a few MPPT controllers around nowadays and they can increase average current to the batteries by 20% to 30% and extract every available watt-hour out of your solar array.

However, possibly the greatest advantage with MPPTs is that most are designed to run with PV voltages much greater than the battery voltage. This means that panels can be configured for higher voltages and hence lower currents. This has several advantages, including reduced PV-to-regulator cable size and cost, and lower cable losses due to the lower currents involved.

The disadvantage with such a system is that PV voltages may exceed the extra-low-voltage range (up to 120 volts DC), making the array not only more dangerous to work on, but also requiring it to be installed by qualified personnel.

However, the advantages of lower losses and higher energy gathering outweigh such concerns in most cases. As MPPT regulators continue to fall in price, many, if not most whole-of-house systems will eventually use them.



← Series regulators, like this PWM unit from Victron, are low cost and ideal for smaller systems using just a few panels.

## Regulator operation

Regardless of the means by which regulation is achieved, control of the regulation process is required. By control, we mean the conditions under which the energy is allowed to flow into the battery, and in some cases, the rate at which it flows. There are various levels of sophistication but the main controlling parameter used is the battery voltage.

### SINGLE STAGE CONTROL

The simplest method of control is single stage regulation. With single stage regulation there are preset upper and lower voltage limits. The regulator switches power to the batteries when their voltage falls below the lower limit and switches it off at the upper limit. The upper limit is usually set at a value that will approximate full charge, and the lower limit is set at a value that can approximate anywhere between 50% and 80% of full charge. The reason for having an upper and lower limit instead of just an upper limit is to prevent the switch turning on and off rapidly once the upper limit is reached.

However, there are problems with using this simplistic approach. One is that the voltage is not a true representation of the charge condition of the battery, as other factors such as temperature and battery condition can influence the battery voltage. The other problem is that flooded-cell batteries require a regular boost charge to equalise the individual cells. This means charging the battery to a higher voltage occasionally, something a single stage regulator cannot do. Single stage regulators should not be used with flooded cell batteries; they are only appropriate for simple sealed-battery systems.

You can have some control over the boost problem by installing a bypass switch that

allows you to manually boost charge the batteries, or by having a manually adjustable voltage set point. But you must remember not to leave your system on boost, or the batteries could be destroyed. For this reason most set points are determined in the factory, but some regulators are adjustable.

### TAPER CONTROL

Taper control involves gradually reducing the flow of energy into the battery as full charge is reached. This can result in a more complete charge being achieved. The rate of charge is determined by the voltage of the battery.

Taper control is typically used with shunt regulators, but it can also be achieved using fast solid-state switching technology in a series regulator (PWM control). The rate of switching is very fast, resulting in no apparent voltage ripple on the load, but this method may produce high-frequency interference that may affect sensitive appliances.

### DUAL STAGE CONTROL

Dual stage regulators serve to address the problem of providing some boost charge. With this method of control there are two charging conditions. One is 'boost' and the other is 'float'. When the battery is being charged from a starting voltage that is below that of the float voltage, for instance, after a discharge, the battery is charged until the boost voltage is reached. Then the regulator drops the voltage to the float level and maintains it until a load is applied.

Once again, the correct voltage for regulation can be affected by other factors and though the boost is available, it occurs on every charging cycle. This can result in excessive gassing and more than normal loss of water from flooded cell batteries.

## MULTISTAGE CHARGING

This is a rather loose term which includes any regulator that is using more than just the instantaneous voltage of the battery to determine regulation. These regulators may be referred to as 'intelligent', 'programmable' or 'smart', but the basis of all of these regulators is that they provide a complex sequence of control. With modern electronics, these regulators are most likely to use microprocessors, but complex sequences are possible using more basic electronic circuitry.

Due to the very low cost of modern microcontrollers, the majority of regulators, even low cost eBay units, use this form of control nowadays. Some of the things that these regulators are capable of include boost regulating at a particular time of day; determining correct voltage to charge up to, based on rate of charge; knowing what battery configuration is being used; and keeping track of the amount of energy that has been discharged from the battery.

If you are setting up anything more than a simple system then you should really only be considering a multistage charger as they will look after your batteries much better than a simpler unit.

## Additional features

Although the chief purpose of a regulator is to regulate the energy flow into the batteries, many regulators provide additional features that allow the user to observe what is happening and to control other aspects of an independent power system. Displays on regulators vary from nothing to the very complex. The range of displays that you are likely to find include the following.

### STATUS LIGHTS

Status lights are usually LEDs (light emitting diodes). The number of status conditions can vary but typical status indicators are for boost charge, float charge and low battery voltage. These are useful as they provide a visual indication of the battery condition.

### METERS

Meters can show voltage, current, energy input, energy consumed and a range of other parameters. Usually, meters are digital and use liquid crystal displays (LCDs), although some regulators also use LED displays. There may be a separate display for each function, but a more common approach is to use a



single display with a selection switch to allow you to look at different parameters.

#### HISTORICAL DISPLAYS

By using microcontroller-based control and data storage memory, some of the more advanced regulators are capable of recording the number of amp-hours or watt-hours being collected and used by the system. This information will not make the system run better, but those who take a keen interest in their system's performance may consider these features money well spent.

Be aware that an advanced display system may not mean advanced regulation control and vice versa—advanced regulation control can exist without advanced display systems.

#### LOW-VOLTAGE CUT-OUTS

If the battery is overused and the voltage drops to a low level, some controllers offer an option where all or part of the output load can be switched off via a relay or MOSFET. This reduces or removes the load and prevents the battery from being run completely flat. This is particularly useful in an unattended system where something may have been left on unintentionally. Some form of time delay is usually included to prevent operation of the low-load cut-out due to a sudden large power draw, such as a motor starting up.

#### GENERATOR CONTROL

Some regulators include a generator start relay or control output to operate a backup generator if the voltage drops below a certain point. Once again, delays are built in to prevent a premature start and to allow the generator to operate for a reasonable time.

#### TEMPERATURE COMPENSATION

The battery voltage can be affected by temperature, particularly when cold. Because of this, the voltage set points for control can be inappropriate. Many regulators, including some of the simple types, offer temperature compensation. This is achieved by using a temperature probe to sense battery temperature and adjusting the voltage set points based on that temperature.

The choice to install a temperature sensor is usually optional, so you can have the feature but not use it if you wish. However, if your batteries are subject to a reasonably wide temperature range then it is recommended that you use it.

#### Weather proofing

Your regulator may be subject to high humidity or occasional exposure to rain. The unit should be sealed to prevent internal corrosion of the components. If you are in the tropics, be particular about establishing the suitability of the regulator under high moisture conditions.

#### Operating temperature

There are temperature ratings associated with most electronic components. If your regulator is likely to be operating in a hot environment, then check to see that the unit you are purchasing is capable of operating at high temperatures (40°C plus).

#### Lithium batteries and BMS

While the vast majority of independent renewable energy systems use lead-acid batteries of one type or another, lithium-based batteries are now available that represent a cost-effective option for systems that require low maintenance and long lifespan. Lithium batteries can have cycle life figures of up to 5000 cycles, even at relatively high discharge depths. While they are expensive initially, the much greater lifespan means the overall cost can actually be less than a lead-acid battery bank.

Lithium battery banks almost always include a battery management system (BMS) which prevents the cells from being overcharged or overdischarged. This is very important as lithium chemistry batteries are very susceptible to damage if they are incorrectly charged.

The BMS may or may not be able to completely replace the need for a separate regulator—that depends on the BMS. However, we are starting to see some of the more advanced regulators being supplied with a lithium battery option. The MPPT series regulators from GSL are one example.

#### Choosing your regulator

The table included in this buying guide lists many regulators with different features. When you take voltage and current rating into account there are lots of regulators to choose from. So which regulator do you choose?

Generally, your system will be configured as a 12, 24 or 48 volt system, though other less common voltages such as 36, 96 and 110 volts are possible. Many regulators can operate over a range of voltages and you simply select

the operating voltage. Many regulators will work out the voltage for themselves. Buying a regulator where the operating voltage is selectable is of value if you anticipate that your system will grow, resulting in the voltage being increased. This is particularly true if substantial investment is made in an advanced unit because you don't want to have to replace it later.

Current ratings are more varied than voltage ratings and can range from five amps to over 100 amps. The selection of the correct size depends on the size of the energy system that you are installing. With PV systems, calculate the current rating based on the maximum peak power of the array plus around 20%, and allow for the addition of a few more PV modules later. Wind and hydro generators are often sold with regulators as part of the package, so the regulator will be appropriately sized to meet the maximum generating capacity.

We must also note here that with MPPT regulators, the solar array current and the maximum battery charge current are not the same—the array current can be considerably less, even though the array power and power into the battery are very similar. It may be more useful to compare input power ratings if you are comparing MPPT controllers. Indeed, for many people it is much easier to just do all calculations using watts, and MPPTs allow you to do this much more easily than series or shunt regulators.

The choice of regulator type is to some degree dictated by the market. Wind and hydro regulators are usually shunt type and are often prepackaged with the wind or hydro generator, thus limiting your choice. The choice for PVs on the other hand is huge, and almost any combination of features and charge control types can be found if you look around.

Intelligent control really is the way to go nowadays, and if you are installing a whole-house system then you should be considering an MPPT controller. Simple regulation systems are generally cheap, but will not provide as good performance or lifespan from the batteries. If a substantial investment is made in batteries, then using a cheap regulator is not a good idea. \*

Manufacturer/supplier	Model	Voltages available (V)	Current capacity (A)	Control method	Application	Adjustable setpoints	Temperature compensation	Battery types	Displays	RRP \$
Altronics ph: 1300 797 007 www.altronics.com.au retail@altronics.com.au	N 2071A	12	20	PWM	PV	Yes	Yes (sensor optional)	Flooded or sealed	LCD – Batt V, Panel V, Ah, Charge mode	149.00
	N 2072	12	30			179.00				
	N 2067	24	20			179.00				
	N 2075	12	6			No	No		None	39.95
	N 2076	24	8							49.95
	N 2077	12	6							40.00
	Altronics are resellers of GSL MPPT and BMPPT solar chargers in Australia.									
Australian Energy Research Laboratories (AERL) Pty Ltd ph: (07) 3879 2192 sales@aerl.com.au www.aerl.com.au	SRMV60W	24-84	60	MPPT	Domestic, small-medium scale PV	Yes	Yes (sensor optional)	All battery types	LCD with front panel programability	999
	SRHV45W	48-132	45							1599
	SRMV30R	24-84	30		Industrial, telecoms, large scale PV					POA
	SRHV20R	48-132	20		RV, Marine					POA
	BLV	12-24	TBA		Small-large scale PV water pumping					POA
	LVP/MVP	48,90,180	TBA		Wind					
	HVP/XHVP				Hydro					
	TURBOMAX	TBA	TBA							
HYDROMAX	TBA	TBA								
Blue Power Victron Energy, Netherlands	For information on products and where to buy, go to www.victronenergy.com									
Blue Sky Energy Inc. Solar Power Australia P/L ph: (02) 4954 3310 www.solaronline.com.au	SB2000E	12	25	MPPT	PV	Yes	Yes (sensor optional)	Flooded or sealed	LCD	329.00
	SB50L	12, 24	50							669.00
	SB3048L	24,48	30							719.00
	SB3024iL	12,24	40 (12V) 30 (24V)		PV, lighting, hydro and wind (with DUO option)					535.00
	SB1524iX	12,24	20 (12V) 15 (24V)		PV, lighting				Remote LCD optional	279.00
	SB2512i	12	25		PV				239.00	
	SB2512iX	12	25		PV, lighting				279.00	
GSL Electronics ph: (02) 9620 9988 www.gsl.com.au	MPPT10HV	12, 24, 48 (max Voc 90V)	10 (500W)	MPPT	PV	Yes	No	Vented and sealed lead-acid, lithium models available	LED indicator	210.00
	MPPT25HV	12, 24, 48 (Max Voc 180V)	25 (1250W)			Yes			LED indicators and optional LCD control module	465.00
	MPPT50HV	12, 24, 48 (max Voc 180V)	50 (2500W)			Yes				595.00
	MPPT12	12, 24 (max Voc 55V)	12 (200W)			Yes			LED indicators	150.00
	MPPT30	12, 24, 48 (max Voc 95V)	30 (1750W)			Yes			LED indicators and optional LCD control module	385.00
	MPPT60		60 (3500W)			Yes				495.00
	BMPPT150	24, float charge 48	10 (150W)	(BMPPT) Booster MPPT for systems with battery voltage higher than PV voltage	Boosting PV systems	Yes	No	Vented and sealed lead-acid	LED indicator	180.00
	BMPPT250	24, 48	15 (350W)			Yes				210.00
	BMPPT800	24, 48	30 (800W)			Yes			LED indicator and optional LCD control module	470.00
	BMPPT1500	24, 48	50 (1500W)			Yes				595.00
Jaycar Electronics ph: (02) 8832 3200 Orders: 1800 022 888 techstore@jaycar.com.au www.jaycar.com.au	MP3735	12, 24	30	MPPT	PV	Yes	Yes	Lead-acid	LCD	249.00
	MP3737	12, 24	40	MPPT		Yes	Yes	Lead-acid	LEDs	299.00
	MP3126	12	20	Series switching		No	No	Sealed	LEDs	74.95
	MP3129	12	20	PWM		Yes	Yes	Lead-acid, NiCd, lead calcium	LCD	149.00
	MP3722	12	30					179.00		
	MP3722	24	20					179.00		
	MP3720	12	8	PWM		No	No	Wet or sealed lead-acid	None	49.95
	AA0348	12	5	Switching		No	No	Sealed	LEDs	29.95
Low Energy Developments ph: (03) 9470 5851 www.lowenergydevelopments.com.au	Juta	12, 24, 48	12	PWM	PV	No	Yes	VRLA, Gel, LA, AGM	LCD	19.95
			30							89.00
			50							149.00
			60							179.00
		12, 24	MPPT	10		No	Yes		LCD	POA
				20						
				30						
	EP Solar	12, 24	10	PWM		No	Yes		LED	39.95
		15	49.95							
12		20	59.95							



Manufacturer/supplier	Model	Voltages available (V)	Current capacity (A)	Control method	Application	Adjustable setpoints	Temperature compensation	Battery types	Displays	RRP \$		
MidNite Solar (USA) DC Solutions ph: (03) 9482 2203 www.dcsolutionsaustralia.com.au	Classic150	12, 24, 36, 48	96 max	MPPT	PV, wind, hydro	Infinite	Standard	Any	Dot matrix graphics panel	999.00		
	Classic200		74 max							999.00		
	Classic250		60 max							1099.00		
	Classic250K	120	35							1099.00		
	Classic150Lite	12, 24, 36, 48	96 max							849.00		
	Classic200Lite		74 max							849.00		
	Classic250Lite		60 max							949.00		
	Classic250KS Lite	120	35							949.00		
Morningstar RFI Solar ph: 1300 000 734 www.rfisolar.com.au	SG-4	12	4.5 PV	Series PWM	PV	No	Yes	Sealed	No	POA		
	SHS		6, 10 PV & Load	Series PWM, 4 stage				Flooded	LED			
	Sunkeeper		6, 12 PV	Series PWM, 3 stage				Sealed	LED			
	SunSaver	12, 24	6, 10 PV only	Series PWM, 4 stage			Flooded or sealed. Link selectable					
	SunLight		6, 10, 20 PV & Load									
	SunSaver DUO	12	25 PV						Yes, plus remote sensor option		LED, optional remote LCD	
	SunSaver MPPT	12, 24	Up to 400W PV, 15A into battery	Series PWM MPPT, 4 stage								
	ProStar	12,24,48	15,30 PV & load	PWM 4 stage, or series	Flooded or sealed	LED and LCD models						
	TriStar	12, 48	45, 60 PV or 45, 60 load, diversion control	Series PWM, 4 stage	PV, wind	Yes		LED, optional LCD, optional remote LCD				
	TriStar MPPT		Up to 3200W PV, 45, 60 into battery	Series PWM MPPT, 4 stage					Yes, includes remote sensor			
Morningstar Solar Charge P/L ph: (03) 9544 2001 www.solarcharge.com.au	SHS	12	6, 10	Series PWM	PV	No	Yes	Flooded	LED	POA		
	SunDUO		25 solar	Series PWM				Flooded or sealed	LED and remote LCD			
	Sunkeeper		6, 12	Series PWM				Remote sensor	—		LED	
	Sun Guard		5	Series PWM				Yes	—			
	Sun Saver	12, 24	6, 10, 20	PWM			Flooded or sealed					
	Sun Light SL10		10 solar, 10 load	PWM								
	Sun Light SL20		12	20 solar, 20 load					PWM			
	Sun Saver SS6	12	6 solar, 6 load	PWM								
	Sun Saver SS10		12, 24	10 solar, 10 load					PWM			
	Sun Saver SS20			20 solar, 20 load					PWM			
	ProStar PS15	48		15 solar, 15 load					PWM/on-off		Remote sensor	Gel, sealed or flooded
	ProStar PS30		30 solar, 30 load									
	ProStar PS15M-48		15 solar, 15 load									
	Tristar TS-MPPT-45	12, 24, 48	45 load or 45 solar	PV, wind	Yes			LED, LCD and remote LCD				
	Tristar TS-MPPT-60		60 load or 60 solar									
	Oatley Electronics ph: (02) 9584 3563 sales@oatleyelectronics.com www.oatleyelectronics.com	K009E	12, 24	15	Series switching	PV	Yes	No	Flooded or sealed		LEDs	24.00
K008		12	2	PV		No	No	—	—	17.00		
K220		12, 24	250W	PV		No	No	Flooded or sealed	LEDs	22.00		
K241		12, 24	300W	Shunt	PV, wind	Yes	No	—	—	48.00		
Outback Power Systems Mpower ph: 1300 733 004 info@mpower.com.au www.mpower.com.au	FM60	12, 24, 48, 60	60	MPPT	PV, also with approved micro-hydro and wind turbines	All including MPPT settings, default set for Australian conditions	Yes	Flooded or sealed	LCD	987.00		
	FM80		80							1117.00		
	Mpower also supply the complete range of Morningstar regulators.											

Manufacturer/supplier	Model	Voltages available (V)	Current capacity (A)	Control method	Application	Adjustable setpoints	Temperature compensation	Battery types	Displays	RRP \$	
Ozcharge DC Solutions ph: (03) 9482 2203 www.dcsolutionsaustralia.com.au	OCSR10 (China)	12	10	Series switching	PV	Switch select	No	Flooded or VRLA	LCD volts and amps	109.00	
	OCSR30 (China)	12	30	PWM						199.00	
Plasmatronics Available through renewable energy equipment suppliers. ph: (03) 9486 9902 www.plasmatronics.com.au	PR1210 PR2410	12 24	10	Series 2 stage	PV, marine	No	No	Flooded	None	76.00 77.00	
	PR1210L PR2410L	12 24	10	Series 2 stage	PV, marine	No	No	Sealed	None	78.70 79.80	
	SPSD series	12, 24, 48	Standard ratings: 100, 200, 300, 400	Series 4 bank switching	PV, telecoms, large RAPS	Yes	Yes	All types	16 x 2 LCD	POA	
	PL20	12, 24, 32, 36, 48	20	Series and/or shunt PWM (selectable)	PV (can be configured for wind and hydro)		Yes (sensor extra)		LCD	335.50	
	PL40		40							429.00	
	PL60		60							671.00	
	Dingo20/20	12, 24, 32, 36 and 48 selectable	20 charge, 20 load		All PV, inc campervans, caravans, cars, trucks and boats	Yes	Yes	All types	LCD	335.50	
	Dingo40/40		40 charge, 40 load						429.00		
Platypus Power ph: (07) 40558057 www.platypuspower.com.au	GV25	12,	20	MPPT with user adjustable setpoints	PV, wind, hydro	Yes	Yes	Flooded or sealed	LCD	1260.00	
	GV25	24, 48	25							1320.00	
	GV25	120	25							1384.00	
Rich Electric Jaycar Electronics ph: (02) 8832 3200 Orders: 1800 022 888 techstore@jaycar.com.au www.jaycar.com.au	MP3736 (Taiwan)	12,24,48	50	MPPT	PV	Yes	Yes	All lead-acid, LiFePO4	LCD	1199.00	
	MP3726	12,24,48	40	PWM	PV or wind (diversion control)	Yes	Yes	All lead-acid	LCD	249.00	
	MP3728		60							289.00	
Si Clean Energy ph: (02) 6655 3930 sales@sicleanenergy.com.au www.sicleanenergy.com.au	Apollo T80 (USA)	PV array up to 72 volt nominal. Battery either 12, 24, 36 or 48	80 continuous @ 40°C	MPPT	PV	Yes	Yes Included	Flooded lead-acid, GEL, AGM and NiCd	Four line LCD with backlight	1395.00	
Solar Pty Ltd ph: 1300 621 700	Western WM-10 (Italy)	12, 24	10	MPPT	PV, marine	Yes	Yes	Flood, AGM, Gel	LCD	285.00	
	Western WRM-15 (Italy)		15							295.00	
	Genasun GB-8 (USA)	12, 24 or custom	8			No	No	Any to order	LED indicator	245.00	
	Genasun GV-10 (USA)		10						Indicator	265.00	
Steca RFI Solar ph: 1300 000 734 www.rfi.com.au	Solsum SSR range	12,24 Autosense	6, 8, 10 PV & Load	PWM	PV	No	Yes	Flooded	LED	POA	
	Solarix PRS range		10, 15, 20, 30 PV & Load						Flooded or sealed		LCD
	PR range		10, 15, 20, 30 PV & Load								
	PR2020-IP		20 PV & Load								
	Tarom range	12, 24, 48	35, 40, 45 PV & Load	Yes							
	Power Tarom	12, 24, 48	70 & 140 @ 12/24V, 55, 110, 140 @ 48V								
	MPPT2010	12,24 Autosense	18 PV, 10 Load							MPPT	
Sundaya (Indonesia) Rainbow Power Company ph: (02) 6689 1430 info@rpc.com.au www.rpc.com.au	SUN-RG05	12	5	PWM	PV	NA	NA	Sealed and wet lead-acid	12 LEDs	44.00	
	SUN-RG10		10							49.00	
	SUN-RG15		15							62.00	
	Rainbow Power Company is also a reseller of a selected range from Plasmatronics, Victron, Outback and Morningstar.										
Xantrex RFI Solar ph: 1300 000 734 www.rfisolar.com.au	XW MPPT-60-150	12-60	60 into battery	MPPT	PV	Yes	Yes	Flooded or sealed	LCD	POA	
	XW MPPT-80-600	24,48	80 into battery								

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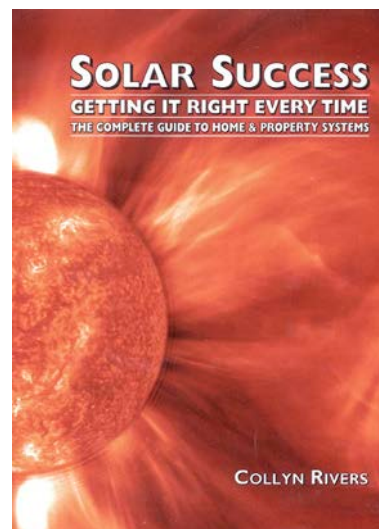
For grid connect an installer's energy audit may suggest changing light bulbs, but that's usually *all* the advice you will get. **In practice usage can often be slashed by as much as 50% and almost always by over 30%!**

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# Hybrid solar hot water

## A novel way to use PVs



It's not easy making hot water during the winter months in Dunedin on the South Island of New Zealand, so Michael Laba has done it in an unusual way.

MAKING hot water for domestic use here in New Zealand has had an interesting history, similar to that in Australia, I suspect. As far back as I can remember, back in the 1940s and 50s, domestic hot water in our NZ cities was almost always made using an electric element, with a thermostat set to about 60°C, and stored in a non-insulated hot water cylinder.

In those days, electricity was cheap. We all had electric heaters and electric ovens (our electric stove had two large electric hobs that were on all the time—you couldn't switch them off!), and many more power hungry devices were coming onto the market.

In the 1960s, electricity supply problems started to appear; transmission lines were being overloaded and the power companies weren't able to supply enough power at peak times.

To get over this peak power consumption problem, ripple control was introduced. This clever system was able to switch off the hot water heating element in people's houses at any time the power companies decided—usually around high use times such as the early evening, when people were cooking, or during the winter months when everybody had their electric heaters on.

Ripple control worked well (and still does), giving the power companies time to upgrade transmission lines and generating capacity.

Around the 1980s, some government-owned power generators were sold to private power companies and some retained as state-owned enterprises, with the government receiving a percentage of annual profits. Then power charges started to rise at a frightening rate. The days of cheap electric power were well and truly over.



↑ Michael's evacuated tube system didn't perform well as the collector was mounted too far from the tank.

### Other ways of making hot water

It was quickly realised that the heating of hot water consumed about one-third of household energy consumption. After the sale of the power companies, a few private individuals and private companies started experimenting to make hot water using the sun, with mixed results. Quite a bit later, the bigger overseas companies started producing solar hot water panels and controllers that fixed most of the early problems.

### Hot water 'off the grid'

When building our house in 2005, we wanted to be off the grid, so items that used heaps of energy were out of the question. Thus, using electricity to heat our hot water was a no-no.

We went with an Ariston LPG gas boiler to heat our hot water via a copper coil inside the hot water cylinder. This system required a Honeywell controller which gave us on/off times and tank temperature options. The controller was programmed to check the tank temperature at 5pm each day, and if the temperature was below 56°C, the gas boiler would automatically switch on, bringing the temperature up to the 61°C preset temperature.

We also liked the idea of using the sun to make hot water so we purchased a then state-of-the-art solar hot water product—an Apricus evacuated tube system. This 20-tube system was installed in May 2006, positioned at a 45° angle. Using the system's Delta-Solar controller, I set the parameters so that the pump would



switch on when the water temperature in the solar hot water tubes was 10°C above that of the water in the hot water tank, and off when it dropped to a 5°C differential.

Over the next two years we had disappointing results from our solar evacuated tube system. We hardly made any hot water temperature gains during summer and made losses in temperature during the winter months.

In late 2008, Apricus added a 10-tube model to their range so I ordered one and called the plumber to connect it in series with our 20-tube setup. The results were still below our expectations, giving only a small improvement during the summer months and still no temperature gains during the winter months. In May 2009 I got annoyed enough to do some serious temperature readings to see what was happening.

First, I fitted a temperature probe on the hot water cylinder just over halfway up, in the same place as the Honeywell sensor.

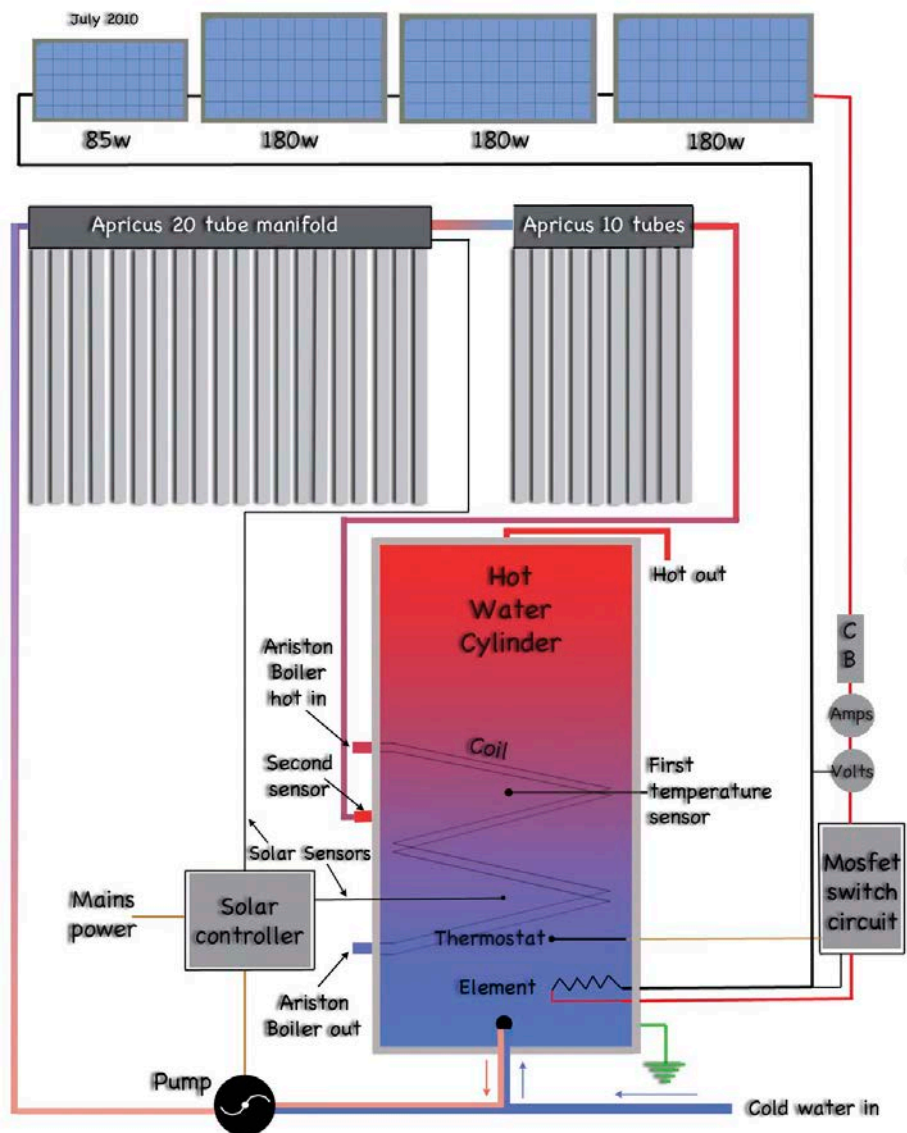
I observed on a sunny day that the temperature went down until about noon, and then after that the temperature slowly rose. No hot water was being used at the time of testing.

I then installed another temperature sensor on the solar copper pipe going into our cylinder. This pipe comes from the 'hot out' on the 10-tube manifold. From the first pump of the day until 12.30pm, readings went down a few degrees every time the pump came on. The temperature drop decreased until 12.30pm and then it started going up!

### What was happening?

There's 15 metres of 12mm pipe between the 10-tube manifold (hot out) and the storage tank and 17 metres between the cold water pump and the input of the 20-tube manifold. There's also a four-metre run between the two manifolds. So when the pump came on in the morning, it had to first move all the cold water in the pipes that had cooled down overnight. I did have two thicknesses of lagging on all external pipes but even the best of lagging couldn't last overnight!

So my problem was that the solar collector manifolds were too far from my storage tank. This was partly my fault: the plumber and the Apricus supplier wanted to install the solar collector on the roof directly above the hot water cylinder, but I was against this because of the very high winds (up to 135 km/h) in our area—and I had a nice space between my PV panels where the Apricus system could sit, as you can see in the photo.



↑ The system schematic explains it all. By adding some PV panels to the system, performance has been improved considerably, with no plumbing hassles!

### What to do?

Our hot water cylinder has 220 litres capacity with an inner coil and a solar input. Because it was an off-the-shelf model it came with a 3000W electric element and thermostat. This element and thermostat had always annoyed me because I was never going to use them—after all it's not an option when you are making your own power.

Around 2009–2010, PV panels started coming down in price and an idea came to mind. What if I purchased a few high wattage, high voltage panels, connected them in series and wired them directly onto my unused hot water element?

So in June 2010 I went ahead and

purchased three 180 watt panels with a rated open circuit voltage (Voc) of around 44 volts. I also had a spare 85 watt panel (22 Voc) so I could use that too. This gave me a total of 625 watts into my 3000 watt element. I mounted the panels on the rear part of our roof and wired a volt and amp meter inside the hot water cupboard so I could calculate wattage from the readings (watts = volts x amps). I angled the PVs at 60° to maximise output during the winter months. I have since discovered that this is the best angle for our latitude (Dunedin is 46° south).

### Results

The results were instant. The first sunny



day temperature gains were beyond my expectations. That day was 5 July 2010, just 14 days past the shortest day of the year, so I didn't expect too much. To my surprise, at around 4pm the cylinder temperature was over 62°C. Normally our cylinder drops down to about 55°C most nights, so this would be the starting temperature most days. I noted that the temperature still went down in the morning until about 12.30pm and then went up, up, up.

Six months later I replaced the 3000 watt element with a 2 x 1500 watt model. This gave me three different wattage options to match to the PVs. I finally settled on using 1 x 1500 watts, giving me the best overall wattage/power output.

On a good blue-sky day during the summer months, cylinder temperature would often go over 70°C. This would have been a concern if we went on holiday and had day after day of sun. I overcame this problem with the help of a friend.

We designed a circuit using MOSFETs (a type of transistor) and the unused thermostat to switch off the PVs. I have set my thermostat to around 65°C. Remember—you cannot use the standard thermostat to switch this DC voltage. At these high DC voltages (154 volts) and a current of between 4 and 5 amps, arcing will occur when using AC-rated switches. My MOSFET circuit, in conjunction with the thermostat, has been working faultlessly now for over two years.

### Understanding the results

I am very happy with the results and think I understand what is happening. The PVs are heating the lower water in the cylinder. This comes about because the PVs are producing a maximum of 600 to 700 watts depending on the sun, air temperature and the time of day into the 1500 watt element. This PV power builds up slowly and is not enough to move

### Maximising energy input

When connecting a variable output device such as a photovoltaic panel to a load with a fixed power requirement (and hence a fixed resistance) such as a heating element, you will only be able to gain maximum advantage from the panels in a narrow band of output currents from the panels. As the current falls, so does the voltage across the element (and hence the solar panels). So, for example, at 50% of maximum panel current you are actually only generating 25% of maximum panel power.

As Michael did, you would normally assume that the output current of the panels is close to maximum and so select the panel voltage and/or element rating to make best use of the panels' output, but at lower insolation levels you will lose useable energy.

One US company has solved this problem with their maximum power point tracking controller for solar PV water heating. Called the Liberty Box, it matches the output of a solar array to the element in a hot water cylinder. Operation is similar to a MPPT battery charging regulator, and while it is designed to operate at US element voltages, there's no reason why you couldn't use it with any water heater, provided you used an element with a similar resistance and appropriate power rating.

It seems that there may be an opening for a potential market here. As PV prices continue to fall, we expect to see a lot more interest in direct PV water heating. For more information, see [www.usa-eds.com](http://www.usa-eds.com)



the warm water to the top of the cylinder—known as the layering effect. Consequently this water is pre-heating the cold water going through the pump to the first 20-tube manifold.

### Other thoughts

The beauty when using PVs is that there is very little transmission loss—unlike hot water pipes! Also it's not difficult to switch off the energy from the PVs, eliminating potential overheating problems of the solar hot water panels.

By mounting my PVs on our 8° negative sloping corrugated iron roof, we get a small reflective gain into the PVs throughout the year. Also, because they're not mounted directly on the roof surface they get plenty of air and wind around them. This gives them a slightly higher output as they run cooler.

I remember one morning during winter we had a snowstorm passing through and the outside air temperature was 4°C. When the clouds opened up just after noon the total PV wattage exceeded their rated value by over 100 watts for a short time until they warmed up, at which time the readings dropped back.

I want to thank my close friend Murray McGregor for helping me with the MOSFET switch circuit.

In addition, I have updated my system and hope to have it in a future issue of *ReNew*. ★

### References

1. [www.ariston.co.uk](http://www.ariston.co.uk)
2. [www.bit.ly/Nn8jz5](http://www.bit.ly/Nn8jz5)
3. [www.switchenergy.co.nz](http://www.switchenergy.co.nz)
4. [www.solarnetix.com/solar-thermal-controllers](http://www.solarnetix.com/solar-thermal-controllers)

### Warning

DC voltages above 120 volts are classed the same as mains voltages (termed low voltage, see [en.wikipedia.org/wiki/Low\\_voltage](http://en.wikipedia.org/wiki/Low_voltage)). Only qualified people, such as renewable energy system installers, should work on systems involving these voltages. For a list of your closest installers, see the Clean Energy Council's accreditation website at [www.solaraccreditation.com.au](http://www.solaraccreditation.com.au). You should also check as to whether it's legal in your area to connect solar panels directly to a water heater.

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WATER MANAGEMENT

# Green on the water—an update

## Challenges of living on the water



When his low-footprint catamaran (described in *ReNew 120*) was finally ready, Geoff Chia was unable to move aboard due to shore-based commitments. Instead, he asked Stef Palmer to boatsit for a few months. She gives us a ‘liveaboard’ report.

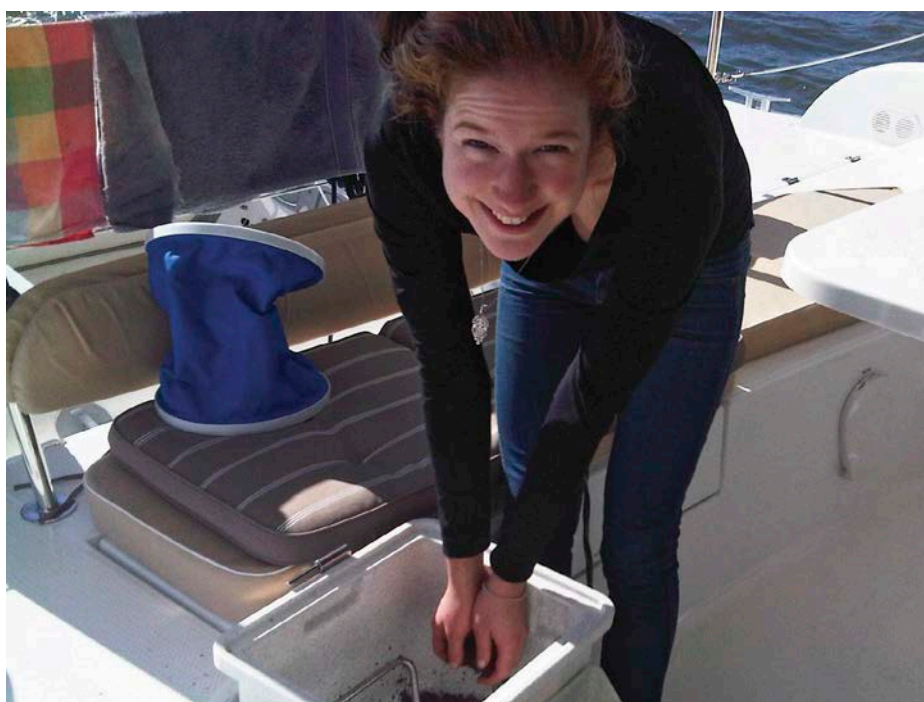
WE are facing a mounting number of global challenges: resource depletion (especially petroleum), climate change, ecosystem damage and over-population. These problems are largely attributable to our over-consumption and wasteful habits. By some reckonings we would require the resources of between four and eight planet Earths if developing countries were to reach our current rate of over-consumption. Such an outcome is clearly impossible. As a result, enforced energy descent looms before us as an increasing threat to the world economy and to world peace.

The concept of voluntary contraction and convergence has been mooted as an equitable means of distributing Earth's increasingly scarce resources. But how do we convince the rich world to make do with less? One way is to demonstrate the viability of pursuing a low-footprint lifestyle without compromising quality of life.

I embarked on the adventure of living aboard Geoff Chia's Mahe 36 to help test and refine the boat's systems for sustainable living. The past few months have been a crash course in sustainable technology and the logistics of living aboard. It's been eye-opening and exciting for me, and I share my observations and experiences in the hope that these may inspire others to strive for a comfortable low-consumption lifestyle, whether on land or water.

### Electricity and appliances

Generating, storing and inverting sufficient power proved to be the most significant challenge to demonstrating the possibility of a low-carbon, high-amenity lifestyle on the boat.



↑ Stef activates peat moss for the composting toilet.

The objective was to power a full suite of mod cons using the boat's solar array. We managed to power all DC systems (e.g. the water pump, ultra-efficient fridge, low-current LED lighting) primarily on solar power. However, powering the washing machine, rechargeable vacuum cleaner and Mac laptop proved trickier. They require AC input and thus require the use of the high-power inverter and so draw significantly from the batteries.

There were a number of situations where I had to run the diesel engines to keep the batteries sufficiently charged. A few consecutive cloudy days and the slightest

glitch, such as leaving on the inverter, a water tap (and hence pump) running continuously (a beginner's mistake never to be repeated) or even falling asleep with a few LED lights on, and the batteries were soon depleted.

We used a DC to DC converter (eg 12V to 9V) or a low power inverter (150 W) rather than the built in 800 watt inverter where possible (depending on the electronic device in use) and thus reduced energy losses. I became rather strategic about timing my use of energy; I also switched from my colossal MacBook to a small notebook computer with much lower energy needs (but still with full multimedia

functionality including digital HDTV).

Spacing out laundry loads and charging appliances while ample direct sunlight was available were simple yet effective measures that helped reduce usage of the batteries. It became possible to go for weeks without needing supplementary charging, so long as the days were sunny. Additional solar power and storage is still on the drawing board, to ensure sufficient energy is available without the need to run the engine after a couple of cloudy days.

### Solar hot water system

The solar hot water system proved a little disappointing. It was effective on sunny days, but the water temperature was a bit low—nowhere near as hot as a commercial domestic hot water system. On cold, overcast days, the system had to be supplemented by stove-heated water. Geoff plans to look into improving efficiency with added insulation.

### Fresh water

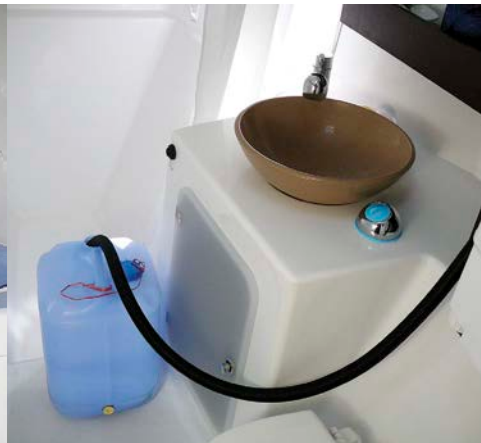
Living aboard for a few months certainly demonstrates the value of water! Despite unseasonal rainfall earlier this year, it was not possible to harvest and store enough rainwater. As Geoff noted in *ReNew 120*, the coach roof area for water collection is small, as is the size of the tank that can fit on the boat. It is intended that the boat will be fitted with a watermaker when the boat's energy storage and solar generation capacity has been boosted. In the interim, able-bodied visitors were recruited to help haul jerry cans of tap water to the vessel, rowing them from pontoon to boat.

This fresh water is reserved for drinking, bathing and laundry, while greywater (from the washing machine rinse water) is harvested for the initial scrubbing of dishes and the decks. Not a drop is wasted, from the three-litre shower technique (also described in *ReNew 120*) to my dishwashing method. My daily rituals have been honed for conservation and the boat's many guests have been surprised to learn just how easy it can be to conserve fresh water with a bit of forethought.

The only unfortunate thing about being moored in the Brisbane River is that the polluted brackish water is really only usable for the lowly tasks of scrubbing growth off the hull of the dinghy tender and flushing the marine toilet (which is used solely as a urinal).

### Waste

The most common onboard sewage option is to fit a holding tank which can be periodically



← After the wash water has been discharged, the drain outlet of the washing machine is connected to a hose that fills a jerry can so that we can harvest the rinse water as greywater for reuse,

pumped out into the on-shore sewage system. Alternatively, present legislation allows the discharge of class C waste, where sewage is macerated and chlorinated before being expelled into the river. Neither of these options satisfied the sustainability criteria of this project and so a compost unit was sourced. I must confess this was my greatest concern about living onboard. I had a terrible fear the toilet would emit an unbearable stench or, worse still, leak!

Something we didn't initially consider was bug-proofing the ventilation intake. Soon after putting the compost toilet into operation, tiny fruit flies began to appear—not a pleasant situation. This problem was, however, easily solved: initially with a decent dose of (not-so-sustainable) bug spray and finally by applying a gauze screen over the air-intake vent.

Ten weeks in, I am onto my second batch of compost and the system has proved most satisfactory. Dear reader, allow me to reassure you there is nothing to fear. The process is fairly easy.

A peat moss brick is used to establish a high carbon-to-nitrogen ratio and provide the microbial colony which undertakes the humble job of turning solid waste into benign soil. Wood shavings and nutshells are added to keep the compost aerated and dry. We learnt along the way that you can't use sawdust as it absorbs moisture and causes the compost to clump; nor can you use pinewood as it has an antimicrobial effect. It also needs to be churned at least twice a day to keep it suitably aerated. The odour, as stated in the

marketing literature, is merely an earthy, mossy, not unpleasant smell, which is only detectable when the lid is up.

### Food storage and preparation

Both stove and oven are LPG powered. Despite being a keen dinner party hostess, I managed to make a single 3.7kg LPG canister last seven weeks, and the second canister is set to last even longer as I have recently been experimenting with raw foods. Even surplus boiled water is kept warm in a thermos to save on energy to reheat it. Eating less meat and using powdered milk also meant that the freezer and fridge, although fully functional, were hardly needed. Furthermore, a vegetable-based diet reduces the energy embedded in foodstuffs.

### Commute

I was fortunate to live, work and shop all within a two kilometre radius. Commuting to land was relatively straightforward using the kayak for solo trips and an inflatable dingy for carting guests, groceries and water. With a little adjustment I managed to make it to work every day in my suit without using a drop of fossil fuel.

Many of us have ideas about living sustainably but few of us land dwellers have the knowledge, resources and determination to obtain and implement the necessary systems. With a well-planned setup, a few pearls of wisdom from my dear neighbours afloat and Geoff's determination to refine and improve the houseboat, his Mahe has become a comfortable low footprint dwelling. ✨

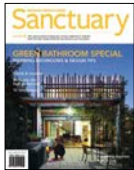


# Shop with the ATA



## Books, kits and energy-efficient devices

These are just some of the products available in the ATA Shop. To browse the full range and place an order go to [shop.ata.org.au](http://shop.ata.org.au), or fill out and return the form at the bottom of the page.



### Sanctuary: modern green homes issue 20

Price: \$11.95

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(No member discount on this item.)



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Price: \$7.50 (print) and \$5 (PDF; free for ATA members)

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### Solar system for an East Timorese family

Price: \$250

Give the gift of light to families in East Timor. Support the installation of clean green energy by giving to the ATA Village Lighting Scheme. This donation is tax deductible. (No member discount on this item.)



### LED economy bayonet bulb 5W warm white

Price: \$19.50

These economical warm white LED units draw only 5W yet produce the light equivalent of an average 60W incandescent. Simply plug-in in place of a standard bulb. They should last for decades under normal use. Available in bayonet and edison screw base. Not dimmable.



### East Timor coffee blend

Price: \$8

Treat yourself to a 250 gram vacuum-sealed pack of yummy East Timorese coffee. All proceeds go to ATA's projects in East Timor.

(No member discount on this item.)



### Valvecosy

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ATA members receive a 15% discount on ATA products, except where noted. Ask for your discount when you order!



## Electric cars are for girls

Touted as a 'mostly painless guide to electric vehicles and conversions', this website is dedicated to explaining everything about electric vehicles including politics, conversions, batteries and even electric drag racing.

The site consists of a blog, with posts about all sorts of stuff EV related, as well as a number of fixed pages that cover various topics. The categories listed down the left-hand side include areas such as EV advantages, electric car history and the like.

There's a section about building your own EV, otherwise known as an EV conversion. The key questions, such as motor sizing and what batteries to use, are answered. The pages on the

various components should cover the basic questions most people will have about what makes an EV go.

Dotted throughout the site are useful videos, with EV experts talking on a range of EV-related subjects.

The whole site has a very conversational style. While not the most extensive EV resource out there, it is a great place to get news, inspiration, ideas and opinions about EVs, including EV advocacy, without being bamboozled by technical jargon.

Like most EV websites out there, this one is hosted in the USA and so is fairly US-centric, but most of what applies there also applies here.

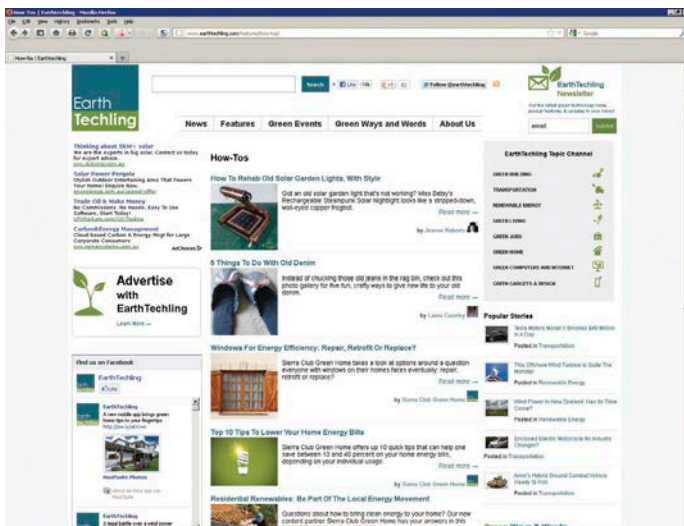
One exception is the topic of neighbourhood electric vehicles



(NEVs)—these are low-speed vehicles designed for use only in local neighbourhoods and so exempted from crash testing standards. Australia is yet to have

an NEV vehicle class, or towns and cities where they can be safely used.

[www.electric-cars-are-for-girls.com](http://www.electric-cars-are-for-girls.com)



## Earth Techling

There are quite a few techie websites out there, and many look at green technology on and off, but Earth Techling is green technology oriented, so there's

plenty to keep the green techie interested.

Earth Techling is a commercial online publication and includes some 'sponsored' articles (a nice way of saying advertorial).

But despite this, there's some interesting stuff to be found on the site.

Like many sites such as gizmag and treehugger, Earth Techling has a news section, an ever-growing list of posts on all manner of topics, from biofuels, solar technologies, electric vehicles and other greener transport options, to recycling and many other subjects.

The features section includes sub-categories such as how-tos, buying guides, interviews, previews (mostly of possible upcoming tech advances) and columns, many of which are cross-posts from other sites.

The green events section is a little sparse and is mostly US-oriented anyway, but it is interesting to see what's

happening around the world.

On the right of the site there's a topic channel list; clicking on a topic will bring up the most relevant posts and articles without having to search.

Of course, there's also the usual Facebook and twitter feeds—what site would be complete without those!

Earth Techling may be a commercial online publication, but it is worth checking out.

[www.earthtechling.com](http://www.earthtechling.com)



# ATA member profile

## Efficiency in action

Sasha Shtargot talks to active ATA branch member Alan Strickland about his 10 years spreading the word on energy efficiency.

YOU could say energy efficiency has always been part of Alan Strickland's thinking—a culture of thrift was as much an element of life in the England-Scotland border country, where he grew up in the 1950s, as the persistent wind and rain.

"Wanting to use renewables to provide power came naturally to the 'something for nothing' mentality of northern England," Alan says. "Trouble was the lack of sun."

So perhaps it was no surprise that the electronics engineer would one day become a passionate and committed member of the ATA in his adopted home town of Adelaide.

In 2003, while working on the electrics for a car competing in the World Solar Challenge through the outback, somebody mentioned the ATA to him. He'd been involved in sustainability groups in England and Australia in years past, so decided to investigate.

"The South Australian branch had been in recess for a while and Hugh Grundy bravely decided to revitalise it," Alan says. "He organised the first meeting, spread the word that something was happening and we were off."

An enthusiastic ATA group emerged, running monthly meetings with presenters and operating information stalls at events such as the Home Show and rural fairs. An early highlight (and test) was the Uraidla Show in the Adelaide hills, where the group held a small marquee on renewable energy.

"The first year was in driving rain and freezing cold. The next year was 43 degrees. You gain a lot of credibility with the public, especially country folk, by operating in these conditions."

→ Alan out and about at a home show sharing his knowledge of energy efficiency.



Alan was convenor of the South Australian branch for six years and is its current treasurer. He was on the South Australian organising team for Sustainable House Day for 10 years. His dedicated and selfless involvement with the South Australian branch was recognised when he was awarded life membership of the ATA at its 30th birthday celebrations in 2010.

Many highlights come to mind when he looks back over the past 10 years: well-attended public meetings with stimulating speakers who capture people's imagination; the branch being contacted by the media to explain energy efficiency; good attendances and positive responses at Sustainable House Day. Four years ago, a packed crowd of 110 people came to a meeting the SA branch held on electric vehicles. A Designers' Forum with a panel of sustainable home designers also attracted enormous interest.

"Years ago we'd run an information stall and people would ask questions like 'Why do you do it?' Nowadays they ask 'How do you do it?'"

Alan says people are typically interested in the 'bricks and mortar, how-to stuff' of sustainability: the practicalities of installing and running solar PV on their roof, the ways you can achieve passive solar design and save on heating and cooling costs. Community organisations like the ATA do a lot of the education and publicity that should also be done by governments.

"The most encouraging aspect (in recent times) is the developing public interest in energy efficiency and renewables," Alan reflects. "Years ago we'd run an information stall and people would ask questions like 'Why do you do it?' Nowadays they ask 'How do you do it?'" \*



The ATA branches are an active lot. To give you an idea of the sorts of events and activities in the branches, here's what they've been doing recently.

**Adelaide:** Adelaide branch members paid a visit to the factory of Australian-owned solar panel company Tindo Solar on 16 July. The branch organised houses for Sustainable House Day on 9 September.

**Tasmania North:** Paul Gilding, author and former head of Greenpeace, spoke about the global sustainability crisis at a public meeting organised by the branch in Launceston on 21 August. The branch also held an ATA stall with displays at the Queen Victoria Museum and Art Gallery's Energise Day at Launceston on 11 August.

**Perth:** Perth branch co-hosted an information evening: getting the facts right on solar PV Systems, on 18 July at Morley.

**Sydney Central:** At its August meeting, Sydney Central branch discussed sustainability and apartment buildings, with a guest speaker from Green Strata. In July, the branch investigated the technology, products, applications and challenges of LED lighting.

**Sydney West:** The branch was working to open the Hawkesbury EarthCare Centre for Sustainable House Day.

**Brisbane:** Peter Casey from Energex spoke about the structure of new tariffs and how consumers can use them to reduce their bills at Brisbane branch's meeting on 26 July.

**Melbourne:** Homes with no heating or cooling and cool roofs were the discussion topics at the 15 August branch meeting. Guest speakers were designer Tim Adams and paint and roof specialist Perry Eckhart.

**Melbourne EV:** The branch co-hosted a showing of the film *Revenge of the Electric Car* on 10 August. Byron Kennedy spoke about Team Solar Dog and the challenges of making an electric vehicle to cross Antarctica at Melbourne EV branch's meeting on 25 July.

**Geelong EV:** The Geelong EV branch held a regular meeting on 4 August at Gordon TAFE. It had its AGM with an update on recent activity and projects at its July meeting.

**Cairns:** The branch held a stall at the Cairns Sustainable Living Expo on 15 July and is helping to promote the Cairns and Far North

Environment Centre's guide to retrofitting homes for sustainability. Convenor Daryl Douglass will judge a sustainable design competition for a local primary school.

**Sunraysia:** Sunraysia branch is organising to open several homes for Sustainable House Day.

**Coffs Harbour:** The branch organised for back copies of *ReNew* and *Sanctuary* to be distributed at the Bellingen Energy Festival on 28 July.

**Canberra:** Off-grid solar PV was the topic for discussion at Canberra branch's meeting on 25 July at Australian National University.

**Warkworth, NZ:** Check the ATA website for more details about Warkworth branch activities.

**Blue Mountains:** Check the ATA website for more details about Blue Mountains branch activities.

To find out more, or to join a branch, see [www.ata.org.au/branches](http://www.ata.org.au/branches).



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# The Pears Report

## A fundamental technology shift

As energy generation evolves, centralised energy companies will need to evolve as well, or face extinction. Alan Pears explains.



WE are part of a vicious technology war on many fronts, as entrenched interests struggle to defend their turf. The fundamental shifts are from traditional physical, centralised technology solutions to a rapidly evolving mix of virtual, decentralised, modular, retail-focused solutions. In media, we see online versus hard copy battling. In transport, virtual transport via communications and electronic devices compete with physical transport and service provision. In water, traditional large water and sewage networks with large dams and treatment plants confront efficiency, local solutions and even waterless solutions. In energy, the battle is between traditional centralised energy systems and the combination of virtual solutions, smart management systems, high efficiency and distributed generation.

Commentator Giles Parkinson has described the crisis facing the electricity industry as its “Kodak moment”: Kodak was an early leader in digital photography, but couldn’t bring itself to cannibalise its core film business by promoting its new approach. So others did it. All existing communication, energy, water, and goods and services retailers are desperately trying to develop new business models and undermine, out-compete or absorb competition from agile, mass-produced, consumer-focused alternatives.

A recent paper from energy company AGL (*Economic Policy Working Paper 31*) revived the 1980s term ‘death spiral’ as it discussed the future of conventional energy companies. Their cost structure is dominated by capital costs and assets that take a long time to build and last a long time. If energy consumption stops growing (or declines) while peak demand keeps rising, they have to spread

increasing fixed costs across lower than expected sales. So they must increase prices and fixed charges to balance their books—but this makes competing options more attractive, which makes the situation even worse: the death spiral.

Policy makers are struggling to understand the emerging reality. For example, they still treat electricity networks as ‘natural monopolies’ and look at emerging technologies in terms of their impacts on the existing electricity industry. As I pointed out to the Victorian Competition and Consumer Commission, mobile phone businesses are not paid based on how much they save landline networks. So why are emerging energy solutions such as PV paid based on how much they save incumbent electricity companies?

The existing electricity industry faces a fundamental problem: the harder they work to block emerging competitors, the more they encourage new solutions and

the greater the risk of pent-up demand for alternatives exploding uncontrollably when costs fall enough and technology works well enough. PV is a great example: denying PV owners a fair feed-in tariff encourages a shift to including storage and even going off-grid. Major appliance manufacturers such as Samsung are moving into these markets with enormous economies of scale and sophisticated retail marketing capability.

As the AGL paper points out, these developments create potentially serious challenges for social justice policy. Wealthier people are better placed to invest in PV, energy efficiency and storage to manage their costs. AGL points out that, while families with children at home comprise only 16% of their customer base, they are 24% of customers at risk of disconnection. Yet many are not eligible for welfare support. These families are paying the price for succumbing to building industry marketing and government incentives to buy



← Energy generation is steadily becoming more decentralised, with more and more buildings being fitted with photovoltaic systems.

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“Commentator Giles Parkinson has described the crisis facing the electricity industry as its ‘Kodak moment’”

big, inefficient houses on the urban fringe with poor access to public transport and services. So their problems go far beyond their difficulties with electricity bills.

If we focus on reducing peak demand as well as total consumption, the ‘death spiral’ can be managed. As US energy expert Amory Lovins pointed out many years ago, the electricity sector depreciates the value of its assets each year, gaining tax benefits. So as long as they don’t have to build more capacity, they can hold energy prices stable while consumption continues to decline.

As part of our attack on peak demand, we will face a choice between higher fixed charges and time of use (TOU) pricing. TOU is the lesser of two evils, as high fixed charges are regressive and disempowering. We need to use TOU as part of management of demand, to send signals and manage costs, but we need much more sophisticated and equitable approaches. Victoria’s approach illustrates the problem: consumers pay a high price from 7am to 11pm on weekdays. Low income households can’t work around that structure. Alternatives with lower prices from 10 to 2 would allow them to cook a main lunch meal and run appliances. The peak does seem to pass by 7.30pm, so prices could drop then.

Maybe options with a voluntary limit on peak demand in certain time blocks could also work. In Italy, most households have a 3 kilowatt demand limit—and they think this is pretty normal and reasonable. The Bushlight remote power scheme for Indigenous communities includes negotiated load shedding hierarchies. Their approach shows it’s possible to work with consumers to set priorities to limit peak electricity demand.

As sustainable energy costs decline, there is an increasing financial case for government to deliver social welfare by providing energy efficient equipment and PV systems instead of or as well as traditional energy price reductions. Housing financiers should allow extra funds for higher building efficiency, efficient equipment and PV in their mortgages, and encourage people to consider smaller, more adaptable housing.

### Future carbon prices

Conventional wisdom of economists has it that carbon prices will increase as emission targets tighten. Some politicians claim this will drive increasing costs to the economy. This is simply wrong.

First, tighter emission targets will mean we emit less, so we will have to pay for fewer tonnes of carbon dioxide, offsetting the higher unit price. For example, Treasury expects the greenhouse intensity of Australian electricity to decline by around three-quarters by 2050 (Table 5.18 p.103, Treasury modelling report)—so a carbon price four times higher would have the same overall impact on the electricity price as today.

Second, where we invest in energy efficiency, we save not just carbon cost but also the cost of the energy we would otherwise have consumed. For example, saving 10% of a household’s electricity use offsets its electricity-related carbon cost.

Third, driving innovation harder cuts the carbon cost. A rarely quoted analysis in the IPCC’s 2007 mitigation report (IPCC WG3 Report Cross-sectoral chapter) indicates that more aggressive innovation could cut the 2050 carbon price by 60% for a given target.

Why? Innovation means higher energy and resource efficiency, cheaper renewable energy and lower cost renewable and recycled materials. So investment of income from carbon pricing in innovation will pay off.

### Vale Deni Greene

Deni Greene has been a pioneer in sustainable energy, environmental issues and ethical investment research in Australia since she arrived here from the USA in the early 1980s. Sadly, she passed away in June. Deni has been my friend and colleague for over 20 years. She initially came to Australia to advise on energy options in the Tasmanian Franklin River battle. In the 1980s, she did leading edge studies to show the enormous potential of cogeneration. In 1990, she took on the energy and economic establishment: she produced a brilliant and thorough study that showed Australia could meet its Toronto Target (20% reduction from 1988 carbon dioxide emissions by 2005) while improving the economy by \$6 billion. She paid a high personal and professional price for challenging orthodoxy.

Deni also prepared some of the early life-cycle analyses of appliances, documented the performance of ethical investments, and represented Australia on the development of international environmental information standards. And she built a great solar-efficient house at Aireys Inlet.

We’ll miss you Deni. ✨

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Alan Pears has worked in the energy efficiency field for over 20 years as an engineer and educator. He is Adjunct Professor at RMIT University and is co-director of environmental consultancy Sustainable Solutions.



# Q&A



Do you need to know the best solution for insulating brick walls? How about adding your own double glazing or a false skylight that uses LEDs and a solar panel?

Ask *ReNew* your question via [renew@ata.org.au](mailto:renew@ata.org.au).

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## False skylight design

**Q –**

We have a dark spot in our house that I would like to lighten up with a false skylight. I was inspired by an article in *ReNew* many moons ago. Some time ago I purchased four 12 volt Bell Rock 30-LED cabin lights from Whitworths Marine on a half-price special (item number 49500). They are quite a neat-looking light and are 470 mm long, 35 mm wide and 31 mm high, and rated to draw 0.21 amps per light. They throw quite a good light and allow for some adjustment of angle. Hopefully their design will not cause overheating and I will watch this.

I intend to mount them side by side on the ceiling, approximating the appearance of a skylight. I intend to wire them in parallel and connect them to a solar panel, and I have an old 50 watt panel that hopefully will do the job.

As the panel might supply voltage higher than the rated 12 volts for the lights (at times, say, 18 volts), do you think that I would need a DC to DC converter to keep the supply close to 12 volts? I would like to avoid this if I can but wonder whether the LED lights will tolerate the higher voltage.

I will value any advice that you can give on my approach, especially any problems that you think I may encounter.—Dave Johnston

**A –**

The problem with that proposal is that the panel is much larger than is needed for those lights. They total about 10 watts in total, so if you feed a 50 watt into them, the panel will be sitting up around 18 or 19 volts. That may or may not be a problem for the lights. If they use resistors to limit current, that will be a problem as they will have resistor values designed for around 14 volts maximum—at 18 volts you will be massively overdriving the LEDs.

If they use switchmode regulators to control LED current then you might be okay, but it depends on the IC used in the

converter. Some ICs only go to 15, 16 or 18 volts maximum whereas others go to 30 or 40 volts or more.

In short, you need more details on the lights themselves and how they work.

Really, the idea behind a false skylight is that you match the LEDs to the panel current-wise, so that the LEDs are rated to handle the maximum output current of the panel. By doing this there are no current control or electrical design issues; you just connect the panel to the LEDs and that's it.

Your light fittings are probably better suited to running from a battery-based system or a mains power supply. If you did want to run them from your 50 watt, then you may well need a regulator, either a simple linear shunt regulator to burn off the excess energy from the panel (wasteful) or a switchmode stepdown converter to drop the voltage to 12 volts or so. It will also waste most of the available energy from the panel, just not as heat—it simply won't use it.—Lance Turner

---

## Retrofit double glazing

**Q –**

I have just read Michael Gunter's article in *ReNew 81* on how to fit 'double glazing' by adding a second panel to existing windows. His article does not mention the condensation factor, so I wondered if you could give me some input on how he has overcome this potential problem.—Denis Kennealy

**A –**

Even though my white Selley's butyl mastic cracked, and I was therefore forced to retain the new glass panes with a strip of clear silicone sealant, we never had a problem with condensation. This was probably just good luck related to the overall draughtiness of the old house and the regular use of a kitchen extractor fan, both factors keeping indoor humidity in cold weather to relatively low levels.

I had enquiries from someone who

seemed to be turning the concept into a small business. He recommended getting a top-quality automotive windscreen sealant, apparently available at Bunnings, and black! He found it very successful. Anything that makes the glass stick permanently and is not porous to water vapour has to be a good thing, but I have not tried this other adhesive.

So my experience (only one house!) is that condensation was not a problem, although glaziers and double-glazing salesmen probably think I'm lying!—Michael Gunter

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## Electric ride-on mower

**Q –**

A couple of issues ago you reviewed an electric ride-on mower that you were using in Tassie. I was just wondering if, a couple of months further down the track, you are still impressed? We have a quarter-acre to mow weekly in the spring.

Also, I think I saw a catcher on the back. Did I see right and does it work well? And would you buy the same again now?—Steve Clarke

**A –**

The mower has been pretty good but I had to do a repair on the rear differential as it was assembled with a lot of slop in the gears. I treated it pretty harshly, much more so than what it was designed for, and the diff started to slip.

Opening it up I found that one of the small gears had a fair bit of wear, so I cleaned out all the grease and metal particles and added a 4 mm spacer to one shaft to tighten it all up, and repacked it with copper-based grease for wear resistance. But, as we only have a small lawn in our new house, I haven't had a chance to test it.

The electronics has all been fine, with no issues there really. The catcher didn't work well as the grass I was cutting was too thick and long. The mower is really designed for maintenance mowing, not taming Tasmanian cow paddocks!

If I had the money and a large area to mow I would go for the Hustler Zeon. For your uses, the Tandem Power unit might be overkill; a standard rechargeable push mower might be a better option.

All the commercially available cordless mowers seem to have small battery capacities and are designed to cut small areas. I used to own a Black & Decker Stealth unit which would cut a quarter-acre block and was an excellent mower, but there just doesn't seem to be an equivalent nowadays. They do come up on eBay from time to time, but another option might be to convert a petrol mower. It's a fairly simple task and DC motors are readily available at low cost.—Lance Turner

## DC refrigeration

Q –

In *ReNew 103* you listed a number of 12 and 24 volt fridges, including some converted from 240 volt units by Conergy. Conergy's website does not appear to mention fridges. Do you know if they still do these fridge conversions or if there are any other suppliers of efficient domestic fridges?

I am looking for either a 12 volt DC or 240 volt AC unit of around 200 to 300 litres capacity, which is well-insulated and does not consume power when the compressor is off—i.e. without any 'frost free' heating.

—David Robson

A –

There's not much in the way of DC fridges around now. AC units have become so much more efficient and are much cheaper, so even most independent systems end up using an AC fridge.

However, I'm not really a fan of doing it that way due to the reliance on the inverter. If the inverter dies, all your food is ruined unless you can replace the inverter quickly—something which is not always possible.

One thing a lot of people have done is to convert chest freezers into fridges. Some

models of Haier, Vestfrost and various other brands work well. They are still 240 volt powered, but have a lot of insulation and a long hold-over time. You'll find an example at [www.mtbest.net/chest\\_fridge.html](http://www.mtbest.net/chest_fridge.html). There's also been discussion on the ATA forums about this approach.

Another option is to make your own. This is common for marine uses; companies such as Waeco ([www.waeco.com.au](http://www.waeco.com.au)) make equipment to allow you to make your own fridge using a Danfoss compressor. You select the right evaporator and condensor to suit the size of your cabinet, and then put it all together.

Camec appear to still be making the Vitrifrigo range of DC fridges; check out their appliances brochure at [www.camec.com.au](http://www.camec.com.au).

Or you could go 240 volt and find the most efficient fridge you can. Check out the star ratings at [www.energyrating.gov.au](http://www.energyrating.gov.au) to see which fridges of each type are the most energy efficient.—Lance Turner

## Brick cavity insulation

Q –

I live in Sydney and my house has double-brick cavity walls which are painted on the outside. I'm renovating the attic and have access to the brick wall cavity from above. The cavity is about 5 cm wide and I was thinking of putting in blown-in insulation.

Is it okay to do this in Sydney? I've heard different opinions, with some saying that there's a risk of moisture penetration. If it is okay to use blown-in insulation, what material would you recommend?

I had termites so I am not keen on cellulose, and it is also not hydrophobic, and foams are too chemical. The *Your Home* technical manual recommends Rockwool granulate, but the Rockwool company has advised that none of their granulated products is suitable for this purpose.

I'm thinking of using perlite. I had a look at the product description and can't find any reason not to use it. It seems to be

hydrophobic, light, non-combustible, safe for cables, and I can do it myself.

Any thoughts or recommendations would be much appreciated.—Zofia Perkowska

A –

The problem with double brick cavities is that the surfaces inside the cavity are very rough, with lots of cement dags, brick ties, etc in the way, so anything fibrous is going to be difficult to install.

There are a few options, including envirofoam, which is supposed to be VOC and CFC free: [www.envirofoaminsulation.com](http://www.envirofoaminsulation.com).

Another option is Insulbloc. This is recycled polystyrene, cut into small cubes, which is then blown into cavities; see [www.insulbloc.com.au](http://www.insulbloc.com.au). My main issue with this material is during house deconstruction—it would be a very messy process, with a lot of the material escaping the work site, I would expect.

Perlite is also an option as it insulates well and is easily blown in and is a natural, if not renewable material (see [en.wikipedia.org/wiki/Perlite](http://en.wikipedia.org/wiki/Perlite)). Given that, I would think that perlite is probably your best option.

—Lance Turner

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We welcome questions on any subject, whether it be something you have read in *ReNew*, a problem you have experienced, or a great idea you have had. Please limit questions to 200 words.

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Advanced ECO Solutions.....	93	Jaycar Electronics .....	2-3	SolarWorld.....	7
Aquamonitor .....	26	Landcom Eco Living Display Homes .....	19	Solazone.....	35
Aussie Batteries & Solar .....	35	Latronics .....	IFC	Solco.....	14
Australian Clean Energy Fund - Aquatronic.....	27	LC Energy .....	47	Solon .....	67
Australian Correspondence Schools .....	93	Low Energy Developments.....	41	Something Solar .....	46
Australian Ethical Investment .....	IBC	mepfilms .....	9	Steplight.....	50
Carbon Trading International.....	69	Midland Insurance Brokers .....	63	Subgreen Design .....	87
Delta Energy Solutions.....	50	MPOWER .....	51	Successful Solar Books.....	78
DC Solutions Australia.....	1	MR Components .....	63	Sungrow Australia .....	40
Eco Drive .....	34	NOWarchitecture .....	35	The Natural Paint Company .....	47
EcoFlo Water Management.....	81	PowerSupplies Australia .....	41	The Owner Builder Magazine.....	41
EcoInnovation - Powerspout .....	35	Powerup Lawncare Products.....	13	Timor Adventures .....	96
Energy Conscious Design/Splash Monitoring.....	47	Prestige Lighting .....	63	V-ZUG.....	18
EnviroShop.....	47	Rainbow Power Company.....	87	Watersweet Pty Ltd .....	77
Excelsior Power.....	15	Run On Sun Australia.....	15		
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# Personal Computers

## A plethora of parts



Old PCs can be useful, even if they have passed their useful life as a computer—they are full of components just waiting to be reused. Julian Edgar shows you all the goodies that can be salvaged.

PERSONAL computers are among the most common of electronic goods thrown away. So is it worth picking up discarded ones and pulling them apart for their good internal bits? The answer is usually 'yes'—and two different paths can be taken.

Firstly, if you're really into PCs, you may be able to salvage useful items such as sound and video cards, DVD drives, the power supply or even the motherboard. However, the pace of change in PC hardware is so great that in many cases these parts will be outdated or not compatible with other components. But if you know your PC hardware inside out, making use of complete assemblies is the most efficient way of recycling computer parts.

And then there is another way—the approach I'll use here. So what's that then? It's to disassemble the PC down to its component level—obviously, not to every single electronic component, but to the level where you grab just the bits that are useful. So stand by as I get inside the hard drive, the floppy disc, CD drives and the power supply! Incidentally, pulling apart the hardware to this level shows how the 'moving parts' of a PC work—ideal for kids who might see the computer as just a 'big box'.

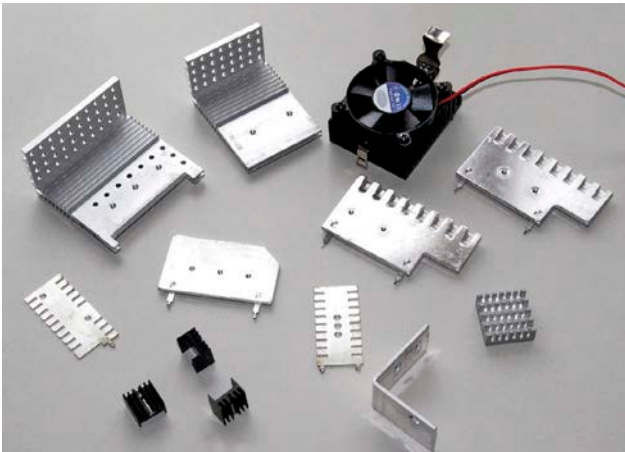
The items shown here were salvaged from two PCs picked up at random at the local rubbish dump.



→ You don't usually think about a PC as having lots of salvageable plugs and sockets—until you look inside. There are 1/8 inch stereo sockets (on the sound card), multi-pin DC plugs and sockets (on the power supply, motherboard and disc drives), IEC power sockets, and lots of other plugs and sockets!



↑ Floppy disc, CD, DVD and hard drives have small brushed and unbrushed motors inside them. The easiest to remove and use are the motors that drive the CD tray and move the laser—like the four shown here. These are very small motors: the pictured ones are only 25 mm in diameter and 10 mm thick! The larger one up the top is a brushless motor from a hard disc drive.



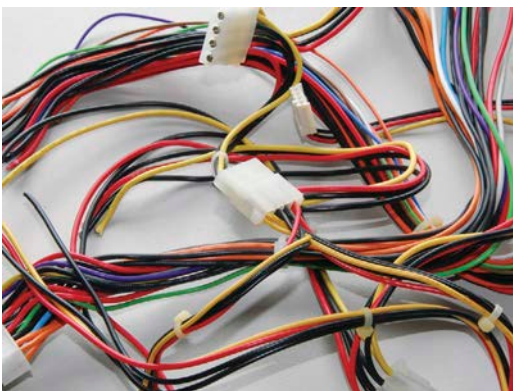
↑ Inside a typical PC you'll find an excellent range of small to medium size heatsinks. As well as the fan-cooled heatsink on the main processor, you will often find smaller heatsinks on the motherboard. Inside the power supply is a range of heatsinks, from ones designed to work with three or four components to others designed for a single component. The 13 heatsinks shown here were salvaged from just two PCs—and one of those no longer had its main processor heatsink!



← If you want to fold up enclosures or make small brackets, or you need coated sheet metal for any other purpose, there's plenty available in the PC enclosure and the disc drive trays. You can also use the whole PC enclosure as a large box, or gut the power supply and have a smallish fan-cooled box complete with an IEC power socket and (often) a mains power switch.

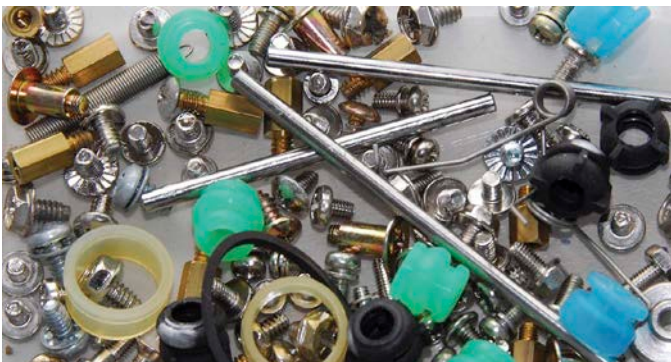


← I can remember back in what seems like the dark ages when low voltage cooling fans were quite expensive. Well, that time is sure past now—these days, fans are free! Also able to be seen here are two fuses, three miniature pushbuttons already soldered onto wires, three LEDs and a buzzer (again on wires), one mains power rocker switch, two mains power slide switches and two large cable clamps/grommets.



← Always snip off and keep the power supply DC wires. Why? Well, they're capable of handling more current than typical hook-up wire, are boldly colour-coded and come complete with plugs for which you can easily salvage sockets while you're pulling the PC apart. Inline sockets are also integrated into this cabling. If you need lighter gauge wires, the cables running to the LEDs and reset button usually fit the bill.

↓ Finally, if you have a need for a 5V or 12V bench power supply, don't forget that it's easy to modify a PC power supply to provide this function.



← The amount of hardware quickly salvageable from a few PCs is amazing—this pic shows about half of it. There are machine-thread screws and self-tappers, threaded spacers, rubber grommets, springs, steel shafts, squishy plastic vibration-absorbing mounts, and nuts and bolts.





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A photograph of a woman with a joyful expression, wearing a patterned pink and white shirt, working on a traditional woven basket. The basket is made of light-colored natural fibers and has a wide, shallow shape.

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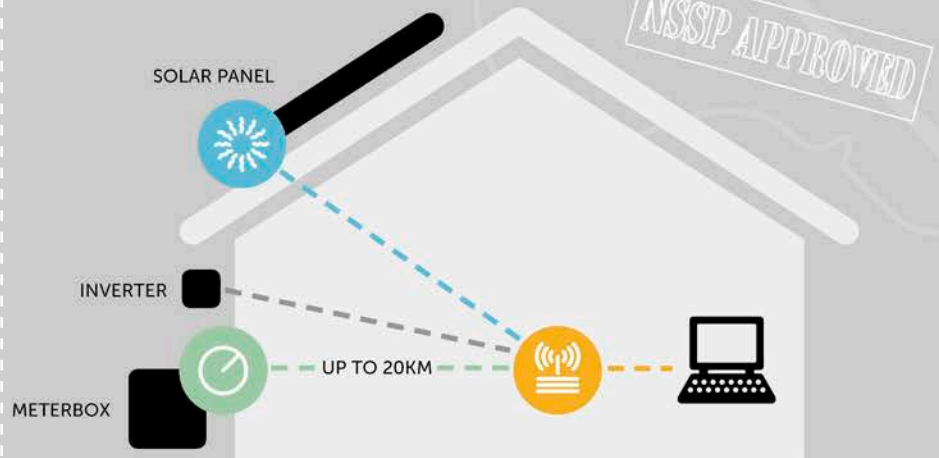


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