ReNew

Technology for a sustainable future

Inside Issue 122
Guilt-free cooling
Pool pump buyers guide
Reuse projects
Solar, wind and EV advice

Choose to reuse

Handmade house
Finders keepers—a tip shops guide
Shipping container homes

WIN
a complete solar power system from Delta Energy!
*Australian residents only

Issue 122 January–March 2013
AU $7.95 NZ $8.95
www.renew.org.au
ISSN 1327-1938
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The reuse issue: the art and heart of reuse + sustainable summertime options for cooling and pools

+ Inverter Buyers Guide

AUSTRALIAN MADE

Don't be left in the dark. Get more out of your panels.

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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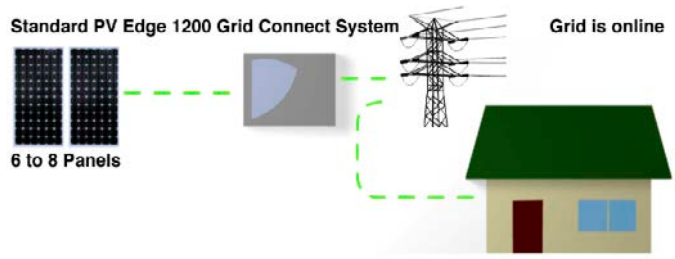
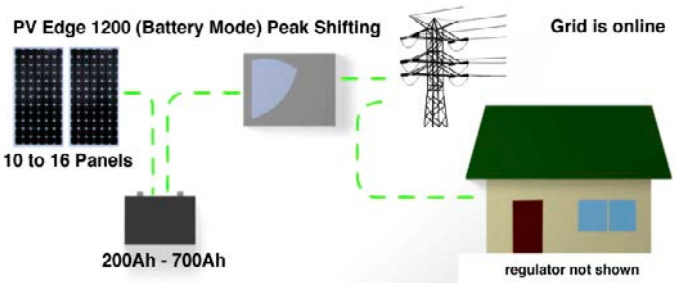
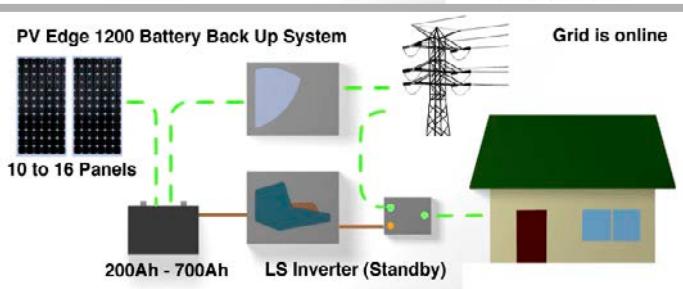


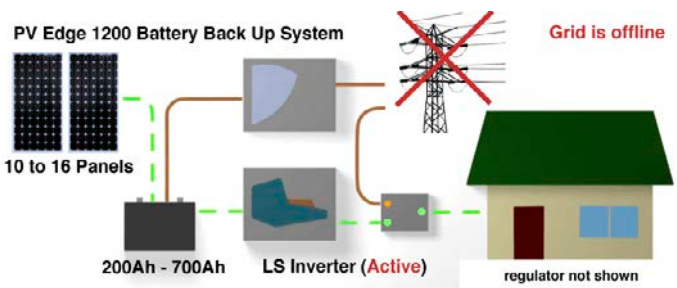
Start off with a standard system, then add panels and batteries for sustained grid output without changing your inverter at all.

Stage 2



Stage 3





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The new Classic Lite, there is nothing "Lite" about it!

MidNite Solar are proud to announce the new ***Classic-LITE*** range of MPPT battery charge controllers. Almost all the features of the regular model, without all the cost.

The new Classic-LITE models have all the same high performance features as the regular model such as up to 250V input, controlling up to 96Amps on a 12V battery (or up to 5kW on a 48V battery) of solar/wind/hydro, Ethernet port, 380 days of data-logging, and of course the now famous super-fast tracking algorithm that outperforms all other controllers.

Without the extra complexity of a LCD or Arc Fault detection, the cost is significantly less making it the best value solar controller on the market today. Simple programming is done via DIP switches and more complex programming can still be done via the Ethernet port and the free PC software included with each unit. User feedback is now done via LED's and a manual Equalise button (auto-Equalise can be programmed via a PC).

The new Classic-LITE is ideal for RV power where relatively inexpensive gridtie solar panels can now be used on a bus or boat and high levels of user information are not needed.

The new Classic-LITE is also ideal when installing multiple units into larger systems or expanding an existing system as all of the programming can be done via the master Classic unit.

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DIY SOLAR & 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.

Recreational Solar Panel Packages

Clean renewable energy wherever you go. Adding this package to your caravan or 4WD gives you a set up that will generate sufficient power to operate or change several appliances - including your laptop, portable lighting, CB radio and 12-24V camping electricals. Just add a battery and cables for your own self-sustained solar powered setup. Two recreational solar package deals to choose from:

80W Standard Package
- 1 x 80W monocrystalline solar panel ZM-9097
- 1 x 12V 8A charge controller MP-3720
- 2 x female PV connector PS-5100
- 2 x male PV connector PP-5102

ZM-9300 $300.00

160W Premium Package
- 2 x 80W monocrystalline solar panel ZM-9097
- 1 x 12V 20A PWM charge controller MP-3129
- 3 x female PV connector PS-5100
- 3 x male PV connector PP-5102
- 1 x solar panel Y-lead 2 socket to 1 plug PS-5110
- 1 x solar panel Y-lead 2 plug to 1 socket PS-5112

ZM-9303 $650.00

FROM $300.00

See website or in store for other packages.

Solar Charge Controller

This professional grade, high current solar charge controller offers the flexibility to suit almost any solar installation. System voltage can be 12, 24 or 48V, and multiple units can be stacked together (up to 10 units max) allowing the system to grow and expand without rendering the old charge controller useless. The unit features an LCD and front panel controls, and can be used as either a battery charger, load controller or diversion regulator. It can also be connected to a remote control for remote monitoring, and are fully protected against reverse polarity, short circuit, high temperature and over-voltage.

Available Separately: This unit is particularly suited to the SuperCombi and CombiPlus units, as they communicate via data cables to exchange charging information.

60 amp MP-3728 $389.00
Remote MP-3729 $129.00

$389.00
MP-3728

Sine Wave Inverter Generators

These inverter generators are petrol powered and differ from cheaper units, as 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.

*Electric key and remote start on 2kW and 3kW models only.

MG-4502

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 $599.00

MG-4501

MG-4504

Pure Sine Wave Inverters

Range in power from 180 to 2000 watts and provide stable and reliable power in mobile and permanent installations. Recommended for products with sensitive electronics, timers or motor-powered devices. In addition to the normal 240VAC outlet, all models have a USB port for powering all your gadgets.

180W	12VDC	Cat. MI-5160	$189
380W	12VDC	Cat. MI-5162	$239
600W	12VDC	Cat. MI-5164	$349
1000W	12VDC	Cat. MI-5170	$599
1500W	12VDC	Cat. MI-5172	$899
2000W	12VDC	Cat. MI-5176	$1199
2000W	24VDC	Cat. MI-5174	$1199

See online for more information.

FROM $189.00

MI-5170 MI-5176

Portable Fold-Up Solar Panel Kits

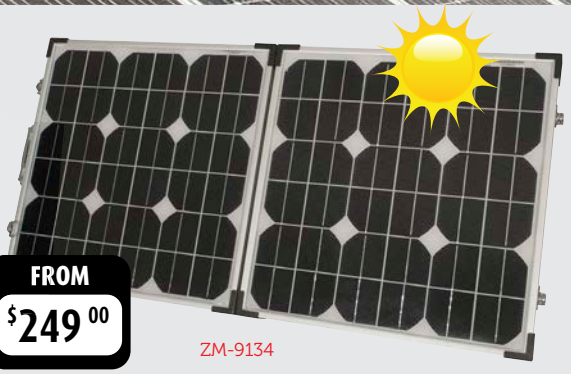
These fold away solar panel and charging kits easily charge a battery (not included) allowing the power to run, lights, TV etc. Each model features folding solar panel with alligator clamp connections on a 10m lead, and has the charge controller included to connect directly to a battery without fear of over-charging. All supplied with a heavy duty metal carry handle and latches, plastic protective corners and a durable nylon carry bag.

- 12V
- Monocrystalline

40W • Open Size: 840(W) x 420(H) x 36(D)mm
Cat. ZM-9132 $249
80W • Open Size: 1090(W) x 623(H) x 36(D)mm
Cat. ZM-9130 $379
120W • Open Size: 1090(W) x 835(H) x 36(D)mm
Cat. ZM-9134 $499

Now Feature 50A Anderson Connectors and 10m Output Cable

FROM $249.00



ZM-9134

Want more info? **Have a burning question to ask?** **www.jaycar.com.au/powertech**

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

12V 5W	ZM-9091	$22.95
12V 10W	ZM-9093	$42.95
12V 20W	ZM-9094	$85.00
12V 40W	ZM-9095	$159.00
12V 80W	ZM-9097	$289.00
12V 90W	ZM-9086	$325.00
12V 120W	ZM-9098	$425.00
24V 200W	ZM-9088	$699.00

25 Year Warranty!

Visit our website to view our full range of panels, controllers, batteries & accessories.

FROM $22.95

Solar Panel Power Connectors & Cables

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

PS-5104

PP-5106

Female In-line Connector	PS-5100
Male In-line Connector	PP-5102
Female Panel Mount	PS-5104
Male Panel Mount	PP-5106

$7.50 Each

UV Stabilised Solar Power cable

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

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

FROM $3.50/m

Two Types Available:
4mm sq. WH-3121 $3.50/m $295/100m roll
6mm sq. WH-3122 $5.50/m $460/100m roll

Roll length 100 metres. Prices per metre.

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.

See website for more details

10 Year Materials Warranty

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

FROM $49.95

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:

End Clamps 35mm	HS-8804	$3.95ea
Mid Clamp 35mm	HS-8805	$3.95ea
Tin Roof Hook	HS-8807	$8.95ea
Rail splice	HS-8803	$9.95ea
Tile Roof Hook	HS-8806	$26.95ea

Cyclone Rated

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

FROM $3.95

Easy to use PV Connectors

NEW

Designed for use with solar systems and feature a unique spring cage connection which attaches to your stripped cable without requiring a specialty crimping tool.

- Silver plated copper contacts
- Current rating: 40A
- Voltage rating: 1100V

IP67 Spring Cage Solar PV Socket
PS-5120 $9.95
IP67 Spring Cage Solar PV Plug
PP-5122 $9.95

See Video on Website

$9.95 Each

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NEW

SAVE POWER!

A range of very bright mains LED light globes that are a true replacement for traditional lighting. Offers a brilliant lumen performance with wide, evenly spread light output across a 270 degree output angle, making them better than traditional light globes in many cases.

- 10W models are dimmable

Watts	Lumens	Colour	Base	Cat.	
5W	300	Warm white	Bayonet	SL-2210	$14.95
5W	300	Warm white	Screw	SL-2211	$14.95
5W	360	Natural white	Bayonet	SL-2212	$14.95
5W	360	Natural white	Screw	SL-2213	$14.95
10W	820	Warm white	Bayonet	SL-2214	$29.95
10W	820	Warm white	Screw	SL-2215	$29.95
10W	900	Natural white	Bayonet	SL-2216	$29.95
10W	900	Natural white	Screw	SL-2217	$29.95

SL-2210

FROM $14.95

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Blacktown	(02) 9678 9669
Bondi Junction	(02) 9369 3899
Brookvale	(02) 9905 4130
Campbelltown	(02) 4620 7155
Castle Hill	(02) 9634 4470
Coffs Harbour	(02) 6651 5238
Croydon	(02) 9799 0402
Erina	(02) 4365 3433
Gore Hill	(02) 9439 4799
Hornsby	(02) 9476 6221
Liverpool	(02) 9821 3100
Maitland	(02) 4934 4911
Newcastle	(02) 4965 3799
Penrith	(02) 4721 8337
Port Macquarie	(02) 6581 4476
Rydalmere	(02) 8832 3120
Sydney City	(02) 9267 1614
Taren Point	(02) 9531 7033
Tuggerah	(02) 4353 5016
Tweed Heads	(07) 5524 6566
Wagga Wagga	(02) 6931 9333
Warners Bay	(02) 4954 8100
Wollongong	(02) 4226 7089

NORTHERN TERRITORY

Darwin	(08) 8948 4043

QUEENSLAND

Aspley	(07) 3863 0099
Caboolture	(07) 5432 3152
Caloundra NEW	(07) 5491 1000
Capalaba	(07) 3245 2014
Cairns	(07) 4041 6747
Ipswich	(07) 3282 5800
Labrador	(07) 5537 4295
Mackay	(07) 4953 0611
Maroochydore	(07) 5479 3511
Mermaid Beach	(07) 5526 6722
Nth Rockhampton	(07) 4926 4155
Townsville	(07) 4772 5022
Underwood	(07) 3841 4888
Woolloongabba	(07) 3393 0777

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Clovelly Park	(08) 8276 6901
Elizabeth	(08) 8255 6999
Gepps Cross	(08) 8262 3200
Reynella	(08) 8387 3847

TASMANIA

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Launceston	(03) 6334 2777

VICTORIA

Cheltenham	(03) 9585 5011
Coburg	(03) 9384 1811
Ferntree Gully NEW	(03) 9758 0141
Frankston	(03) 9781 4100
Geelong	(03) 5221 5800
Hallam	(03) 9796 4577
Kew East	(03) 9859 6188
Melbourne	(03) 9663 2030
Ringwood	(03) 9870 9053
Shepparton	(03) 5822 4037
Springvale	(03) 9547 1022
Sunshine	(03) 9310 8066
Thomastown	(03) 9465 3333
Werribee	(03) 9741 8951

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Mandurah	(08) 9586 3827
Midland	(08) 9250 8200
Northbridge	(08) 9328 8252
Rockingham	(08) 9592 8000

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Christchurch	(03) 379 1662
Dunedin	(03) 471 7934
Glenfield	(09) 444 4628
Hamilton	(07) 846 0177
Hastings	(06) 876 0239
Manukau	(09) 263 6241
Mt Wellington	(09) 258 5207
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Newmarket	(09) 377 6421
Palmerston Nth	(06) 353 8246
Wellington	(04) 801 9005
Freecall Orders	0800 452 922

Dedicated Power Systems Website

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Issue 122, January – March 2013

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The reuse issue
+ sustainable summer guide

↑ The reasons to reuse and where to find second-hand building materials. Page 26.

↑ The care and craft of reuse. Page 28.

↑ A greenhouse on the north side of an earthship helps to both warm and cool the building. Page 40.

Reuse special feature

↓ Recycling paper by blending papercrete for construction in Alice Springs. Page 44.

← **Cover image by Peter Bennetts Photography.** At Skinners Playground in South Melbourne, Phooey Architects used shipping containers to create this children's activity centre. All building materials were scavenged, salvaged or recycled. See **page 36** for more shipping container projects, including a DIY home, a shopping mall in NZ and architects using shipping containers for modular housing.

Sustainable summer

← Plants can alter the microclimate in which a building operates. Page 47.

Sustainable technology

Inverter buyers guide

↑ Watts on wheels, mobile solar arrays. Page 82.

Regulars

About *ReNew* and the Alternative Technology Association

ReNew magazine

ReNew has been published by the Alternative Technology Association (ATA) 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. www.renew.org.au

Sanctuary magazine

In addition to *ReNew*, the ATA publishes *Sanctuary: modern green homes*, providing inspiration and practical solutions for a sustainable home. The current issue features green roofs, bushfire resilient design and an interview with Kevin McCloud. www.sanctuarymagazine.org.au

ATA branches

ATA branches are involved in activities such as running monthly seminars, visits to sustainable homes and projects, and attending community events. See page 87 for a list of recent activities. www.ata.org.au/branches

Webinars

With the support of bank**mecu**, the ATA YouTube channel hosts a series of free online webinars with experts sharing practical knowledge about sustainable living. Webinars include what to look for when choosing a solar PV system, building a sustainable house to suit your site, hydronic heating, retrofitting your home for energy efficiency and more. The next webinar on energy efficient lighting will be available in December. 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

Advocacy and projects

As well as advocating to government and industry, the ATA also conducts research projects with partners from government, industry and community sectors. In a recent submission to the Climate Change Authority, the ATA has called for a stable or expanded Renewable Energy Target (RET). Damien Moyse, ATA's Energy Policy Manager, says this is especially important considering the federal government's recent decision to bring forward the reduction of the solar multiplier, adding $700–$1000 to the price of an average solar system. www.ata.org.au/projects-and-advocacy

International projects

Since 2005, ATA volunteers have installed hundreds of solar power systems, providing lighting for over 4000 East Timorese. They have also trained 20 technicians to install and maintain solar lighting systems. For more information and to make a donation to give the gift of light in East Timor, go to www.ata.org.au/ipg

Publisher: ATA
Editor: Robyn Deed
Technical editor: Lance Turner
Advertising manager: Katy Daily
Proofreader: Stephen Whately
Editorial and production assistance: Beth Askham, Donna Luckman, Sarah Robertson, Stephanie Juleff, Sasha Shtargot, David Ingram
Design templates: SouthSouthWest
Cover design: Subgreen Design

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www.renew.org.au

Contributions are welcome; guidelines available at www.renew.org.au or on request. Next editorial copy deadline: 21 January 2013.

Advertising in *ReNew*

Advertising is available for products and services relevant to our audience. We reserve the right to refuse, cancel and withdraw advertising at our discretion. For enquiries email adverts@ata.org.au or call (03) 9631 5412.

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Booking: 8 February 2013
Advertising copy: 15 February 2013

Printed by CaxtonWeb using environmental best practice and PEFC certified stock. Distributed in Australia and New Zealand by Gordon and Gotch.

$7.95 (Aus) $8.95 (NZ) Recommended Retail Price

Registered for posting by Aust Post: No VBG 4172

ISSN 1327-1938

Reg. No.: A0017411T ABN: 57 533 056 318

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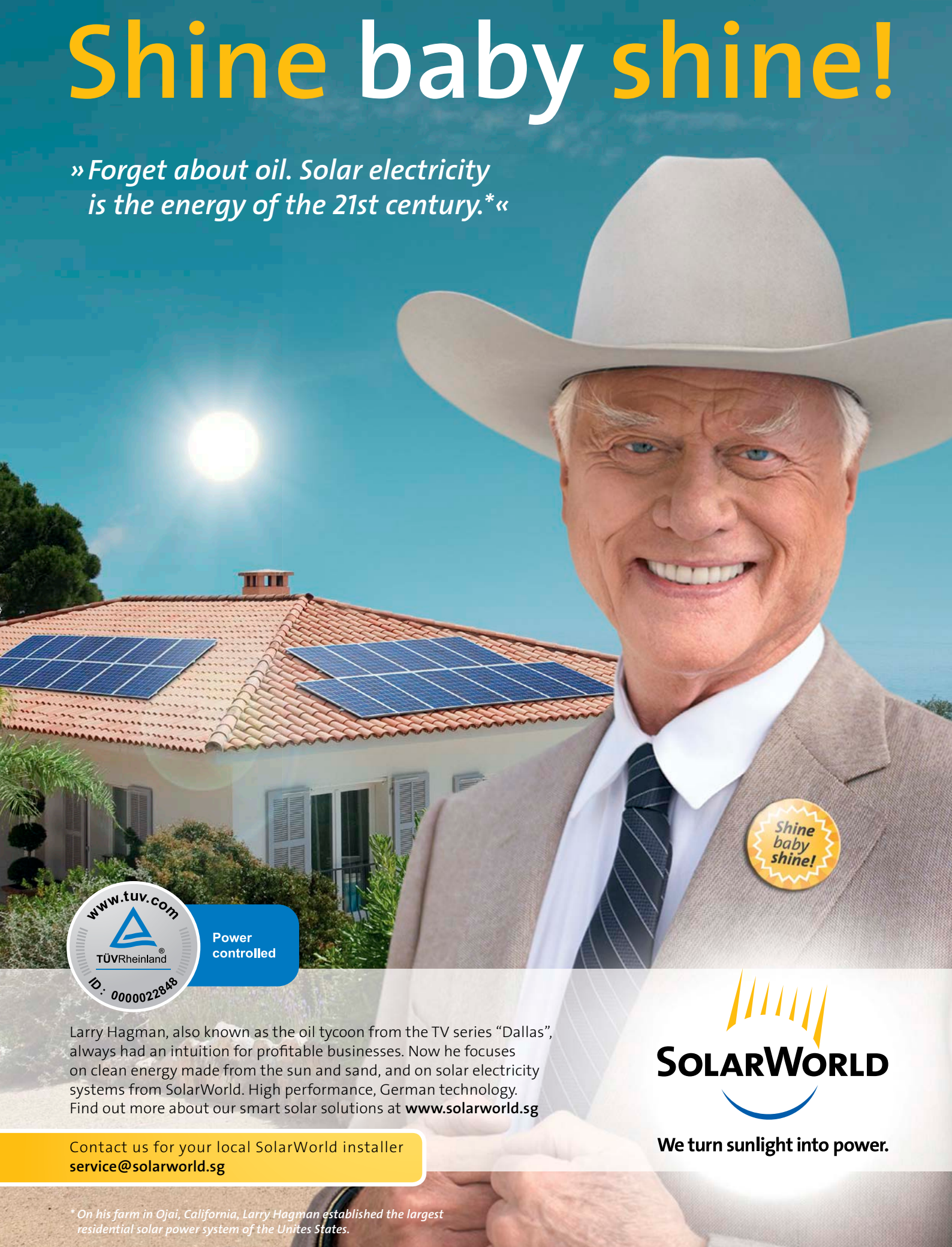
» Forget about oil. Solar electricity is the energy of the 21st century.«*



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

Editorial

Choose to reuse, sustainable summer + survey feedback

REUSE can lead to some of the most original and beautiful builds or renovations, while also reducing landfill and carbon emissions—not to mention the thrill of the find, as any good op shopper will tell you!

The projects we feature in this issue demonstrate reuse at many levels: from whole structures, such as schoolroom portables and shipping containers; to smaller parts of a home, such as a kitchen cupboard carcass or windows that inspire a whole build; through to reuse of the basic building materials themselves, such as timber boards, sheet metal and tyres. The latter are reused in earthship builds, and Martin Freney evaluates just how such builds stack up environmentally.

We also see recycling take it one step further, transforming paper—that would otherwise need to be buried like "pirates' treasure" in Central Australia—into inspired papercrete creations. You'll find these inspiring homes and reuse projects featured on pages 26 to 45.

This issue we also have a summertime focus, with sustainable cooling from Alan Pears—just how far have we come towards guilt-free cooling?—plus our first-ever pool pump buyers guide.

Outside our two main themes of reuse and 'summertime', we also have a host of other articles. We examine safety issues when building an electric vehicle, consider comparison criteria for selecting PVs and set down rules for wind turbine siting, alongside our popular inverter buyers guide, a DIY on moveable PV panels, and more.

I hope you get the chance to chill out this summer with *ReNew* for company. And of course, we'd love to get your feedback.

Survey feedback

On that note, thank you to all our readers for embracing the *ReNew* Readers Survey, with over 900 thoughtful and useful responses. It was particularly helpful to get your feedback on what you'd like to see more of in *ReNew*.

As just a sample: many people wanted to hear more about renewable energy developments overseas, many suggested our DIY and technical articles need to be easier to follow, and many wanted more technical detail, particularly when it comes to house case studies.

Maintenance of renewable energy systems also popped up frequently as a topic of interest, along with energy storage design and economics—these are both topics we've got in the pipeline, so expect to see more on these soon!

Robyn Deed
ReNew Editor

WELCOME readers, to issue 122 of *ReNew: technology for a sustainable future*. Our byline with its reference to sustainability is important, because that is what the Alternative Technology Association has always been about, as have our members and readers. But sustainability is a complex concept, often unnecessarily so, and sustainable futures are very subjective—one person's sustainable future utopia will sometimes look a lot like another person's unsustainable future dystopia.

However, amid the debates, the robust discussions and the downright arguments about climate change and a sustainable energy future—debates where the ATA has made its view clear through the pages of *ReNew*—a very different conversation around waste and recycling has quietly moved ahead. I will stick my neck out here and say that no one seriously thinks we should be wasteful and use more than we need. And very few would argue that we shouldn't find new uses for old stuff, and recycle wherever we can.

The waste hierarchy pyramid used by many in the community and by governments and the waste industry centres around the 'reduce-reuse-recycle' approach, with reducing how much we consume as the goal at the top of the pyramid. But while the third level of the pyramid—recycling—is becoming better supported by everything from kerbside collections to TV advertising reminding us how to separate our recyclables, the layer between—reuse—gets less attention. Which is a shame, as reuse is an area which offers scope for a huge amount of innovation, and a huge amount of cost saving for households and communities.

So we decided to have a theme of materials reuse in this edition of *ReNew*, featuring homes making environmental and cost savings through innovative reuse of structures, along with where to find scavenged materials. Enough, I'm sure, to whet your appetite and get some new and clever approaches going!

Enjoy.

Ian Porter
CEO, ATA

Our home helps you breathe easier.

Landcom and Clarendon Homes are proud to have created the Eco-Living Display Homes as a showcase in sustainable home design.

The **Net-zero Emissions Home** aims to produce net-zero energy and carbon emissions, minimise waste and be water self-sufficient. Its reverse brick veneer construction shows how you can save on your heating and cooling bills, so you can breathe easy knowing it's good for you and good for the environment.

Other innovative solutions like our **Benchmark Home's** ModWood Deck, made from recycled and reclaimed plastic and pine waste, and the **Greencycle Home's** top grade recyclable, biodegradable kitchen benchtops can really open your eyes to the possibilities.

Check out more real solutions for sustainable living from all three **Eco-Living** Display Homes, now open at Pebble Crescent, The Ponds from 10am–5pm daily!

Call: 02 8814 5781 **ecoliving**displayhomes.com.au

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Up front

Solar cities conference assesses program success

The Solar Cities 2012 conference, held 23–25 October in Brisbane, presented the results to-date of the Australian Government's Solar Cities program, running since 2004 and due to complete next year. The program includes seven cities/regions—Perth, Alice Springs, Adelaide, Central Victoria, Moreland, Blacktown and Townsville—and included home energy assessments, installation of solar PV and solar hot water systems, in-home displays, smart meters and time-of-use pricing trials.

To-date 8.1 MW of solar PV has been installed through the program, with impressive totals in Alice Springs (2.4 MW), Central Victoria (1.5 MW) and Townsville (1.2 MW). Encouragingly, these solar PV systems were found to have no impact on the grid in terms of reverse flow, harmonics, fluctuations due to clouds, low frequency trips, islanding and also no customer appliance failures.

CSIRO is currently collating the energy use and generation data from all the Solar Cities and will release their report mid 2013 on the full results of the program.

Go solar!

Reducing costs and emissions easy

The Low Carbon Lifestyles Report is a practical guide for Australian households on how to reduce both their impact on the environment and their energy costs.

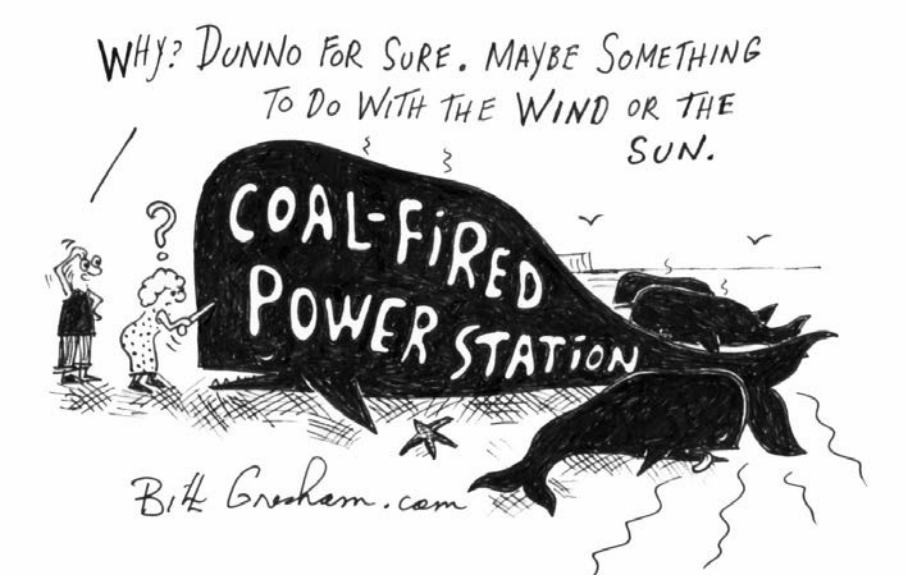
The report, commissioned by Origin and prepared by ClimateWorks and CSIRO, analysed the effects of making simple changes in either an apartment, a small house or a large house, across four different states.

It found that just by replacing light bulbs and showerheads with more efficient ones, installing energy saving plugs to reduce standby power, and limiting clothes dryer use, households could save between $120 and $590 a year, depending on the state they live in and the size of their house.

In a typical large house, the report estimates upgrading to an energy efficient pool pump would save around $390 a year in Victoria, $380 in New South Wales, $260 in Queensland and $500 in South Australia, while upgrading to an efficient hot water system could save around $930 a year in South Australia and $650 in New South Wales.

Installing a 2 kW solar panel system could save around $330 a year in Victoria and $470 a year in New South Wales—significant savings delivering substantial cuts in emissions.

The guides for the four states are designed so consumers can easily work out which changes will give them the best outcomes, both financially and for the environment. www.climateworksaustralia.org/publications.html



First electric car network for hotels

InterContinental Hotels Group (IHG) launched five electric vehicle charging spots at hotels throughout New South Wales on 2 October, adding to their network of three locations in Victoria and Canberra.

Electric cars participating in the Australian Government's 'Smart Grid, Smart City' trial will have free access to charging spots at the hotels, and other customers will be able to plug in by using the hotels' paid parking facilities.

IHG has partnered with electric car charge network Better Place to install charge spots powered by 100% GreenPower that therefore offer zero emission charging.

Every electric vehicle that replaces a petrol run car can prevent four to six tonnes of CO_2 emissions from entering the atmosphere each year. www.betterplace.com.au

DIY video winner

The winner of *ReNew*'s 2012 DIY video competition is Robert Last, a retired engineer who sent us a video of his daughter and her partner building a strawbale house with family and friends. On finding out he was the winner he humbly said, "I didn't really make the video for winning. I'm more interested in being able to pass on knowledge and techniques to others so they can fulfil their dreams. And also to be able to record my daughter, Dana's, dreams." He is giving the prize to his daughter and her partner John who can spend $500 at the EnviroShop. They already know what they would like from the shop: "It has just the batteries we need for our standalone solar system," said Dana.

↑ A willing volunteer helps to make the strawbale walls of Dana and John's new house.

The future of Australia's energy

A complex modelling tool developed by CSIRO allows you to see what Australia's future electricity might look like up to the year 2050. You enter future electricity demand, cost, technology cost, availability of nuclear and intermittency backup options and the model generates a graphed output of projected electricity cost, greenhouse gas emissions and type of energy generation.

This model is not designed as a prediction, but rather a way of understanding and exploring our future energy scenarios. Using it you can see the influences that different variables have on overall electricity production and cost.

First developed in 2006 as a collaboration between CSIRO and the then Australian Bureau of Agricultural and Resource Economics, the model is continuously updated with information from industry and government partners. It's a handy and visual way to get your head around the complexities of the energy market. www.efuture.csiro.au

$1.25 million for geothermal

Panax Geothermal's drilling project looks to be back on track after the University of Adelaide's South Australian Centre for Geothermal Energy Research received a $1.25 million federal grant from the Australian Renewable Energy Agency.

The university's two-year study, *Reservoir quality in sedimentary geothermal resources*, will make use of data and personnel from Panax and receive support from Geodynamics Ltd, CSIRO and the SA Government.

At a full cost of more than $3.5 million, the study could have important implications for the viability of geothermal power in Australia if its outcomes are successful.

One-minute solar data

The Australian Solar Institute has announced a new one-minute solar data resource which it says will make it easier and cheaper for researchers and companies to compile the data necessary to develop large-scale solar projects.

Previously, measurements had to be derived from half-hourly data available from surface stations and hourly data from satellites, an expensive and time-consuming process carried out at the site of planned developments.

The new resource will allow developers to better gauge power plant output at different sites and configure plant designs accordingly to take full advantage of their surroundings.

Data is developed from both historical and recently processed solar exposure data and takes into account infrastructure and topographical data. Users can also synchronise data with other weather observations. www.bom.gov.au/climate/data/oneminsolar

E-waste national recycling scheme

Televisions and computers, including printers, keyboards, mice and hard drives, can now be recycled thanks to an Australian government National Waste Policy. Regulated by Product Stewardship legislation, the program aims to increase the amount of e-waste recycling from the current 17% to 80% by 2022.

Households and small businesses will be able to recycle old televisions and computers for free. The scheme is supported by industries involved in the production of electronic goods, who enter a product stewardship agreement on selling a new television or computer. It is currently being rolled out across Australia, with permanent drop-off points, take-back events and mail backs, to be completed by the end of 2013. There are currently recycling services in Melbourne, Canberra, South Australia and Sydney. www.environment.gov.au/settlements/waste/ewaste

Repower Port Augusta

September's Walk for Solar covered the vast 300 km distance from Port Augusta to the South Australian Premier's door in Adelaide, to push for Port Augusta's two soon-to-be-closed coal-fired powered stations to be replaced by solar thermal—rather than gas.

Participants walked all or part of the way over a two-week long event, to raise awareness for the Repower Port Augusta cause, and aim to gain state and federal backing for Australia's first solar thermal power station.

Repower says there is overwhelming support from the local community, council and local businesses, as well as from the company that owns the existing plants, Alinta Energy, who are in favour of going solar so long as they receive support from government.

The old plants are fuelled by emissions-intensive brown coal and are responsible for more than 50% of South Australia's electricity-related emissions. The six solar thermal plants and 95 wind turbines at the proposed solar plant would prevent the estimated 100 million tonnes of greenhouse gas emissions that a new gas plant would produce over its 50-year life. With the solar facility, 1800 jobs would be created, health concerns in the area would be addressed and stable electricity prices would be ensured into the future.

Photo: Bill Gresham

The South Australian parliament has agreed to set up a select committee to investigate solar thermal in Port Augusta, but they still need support. So head to Repower's Facebook page and see what you can do to help: www.facebook.com/RepowerPortAugusta or sign the petition repowerportaugusta.org/petition.

Up front

Emissions decline in first quarter of carbon tax: data

In the three months since the introduction of the carbon price, emissions have declined markedly, according to figures compiled by the Australian Energy Market Operator (AEMO).

Falls in demand for electricity and the growth in renewable energy sources, in combination with the carbon price, are seeing a number of coal-fired station closures and slow-downs, with the Yallourn brown-coal-fired power station in Victoria one facility that has recently cut production.

The AEMO's figures show electricity sold in the east coast market has produced on average 7.6% less CO_2 per megawatt-hour of energy since the carbon price's introduction, and compared with the same three-month period last year, emissions declined about 6.3%.

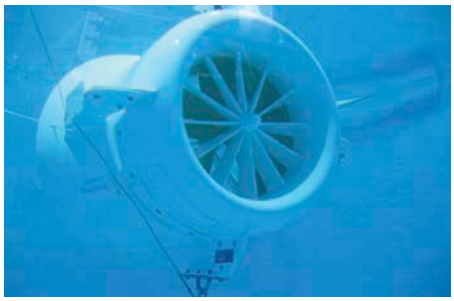
Climate Change Minister Greg Combet was reported in *The Age* as saying the carbon price was one of the key drivers creating change.

South Australia saw the biggest fall in emissions intensity (16.1%) with Victoria next (8.7%). NSW's emissions fell 4.3%.

Portland Sustainability Group has received two boosts to their Community Solar Project

Portand Sustainability Group (PSG) is working on a project to demonstrate the possibilities of community power generation and provide an income stream for PSG. With the help of a grant from Pacific Hydro Sustainable Communities and a subsidy from local solar suppliers Keppel Prince Engineering, they have the funds to purchase a 10 kW solar PV system to start the project. This will be stage one, with perhaps another 15 to 20 kW to follow the following year. They are currently seeking a local partner to host the solar panels on their roof and buy the power generated, at about three-quarters of the grid price.

One of the project's key goals is to create a model for other groups of an innovative way to engage communities to share the benefits of distributed renewable energy. See what they are up to at www.psg.org.au



↑ The SeaUrchin can be mass produced from inexpensive materials and components used by boat builders and marine electrical equipment manufacturers.

Tides on trial in Darwin

Elemental Energy Technologies has recently signed an agreement with Tenax Energy Pty Ltd to install and trial their SeaUrchin™ device in Darwin.

The project will see the establishment of a 2 MW pilot plant and an associated research and tropical tidal testing centre.

It is hoped that the pilot plant will eventually move towards a 10 MW pilot array test, followed by the development of a generation facility that will deliver affordable power into Darwin. The project is expected to be generating electricity by 2015, and reach commercial scale before the end of the decade. www.eettidal.com

Aquamonitor survey prize goes to *ReNew* reader

ReNew reader Quintin Muttton has won an Aquamonitor that will let him see how much water he is using in his home, and where. Thanks to everyone who filled out the *ReNew* readers survey. We received over 900 replies to help us shape the future of *ReNew*. A particular thank you to those who coped with a survey glitch, caused by an upgrade to our survey software. The glitch only happened if the survey window was not maximised and only for questions with an 'Other' category. Ah, technology!

Here are a couple of our favourite quotes by readers about the magazine:

"I like the way *ReNew* seems to be 'owned' by the community who read it. I like the way, for instance, you allow ATA members to access back issues—I think this shows principle over money making."

"Just keep the present high standard and balance...love the small, compact, yet easy-to-read mag that gives great value to those beginning through to the more experienced."

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Letters

Candlebark school

As architect for the earth-covered library at Candlebark school, Victoria, that featured in *ReNew 119*, I'd like to respond to the concerns that John Hermans raised about the building in his letter posted in *ReNew 120*.

Every building project is framed by a set of potentials and constraints that lie in the site, climate, intended use, available capital resources (material and financial) and human resources (time and skill), etc.

Candlebark School sits in a small south-sloping clearing next to a very tall messmate forest. The only vacant land in the clearing suitably sized for a new building was steeply south sloping. Unfortunately, whether built above or into the ground, the new library was never going to receive appreciable low winter sun from the north, nor therefore be the "perfect passive solar building" that John Hermans would have liked to see. I can confirm, however, that despite its southern orientation, the building has been independently assessed to consume less than one tenth of the annual energy allowance for heating and cooling set by the new NCC energy efficiency standards. Technical notes I prepared for the article detail features in the building that contribute to this good thermal performance.

John is correct in pointing out that earth-covered roofing and other heavyweight construction are not a pre-requisite for bushfire resistant construction. Here though, in order to serve also as a school bushfire shelter, the library needs to be able to accommodate 247 students and staff (one person per square metre of floor) for two hours, without internal temperatures exceeding 40 °C.

Computer simulations prepared by engineers, based on the above occupancy and weather conditions culminating from three consecutive days as measured for Black Saturday 2009, calculated a peak internal temperature for the library of only 29 °C. This level of thermal comfort is achieved through high levels of thermal resistance, mass and lag in floor, wall and roof elements embedded by the earth. Above-ground insulated lightweight construction as flagged by John could not achieve this.

John also compares the low cost of his own home with the "indulgent expense" of the Candlebark project. From reading his article in *ReNew 107* and a story on the web, it's clear that John has impressive trade skills and lots of time for owner-building—to live a good life somewhat removed from the mainstream economy.

Through the 1980s and early 90s I lived and worked with remote indigenous Australians to help them design and construct their own homes using local bush materials and community labour (www.bit.ly/T2nX2t). We were also able to build homes at a fraction of the cost of housing delivered via mainstream commercial practices. Like John, those families had no crushing deadlines for project completion—generous timeframes for processing stone, earth, trees and bamboo, first into building materials then into final constructed form.

At Candlebark we didn't have these bush material resources free for the taking, nor voluntary labour or relaxed timeframes to work with. We were required to engage with the commercial building industry. Nonetheless, the library was completed some 14% under budget and well within the unit cost range of other libraries constructed to a standard template design with BER funding.

Paul Haar

No gutters needed

I am currently building a new house which has no gutters, with council approval. Water is collected by a graded subsoil drain located under the drip line. The line is encased in gravel, underlain by an impermeable (0.5 mm thick polyethylene) membrane. Flows are directed to a 25 kL undergound concrete tank constructed by myself.

It is not yet in service but I expect by Christmas that we will have official occupancy and some water in the tank. The setup is plumbed for garden watering and toilet flushing.

While the development application did not attract any comment from the council during the approval phase, some members of the council's staff subsequently expressed disquiet about the potential for contamination. Nevertheless, things are progressing along the as-approved path.

The web is almost totally silent on this method of water collection and I cannot see any significant issues. That I won't have to get up on a (two-storey) roof to clean gutters is a great comfort, particularly as I think that gutter guards in their many forms are not perfect (the proliferation of gutter guard systems is amazing).

My understanding is that the building code does not mandate gutters; rather, stormwater on the site has to be controlled. It seems such an obvious solution, and while it would not be suitable in some locations it's surely an option that should be available.

Jim Purss

Happy with electric mower

You might like to pass on my experience of the Tandem Power electric ride-on to your questioner Steve Clarke in Q&A, *ReNew 121*.

We have a quarter of our half-acre block under grass, mainly because of the septic tank transpiration area. Mowing this area, with the cutters at the highest setting, the battery indicator on our mower has never gone below 'full', so I would say that it has an excellent mowing time! The makers claim three hours.

The brake pedal linkage needs to be kept lubricated, or the brake drags on and the brake cut-out switch can leave you wondering what is wrong.

The catcher works well but annoyingly the machine will not run without it. My preferred method is to leave the clippings to rot back into the soil, so I have made up a little gadget: a bolt that holds the catcher cut-out switch down, held in place by the catcher hold-down lever. The centre/rear ejection point for the clippings

Gutter guard problems

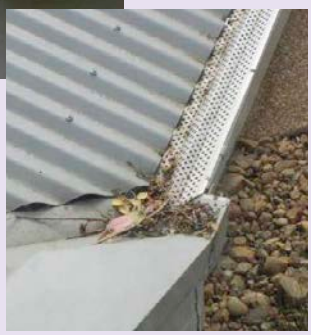
The gutter guard on our house seems to be causing trouble and providing no benefit. Should we just remove it?

In 2007 we had a new house built, and the whole roof drains to a tank. Each downpipe incorporates a leaf and debris diverter. These have to be cleaned out every few months—but this can be done relatively easily from a step ladder at ground level.

In a fit of extravagant enthusiasm, I had all the gutters covered with gutter guard. The gutter guard does not work magically well, however; debris gets caught in the holes, silt still accumulates in the gutter and grass still grows in the silt.

So the gutters still have to be cleaned out, which is a huge task, involving working at heights on a sloping roof, and requiring the removal and reinstallation of the gutter guard. And I cannot see that any other type of gutter guard would work any better.

So, in my case, I am reluctantly considering the removal of the gutter guard, in the expectation that the leaves and debris will still be caught in the debris diverters and the gutters will be much easier to clean out.



Can anyone tell me where my logic is wrong? Have other readers had similar problems?

Lawrence Reddaway

spreads them very well, unlike most mowers that leave them in a long, thick pile. It is in effect an excellent mulching mower.

The machine will be out of its two-year warranty period soon. Modifications I intend carrying out then include raising the cutters somehow. I have not had a problem so far but want to be prepared for needing a higher cut, if the grass ever grows too long.

Richard Stanford

EV prices even worse in NZ

I just bought *ReNew 121* from my newsagent and thought I'd mention the prices in Kiwiland for the Nissan Leaf ($69,600) and the Holden Volt ($82,000 odd), so way higher again than in Australia, which, as mentioned, were a lot higher than in the USA.

I have had Nissans for 20 years and would have broken my rule of never buying new due to depreciation if the Leaf had been anywhere near the price of their ICE equivalent, as a Nissan head said they would be when in NZ a few years ago. I can buy a new Toyota Prius C for about $32,000, with all its duplication of power plants, whereas the Leaf just has a bigger electric motor and battery but is over twice the price!

Brian McKenzie

Solar farming

I have been thinking that the major problem for individuals wanting to install rooftop solar power is that a large percentage of residences either do not have the space, correct orientation or access (renting, multi-level living, body corporate or planning issues), or the opportunity of generating a significant excess of green electricity, enough to make a difference for all Australians. Essentially, the limiting factor is adequate and fit-for-purpose space.

It would seem to me that the best location for solar installations would be in areas of open space, perhaps but not necessarily concentrated as commercial solar installations. Now I understand there are soon to be realised rental/purchase options introduced into Australia, and I know that there are huge financial benefits in minimising the required high voltage infrastructure by having large contiguous areas under PV panels, but this has lead me to my questions below, which are now not necessarily so much to do with individual generation of electricity for a household unit's direct use, but of a more general nature.

What would be the outcome for Australia if every farm business attached to the grid had, say, 30 kW (50, 80, or more?) of generating power onsite? If distributed generation was taken to its logical conclusion in rural areas instead of limiting it to small (and probably mostly metropolitan) rooftops?

Obviously infrastructure upgrades would be necessary which would cost a lot, but would mostly require upgrading of capacity, rather than complete new installation of poles. How much electricity could this generate? What would be the supplementary farm income from electricity sales, even at wholesale electricity purchase pricing? Could Australia's farmers cultivate sunlight directly and bypass the steps that convert sunlight into grasses/grains and perhaps also then into meat before sale to generate farm income? Could this even be a major source of farm income?

Has anything like this been implemented on a regional scale anywhere in the world? I for one, would be very interested to read about it if that were the case.

Matt Kitching

Many farmers have already taken this opportunity with wind power, where the installation of turbines has enabled them to stay on the land in times of drought.

The main issue is that solar panels will prevent grass or other feed from growing from lack of sunlight. But most farms have large sheds and other buildings that could take solar arrays.

It's happening already overseas, such as the example at www.bbc.in/PQ9tbt. In Australia, companies such as www.solarfarmkits.com.au and www.energymatters.com.au are helping rural property owners install solar farms.

Lance Turner

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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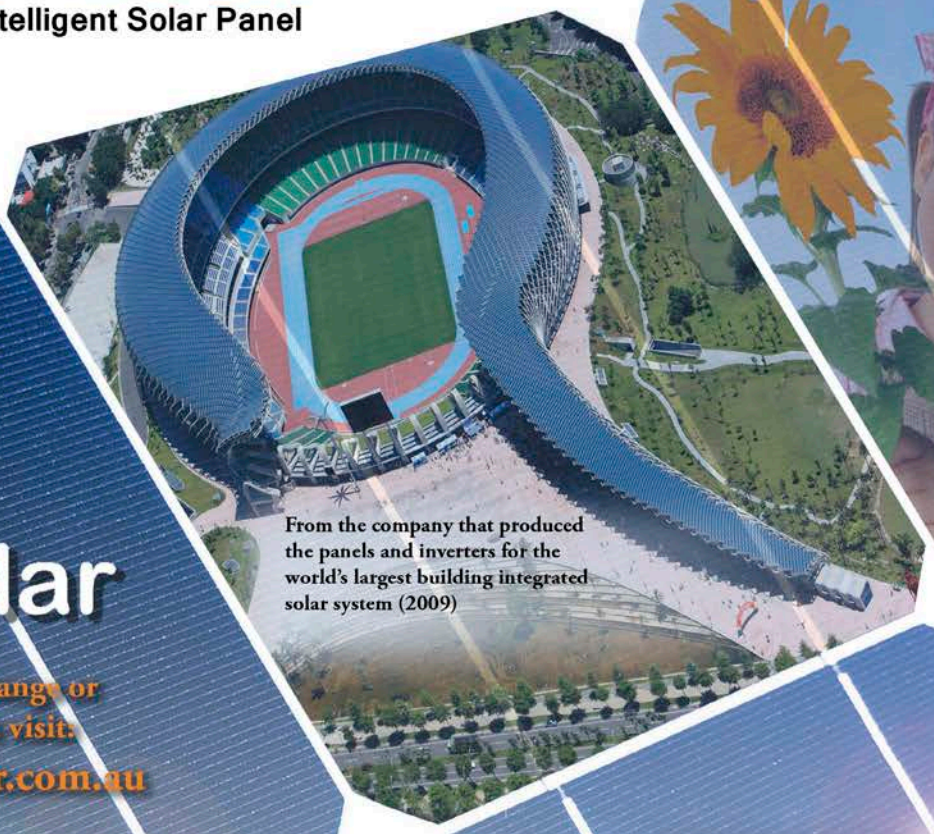

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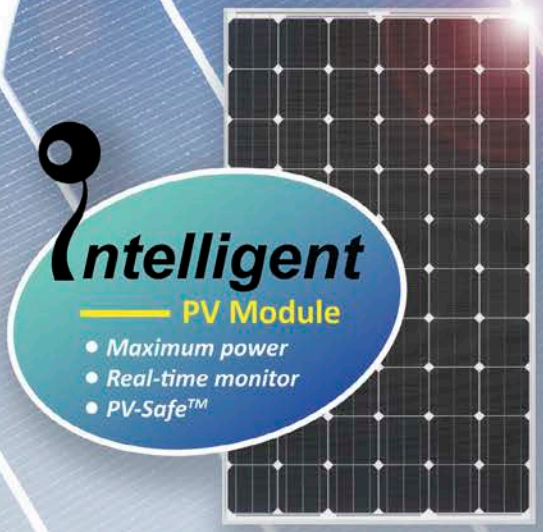

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Products

In this section we share info about products that sound interesting, sustainable and useful. Product listings are not an endorsement by *ReNew* or the ATA of any particular product—they are for reader information only. They are not product reviews and we have not tested the products.

01

Super low energy ceiling fans

Ceiling fans are one of the most efficient methods of providing a cooling effect, but many are noisy, they wobble and they still use a lot more energy than they should for the job they do.

Aeratron fans have been designed not only to look great, but also to use very little energy while helping to keep you cool. They are available in two-blade (e502) and three-blade (e503) versions, in white, black and silver finishes.

Rated power consumption of their DC motors is less than four watts on the lowest of the six speed settings, while maximum speed uses just 18 watts. Regular fans of this size can use 60 watts or more, so there's no doubt the Aeratrons have been designed for high efficiency.

Fan rotor diameter for both models is 1260 mm and the six-speed controller also has a reverse function for pushing warm air from the ceiling down to floor level during winter.

To improve the fans' eco-credentials further, Aeratron has worked to reduce waste during production, the fans are supplied in 'eco-packaging', and carbon offsets are used to reduce their carbon footprint.

RRP: $367.50 for the e502 and $389.50 for the e503. Available directly from Aeratron, ph: (02) 9365 6470, info@aeratron.com.au, www.aeratron.com.au or Lighting Illusions, www.lightingillusions.com.au

02

SP Pro gets an upgrade

The SP Pro inverter from Selectronic is designed to be the heart of a battery-backed grid-interactive renewable energy system. However, Selectronic has recently given the SP Pro an upgrade in features and design to incorporate user suggestions.

Included in the redesign is a new gunmetal grey cabinet to better match modern decors. The cabinet has an additional 145 mm height to provide more wiring space, and also features rear entry for cabling so that wiring can be hidden.

There are built-in USB and RS 485 ports for simpler, faster connectivity, and the ports are now externally accessible. Three-phase AC coupling is now simple due to additional serial ports—no external box is required for three-phase connection. Connecting two inverters together for 480 V dual phase is also possible.

An integrated 12 V, 1 A auxiliary power supply can directly power modems and other devices. Other changes include increased terminal sizes, adjustable export limits, battery charger lockout and an AC input schedule. There's even an optional AC coupled generic grid inverter controller, for coupling with any brand of grid inverter.

A new model, the SPLC1202, replaces the SPLC1201 and has 11% more continuous power (20 kW) and 42% more peak power (40 kW).

For more information, contact Selectronic, ph: 1800 006 474, www.selectronic.com.au or www.noblackouts.com.au

03

The safer star picket

Star pickets are used for both temporary and permanent fencing, but they have many drawbacks. While being quite strong, they are heavy and usually have sharp edges from being driven into the ground, making them quite dangerous unless they are fitted with caps, which often doesn't happen. Being so hard and rigid, they can also cause damage to livestock that come into contract with them, and if they are used for electric fencing, insulators have to be added.

The Fibopost is a better alternative for many uses. Made from glass-fibre reinforced polyester, it is rigid enough to be driven into the ground like a regular star picket, but is flexible enough to reduce or eliminate injury or damage to animals and vehicles. Being made of plastic, they are also complete insulators and so electric wire or ribbon can be attached directly to the pickets.

Around 70% of each Fibopost is post-consumer and post-industrial recycled polyester (PET), with the rest being glass fibre, UV inhibitors and colour. The posts won't rust or rot, and are fire resistant, easily drilled, screwed, stapled or cut to length and available in a range of colours. They are available in four different versions, in lengths up to 2700 mm.

Manufactured by Fiboplast Industries Pty Ltd, Unit 1/8 Iron St, Malaga WA 6090, ph: (08) 9341 8306, info@fiboplast.com, www.fiboplast.com

04

Biodegradable bags of all sizes

When we last looked at the biodegradable bag range from Becausewecare back in *ReNew 112*, their range was limited to a few sizes. Things are a little different now, so we thought it time for an update.

Becausewecare has a huge range of bags and a number of other items that are biodegradable. Their rubbish bags range from 10 litre bin liners through to 240 litre wheelie bin liners. There are also three types of checkout bags, including a heavy duty version, and fashion, nappy and dog poo bags.

Other items in the range include replacement 'foam' trays for supermarket packed goods, produce bags and disposable cutlery. For the garden, there's weed mat, 75 mm and 100 mm seedling pots (just plant the seedling along with its pot) and the soon-to-be-released BotanicBag. There are even lightweight disposable gloves which, like all of the above, are made from biodegradable and compostable plant-based plastics.

While Becausewecare tends to sell in bulk, and some items are special order, the prices are great for this type of material. For example, 30 litre bin liners are $128 inc GST for twelve 25-piece rolls—that's around 43 cents per bag.

Available from Because We Care, 309 Fitzgerald Rd, Derrimut VIC 3030, ph: (03) 9931 6888, www.becausewecare.com.au

05

Ditch the pressure tank

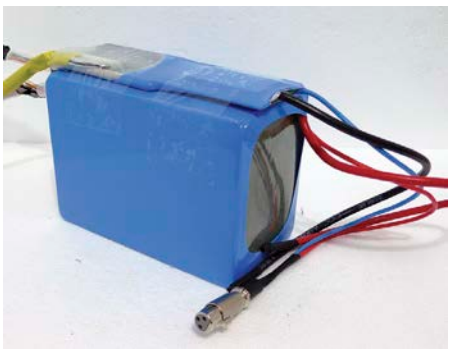
Most mains-pressure domestic pumping systems require a pressure tank to even out the stop-start pulses of the pump when it is cycled. Without a tank, the pump cycles rapidly, resulting in uneven water pressure and premature pump failure.

However, pressure tanks have a few drawbacks, including requiring replacement of the internal rubber bladder every few years. Although this is cheaper than replacing the pump, it is still a maintenance and cost item that can be avoided.

The Flojet VSD (variable speed drive) pump combines a Hall-effect pressure sensor with a variable speed motor drive to produce a constant output pressure regardless of the flow rate, up to the pump's maximum rate. The DC version of these pumps comes in two sizes (13.5 and 16.3 L/m maximum flow) and works from any input voltage from 10 to 29 volts, so is suitable for 12 and 24 volt DC systems. Other features include soft start, thermal overload, over-current and reverse polarity protection.

If you need more flow than the Flojet models can provide or require an AC pressure pump, the Grundfos CME range can provide over 100 litres per minute using a variable speed AC drive system.

Prices for the Flojet VSD are $501.60 and $561; the Grundfos CME pumps range from $1584 to $2587. Available from Pump Warehouse, ph: 1300 661 417, rod@pumpwarehouse.com.au, www.pumpwarehouse.com.au



06

Lithium batteries ready to go

Unlike lead-acid batteries, lithium batteries can be a little daunting for the first-time user. They need careful charging and discharging regimes to prevent damaging them and making up battery packs from individual cells is not for everyone.

However, if you have a rechargeable device such as an electric bike, lawnmower or even a small renewable energy system that needs a new lithium battery, Ping batteries might have a suitable pack.

Ping has packs ranging from 24 V, 10 Ah through to 60 V, 30 Ah. The pack is heatshrink sealed and they come complete with the BMS already installed. They also come with a free charger. Charger and BMS upgrades are available, depending on the pack you are buying, and chargers are also available separately.

All of the Ping battery packs use $LiFePO_4$ cells for reliability and safety, as this type of cell will not catch fire, even when punctured.

Prices range from US$219 through to $1385 and charger upgrades range from $33 to $66. Shipping can be a little steep though, generally costing around $160.
For more information and to buy direct, email pingping227@hotmail.com or go to www.pingbattery.com

Products

07

A bike made of flax

We have seen some interesting bike designs over the years, often made from unusual materials, but most never make it to market. The Schwinn Vestige is one that has, and it's quite unusual in a number of ways.

First of all, the frame is made from resin reinforced with flax fibre—in fact, flax makes up 80% of the frame. The resin used is partly biologically sourced to reduce the environmental footprint further. The forks are also partly flax, with added carbon fibre for strength.

To add to the eco-cred of this bike, the grips and mudguards are made from bamboo and the custom Schwalbe tyres have a recycled rubber anti-puncture layer.

Another interesting feature of this bike is that, because the flax frame is translucent, the frame actually has internal LED lighting, so at night the whole frame glows, making the bike more visible. The lighting is powered by dynamo and can't be turned off, but because it's LED based, the effort to drive it is negligible.

Overall, the Vestige, available in men's and women's versions, is a nice-looking bike with seemingly good eco-credentials—and of course is far better than using your car. But the really interesting thing is that such a high quality bike is relatively inexpensive.

RRP:$2099, although it can be found for less if you look around. Available from many good bike stores, including www.georgesbikes.com.au and www.cycleworld.com.au

08

Easy solar panel grounding

All fixed solar arrays must be grounded for safety, but when you have a lot of solar panels, grounding each one individually can add time and expense to the installation.

The WEEB system of stainless steel grounding washers from Wiley eliminates this problem by providing a reliable ground connection between each panel and the array frame.

WEEB stands for 'Washer, Electrical Equipment Bonding' and there are WEEB washers designed for several different PV racking and framing systems. The washers are simply placed between the PV panels and framing at the mounting points, where the bolts connect the panels to the frame. The raised teeth on the WEEB washers cut through the anodising on both PV panel frame and racking to form a sound, watertight electrical connection between the two. This allows the entire PV array to be grounded at just one or two points, instead of at each panel.

The WEEB washer system is available in Australia from DKSH Australia Pty Ltd, 14–17 Dansu Court, Hallam VIC 3803, ph: (03) 9554 6666, www.dksh.com.au

09

Great shades, man!

Sunglasses are something almost everyone owns and very few people actually think about in terms of sustainability and social responsibility.

But if you'd prefer to support an eco alternative, the Panda range of handcrafted bamboo frame sunglasses might be just your thing.

They all feature polarised polycarbonate lenses made from recycled material and there's a range of styles, each in three colours—black, brown and natural.

Even better, being made from bamboo, the sunglasses float, so no more sunnies lost overboard when you're enjoying a day on the water!

What's more, for each pair of sunglasses sold, Panda pays for a free eye test and pair of prescription glasses for someone in need via the Tribal Outreach Medical Assistance (TOMA) Foundation.

Panda sunglasses are shipped anywhere in the world for $10 per order and come with a 30-day return policy and a lifetime warranty.

All versions of the glasses cost $120 plus shipping. For more information and to purchase, go to www.wearpanda.com or email perfectfit@wearpanda.com

10

Tanks that fit almost anywhere

With house blocks getting smaller, essential features such as rainwater tanks can be left out due to the space they require.

Thintanks solves that problem in many cases by allowing rainwater tanks to be fitted into the narrowest of spaces. The tanks are available in three sizes. The 1000 litre model measures 2400 mm long, 1850 mm high and just 260 mm thick. The 2000 litre tank has similar dimensions but is 480 mm thick, and the 3000 litre model measures 2920 x 1970 x 580 mm.

The tanks are designed to lock together to form larger capacity tanks, and they can also be used to form structures such as walls and fences—you could even build a shed out of four or more tanks.

There are eight standard colours, ranging from cream to heritage green, heritage red and mountain blue, so there should be a colour to suit most homes. Thintanks are manufactured in Australia.

For more information and your local dealer contact Thintanks, ph: 0402 636 826, sales@thintanks.com.au, www.thintanks.com.au

11

Roof mounting without drilling

When mounting solar panels or other devices to metal roofs, the usual method involves attaching brackets and clamps by drilling through the roofing sheet. But penetration of the sheet can cause water leakage and possible corrosion problems.

KlipKlamps from Laddertech are a range of mounting clamps and brackets designed to attach to common roofing sheet profiles without drilling the sheet itself. The clamps are positioned on the sheet ridges and then tightened, locking them onto the sheet.

KlipKlamps are ideal for mounting solar panels, satellite dishes, conduits, and hot water and air conditioning components, and can simplify and speed up installation, thus reducing costs. Of course, when mounting objects subject to high winds on the roof, you must make sure that the roof sheet itself is suitably anchored.

Both vertical and horizontal clamps are available, as well as rail-less assemblies for mounting solar panels and other flat panel objects with thicknesses from 30 to 50 mm. There are also solar panel tilting kits for mounting panels on flat roofs and assorted other components to make mounting items on roofs easier.

For more information and to buy direct, contact Laddertech, ph: (02) 8005 6908 or go to www.klipklamp.com

12

Power system in a box

As energy prices rise and feed-in tariffs fall, more people are looking for ways to reduce energy bills. One way is to buy electricity at night when it's cheap and store it in batteries, using it during peak periods. Or you might even consider taking yourself off the grid altogether and running from renewable energy alone.

The Freedom PowerBank from ZEN Home Energy Systems combines a maintenance free 20 kWh (at 100% depth of discharge) lithium iron phosphate battery bank and an Australian-made, AS4777-approved 5 kW inverter, along with a battery management system and controller. In short, it's a complete system in a box.

The PowerBank looks a lot like a fridge, and can be placed in a garage or inconspicuous corner. It measures 1800 mm tall, 800 mm wide and 580 mm deep.

The PowerBank control system comes with a five-year warranty while the battery bank has one year.

If you need a system for a larger task such as grid levelling or a microgrid system, larger units up to 1 MWh are also available.

Prices are yet to be set, but are expected to be around $30,000 for the 20 kWh unit, with price decreasing as volume ramps up. For more information contact ZEN Energy Systems, ph: 1300 936 466, enquiries@zenhomeenergy.com.au, www.zenhomeenergy.com.au

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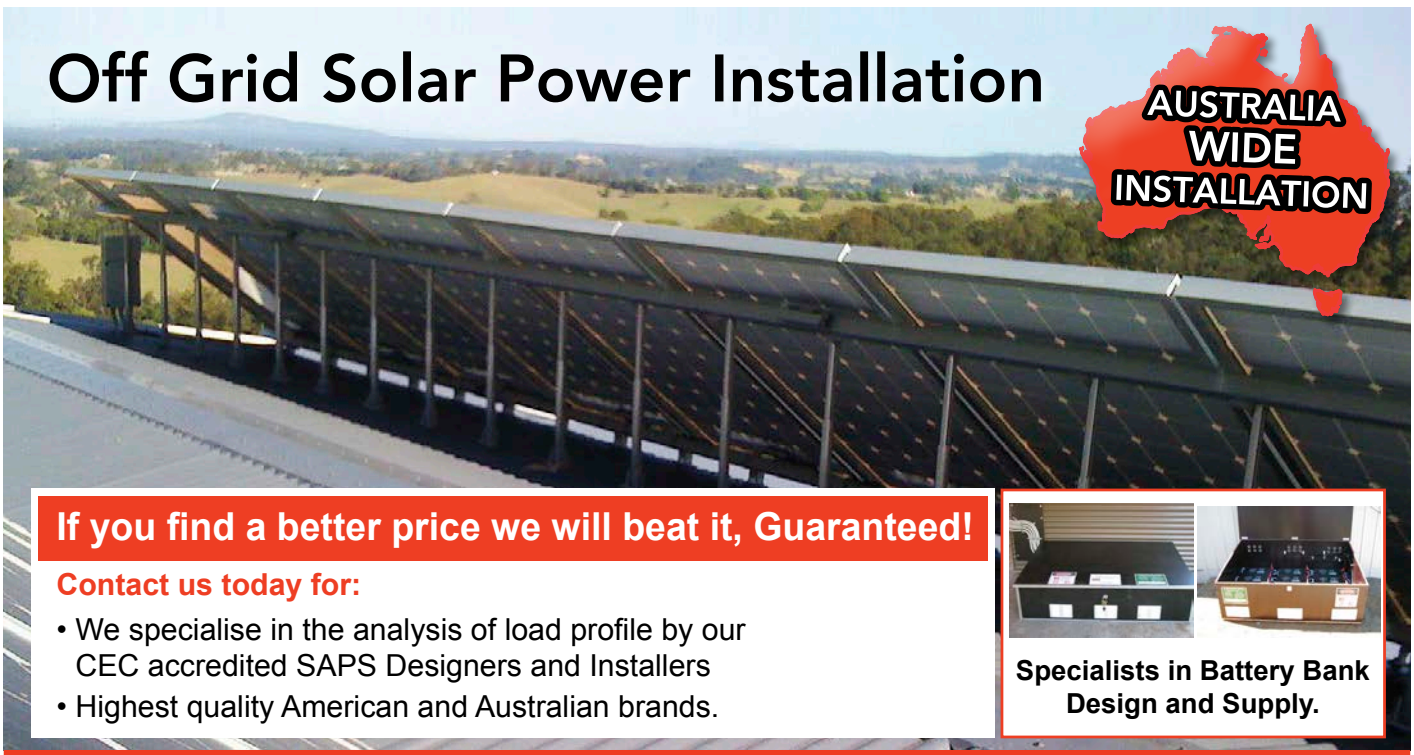

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Finders keepers
The whys and hows of reuse

Reuse centres play a big part in diverting building materials from landfill. Along the way, you can also reduce the embodied energy in your home build and help the local economy, writes Beth Askham.

Photo: Hobart tip shop

↑ Building materials ready for reuse at the Hobart tip shop.

WALKING into the Hobart tip shop shows you just how much stuff can be salvaged from what people throw out. Stacked up outside are piles of metal roofing, timber and windows. A quick search around the tip shop reveals light fittings, carpets, tiles and more.

Finding and using second-hand materials can get addictive. Perhaps it's the thrill of the chase for a beautiful or functional material or maybe it's the heroic feel of wresting something from landfill. Whatever the appeal, using second-hand building materials is rewarding, and when you reuse, you're not only saving materials from ending up as rubbish, you're also saving energy and emissions. And it's fun, unexpected and creative—what's not to love?

In Australia, building materials make up about half of all the materials that we consume. The embodied energy and wastage associated with this consumption is enormous. *Your Home Technical Manual* explains embodied energy as the measure of the energy used in the mining, manufacture and transport of a material. The energy embodied in the current buildings in Australia is equal to ten years of the nation's energy consumption.* Reusing building materials rather than using new materials will reduce the embodied energy of a house by up to 95%.

Reuse is the process of lengthening the life of an item by using it again. Reuse centres are packed to the rafters with timber, windows, doors, tiling, roofing and more.

Recycling reprocesses a material to become a raw material once again, a process that requires fossil fuels, water and other resources. Building materials that include a proportion of recycled materials include plasterboard, carpet, bricks and concrete.

To the landfill rescue

With the consumption of building materials comes the production of waste, and the Australian government website Living Greener notes that building materials make up 40% of our landfill mass.

The Hobart tip shop salvages over two tonnes of reusable goods and recyclable material directly from the tip-face each day. On top of this, they started a demolition company four years ago that diverts building materials to be reused or recycled before they even get to the tip-face.

The demolition team reuses or recycles pretty much everything they remove from a deconstructed building—excluding plasterboard, old insulation and asbestos—saving 90–95% of the building from going to landfill.

Tim Hankey, deconstruction project coordinator, explains that they follow the waste hierarchy; trying to first reuse a material and then recycle, with landfill as the last option: "When we salvage timber, hardwood or softwood, we take it to the shop to sell, or if it's too short, split or rotten it goes to a Hobart City Council operation which mulches it."

The tip shop is also called the Resource Work Cooperative and it has been going for almost 20 years. The cooperative is based on a social enterprise model, a model they define as a group of people coming together and using market-based ventures to achieve agreed social and environmental ends. Some of their core roles are to provide employment and to be part of a community dialogue about what we do with waste.

On finding buyers for reusable materials Tim Hankey says, "Building materials always sell—it would help if we had more and we can never get enough to meet demand." They also pre-sell materials, such as heritage pieces, to architects and builders who take them straight from the deconstruction site.

Another reuse centre in Sydney, Reverse Garbage, diverts around 30,000 cubic metres of resources from landfill each year. It does this so well that it has earned a fair swag of recognition over its 40-year life for its community and environmental credentials.

Mark Bond from Reverse Garbage thinks reuse is important "because it confronts the challenges of waste reduction by treating waste as a valuable resource." He says, "Reuse

Photo: Reverse Garbage

↑ The aisles of Reverse Garbage in Marrickville, Sydney.

Photo: Hobart tip shop

↑ Cleaning bricks for reuse at a Resource Work Cooperative deconstruction site.

"Building materials make up 40% of our landfill mass."

also sustains a comfortable quality of life and supports a productive economy."

You can visit its Marrickville centre and browse the aisles for unexpected, unusual, useful and bizarre post-industrial and post-consumer materials. One week's offerings are never the same as the next.

Where to find second-hand materials

A little bit of research reveals a host of local places and national websites that can help you find recycled building materials. For a starting point, Planet Ark has a website, Recycling Near You (www.recyclingnearyou.com.au), that can help you find local recycling centres.

Further research on the web reveals seemingly more than enough national reuse websites. These include recyclebuild, freecycle, building bargains, salvage bazaar, buildbits, gum tree, eBay, and urbansalvage. Some of these sites, however, can be a little light on the ground, materials-wise, and they can also include new materials (as a form of sponsorship we can only guess), not to mention items which may be on the other side of the country. But it is still worth a look to see what's out there.

The next place to look is closer to home—check out what your local demolition companies, recycling centres and tip shops have on offer. These are in every capital city and many towns, so do a web search or look in the *Yellow Pages* to find them.

There are also second-hand timber companies in most capital cities where you can find timber that you can refashion for your build.

The serendipitous fossicker versus building to a deadline

Finding the right material is made much easier with national reuse websites and well-organised reuse centres. These help you find what you need, at the time you need it, without having to wait for the right item to come along.

The other option is to become a bowerbird-style of builder. This type of reuser finds themselves in the right place at the right time to find that amazing cheap window, or those fantastic hardwood floorboards or bathroom tiles that you can't leave behind. It's a style of reuse that requires some storage space, time and perhaps not a pressing finishing deadline for the build.

However you go about it, working with second-hand and recycled materials leads to a much less energy-intensive home and encourages you to be creative and resourceful. It might not save you time or money but when it's finished you can sit back and enjoy every bit of your luck and labour. ✷

More information
Hobart tip shop:
www.resourcetipshop.com
Living greener:
www.livinggreener.gov.au
Reverse garbage:
www.reversegarbage.org.au

Reference:
* *Construction and demolition waste guide – recycling and re-use across the supply chain.* Department of Sustainability, Environment, Water, Population and Communities. 2011

Safety and reuse

Using second-hand materials demands a heightened level of common sense. Keep your eyes out for nails in timber and stay safe when dealing with old paint that might have lead in it. When removing paint, the biggest danger comes from blasting, burning, dry scraping, dry sanding and using power tools, as small lead particles can be inhaled or can settle into carpets and furniture. Also keep an eye out for asbestos—if in doubt, ask, or have it tested.

Reuse in action
Homemade house uses creativity and care

Peter Ascot takes time out from building to share his art and heart of reusing second-hand materials to build his house in Bega, NSW.

Photos: David Duffy

↑ Looking out east from the house. Inside you can see the rendered niche and supporting posts. Right: Tin clads a shed at the back of the house. Facing page: A beautiful door Peter kept from his now-demolished childhood home in Sydney.

OUR house is one of 31 slated for the Bend eco-subdivision, which mandates a lot of sensible features—passive solar design, composting toilets, rainwater harvesting, greywater treatment for reuse—and includes proximity to shared resources including food-producing land.

For our family of five, Serena and I wanted a beautiful home that would function well in its design and environmental performance. It has been years in the making—18 months building along with nearly a decade of work in a group committed to making an eco-neighbourhood on 10 hectares of river flat next to the NSW south coast town of Bega.

Our original plan was for a total recycle—to relocate a building and retrofit it to a high environmental standard. But that is hard to do so far from cities where such houses are readily available, and harder still given the potentially long wait for the right building. Designated building envelopes on each Bend block, which protect the solar access of neighbours, also limit the houses that would fit here.

So instead we designed exactly what we wanted, with the design emerging from the materials we had and our eco-requirements.

I had collected lots of doors and windows over the years, some of them so beautiful you could build a house around them. Which is exactly what we did.

A series of French doors suggested a balcony and a roof height, while a bunch of small casement windows permitted a natty cross-ventilation layout.

Our low-concrete but high-thermal-mass requirement led to a northern earth floor, and space needed beneath a composting toilet gave value to having an upper storey.

You can't pat yourself on the back merely for pointing a house in the right direction—you could get that right by accident. A true eco-build rests on the integrity of every choice along the way: the design decisions (if plasterboard comes in 1200 and 1350 mm widths, don't make the ceiling height 2800), the choice of materials, even the relationships between the onsite team. (We've got a cruisey team—they seem to know each other from riding waves somewhere.)

For me it starts early each morning when I pedal my bike to the site. We have an organic approach to the whole build—no budget,

"I had collected lots of doors and windows over the years, some of them so beautiful you could build a house around them. Which is exactly what we did."

The western side of the house that will eventually be shaded by a future neighbour. Note the northern window eaves, providing shading from mid-October. The corrugated iron shed sits at the back of the house, on posts reused from an earlier shed.

no schedule, just a determination to create something very beautiful and useful and kind to the planet. Building regulations and our drawings determine much of it, but we're open to change suggested by the available second-hand materials, and we're there to work and to make sure things work out.

We've done pretty well so far. About six months into the build, my principal contractor, Pete of Natural House Builders, said, "Hey, where's all the rubbish?" There just wasn't any.

In fact, we'd started with a large pile of materials I'd gathered over the years or had recently salvaged from other sites in the eco-neighbourhood. It's almost all gone now, somewhere into the building in the myriad places that needed just what we had. Every bent nail went to recycling, and the shortest timber scraps heated our present home through two winters. And the sawdust?—it's in old insulation bags, to use later in the composting toilet!

The nub of our build is a clay render, Pete's speciality, applied internally and externally to the outside walls. It's a great use of second-hand and natural materials and doesn't need painting or future maintenance.

We began by screwing old corrugated iron sheets—pretty much beyond any other use—horizontally onto the standard timber-frame walls. Our large front room, with the curved ceiling, has double-thickness stud walls (fully insulated, of course) to give a great sense of mass, along with deep window reveals. Around curved walls, the sheets are fixed vertically to bend around the arc.

A lot of people loved the look of the house clad all round in tin, and we've left a shed at the back with our best tin neatly fixed vertically. The eaves, too, will remain bare corrugated iron.

A thick body coat of mud render is trowelled on, filling the corrugations and covering the peaks by about 10 mm. This coat includes soaked clay, lime, wood shavings, sand and cement. Borrowing a technique used around the deep reveals of strawbale windows, we rubbed a nylon mesh into the top of this layer.

Everyone asks, 'How does it stick to the tin?' Well, we've developed a pretty good bonding coat, and of course there is some cement in the mix. So my short answer is usually, "Have you ever left a bit of mortar in your wheelbarrow?"

A second, thinner body layer can be used to cover any bumps or help make flowing surfaces, giving a sense of bulk to the walls. In our case though, we moved straight to the final coat without wood shavings, which gets sponged to a smooth finish.

The final appearance is determined by the inherent qualities of the clay used—from

whites to yellows to deep ochre reds, the colours have a depth and vibrancy that seem more alive than those of cement renders with oxide tints. And if cracks appear when the clay dries, or later, it's possible to make up a clay slurry to rub in over the surface, like repairing an earth floor.

Almost every visible surface in the house, except for the plasterboard, is reused or found materials. Every time I've made the trip out to our local tip, I've had a huge score from the recovery section. Someone has chucked this great stuff out, even paid for the privilege.

The trick is to see what something is, not what it isn't. Don't see a broken brick, see a half brick needing a trim. Don't see tile offcuts, see the mosaic they could become. Most people can't see beyond the top layer of shabby paint, which is why the rest of us can access such great stuff, often for the price of lugging it home.

We'd planned for Moroccan tadelakt lime plaster in our wet areas, but at a local tip we found over 80 travertine limestone tiles for $40. Most had broken corners, but we cut them down to perfect 550 mm squares and did the whole job to stunning effect, with lots left over.

All our door jambs and trim joinery is oregon from the tip—a $20 trailerload of old wall framing demanded an upscale use. Another $10 load of 300 x 100 mm beams, after slicing up at a local joinery, became all the skirtings. There's a gentleness and rightness as the available materials settle into their final places and take on a new role and a new life.

Wood is the kindest material there is. Even the dullest, most beaten-up piece is new on the inside, but you don't have to bring it back to perfect. Its long history is inscribed in the nail holes, the chisel marks left from carpenters long gone. It bursts with new life when you finally oil the sanded surface.

But cost saving? If you can do the selecting, the de-nailing, clean it up with the disc sander and get it ready for the carpenter, it's a great start. It takes time and is tougher on tools, so it may not be as cheap as buying a pack of timber and having the carpenter able to reach for uniform lengths, cut what they need and chuck the offcuts in a pile to burn on a cold morning. But it's the environment that pays a premium for that.

Preparation is the key—the sooner you de-nail the timber, the safer it is, and due to lead paints, it's best to work on old painted timber in a contained environment with appropriate protective gear and clean-up.

← Stair treads with rendered risers. Above: Peter's four-year-old, Turlough, in what will be the cellar/cool store.

Notwithstanding the usual stresses of building, our whole build has been a joy, and has seemed very serendipitous and providential—things we've needed have turned up at the right time, like our tiles. Maybe that's due to being open to change, to letting the materials drive the result, or downing tools to listen and discuss alternatives with skilled workers who have their own aesthetic sensibilities.

And being open to how things work out: I tried to scribe out an island bench that evoked something of the f-hole of a violin or cello, but it ended up like a butternut pumpkin! Still beautiful, and apt for a kitchen.

The house contains materials from the old horse shed that used to be the only building at Bend, from my childhood homes, from other houses I've lived in, from a demolished Bega civic building and things I've found or saved along the way. Each has earned its place: to someone else they may simply look good, but for me they form a memory matrix, a social history in glass and timber.

It preserves meaning to value and use what you have. After I'd re-puttied some of the French doors, Pete asked me why on one I'd missed some hollows in the old putty. Those finger dints were my father's home-handyman imperfections. Each generation can learn from and do better than the one before, yet keep something of the past and respect it. ✱

Peter Ascot is a former geophysicist turned freelance editor, who is looking forward to raising children and crops at Bend. But he just found a fabulous window, and may need to build another house for it… bend.org.au.

↑ Oiling a recycled timber internal post.

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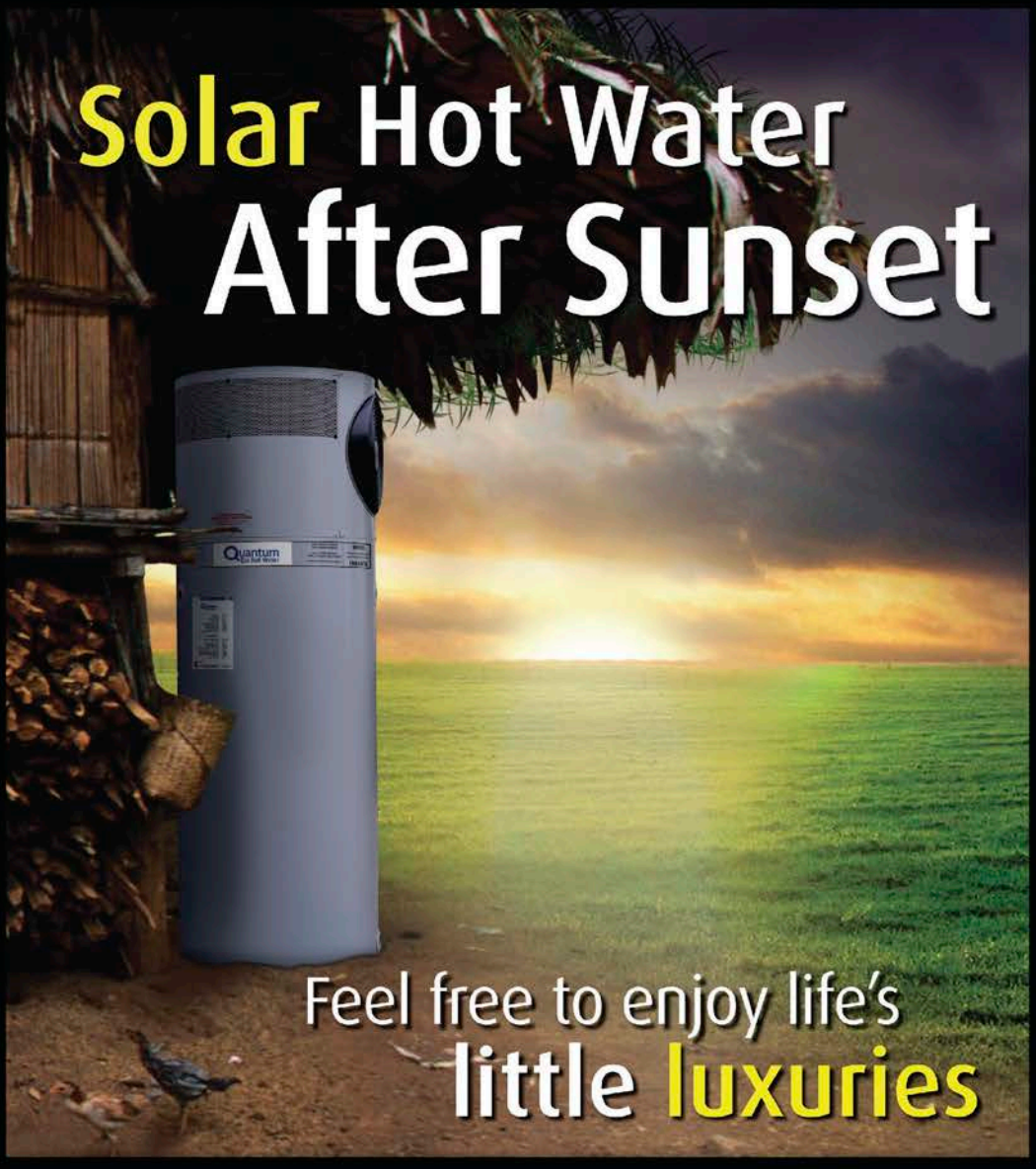

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The journey from schoolroom to home
A tour of reuse

Andy McLeod set out to build a 'spec' home using portables as the shell. His building journey highlights many of the opportunities—and challenges—of reuse, finds Robyn Deed, on a tour of the almost-completed home.

WHO would have thought that the humble portable classroom could be transformed into an 8.1 Star home?

Architect and builder Andy McLeod has done just that, using two portable classrooms to build a lovely passive solar home for himself and his partner, Ambah O'Brien, in Chewton, Victoria, a small town near Castlemaine.

The classrooms' arrival at the site sparked criticism from locals. It's an old area, so something modern caused some waves. Since then, the lime render has gone on and people are less critical, though as Andy says, the look is still significant—it's striking, two glowing white cubes, jutting out of the hillside as you come under the railway bridge from town. It's definitely not faux Victorian, a style that Andy says "rattles my cage."

They are hoping that new plantings around the house will also help soften the look. They've planted nodding saltbush, native geranium and grasses, plus a line of wattles specifically to soften the view—all local plants, selected with the help of a local seed collector.

The steeply sloping site caused some problems for the build. An existing reef of rock dictated the placement of the portables, with excavation needed to level parts of the site. Andy says, "It took two days to break through one small area of rock."

Alongside stone "so hard it doesn't chip with a hammer on an excavator", they found large quartz crystals, black shale and litter such as pick heads and pottery shards. The latter probably date back to gold prospecting days, with diggers' tales of small nuggets of gold found in the black shale. Evidence of blasting suggests a more recent use of the site as a stone quarry.

Photos: Andy McLeod

↑ The 8.1 Star home is built from two portables linked by an airlock which acts as the entry hall. Simplicity was key to the design with the roofline extending across the entry hall between the two portables.

Stone in construction

They've used rocks excavated from the site for a retaining wall. The huge rocks are fantastic for retaining walls, placed offset with earth spilling through, Andy notes.

He's a big fan of local stone in construction: "It's environmentally durable, has low embodied energy and is the perfect building material. It's seen as mining though, to quarry stone, and so there are detractors." He believes it's no more of an issue than digging up earth to use in bricks. Another plus to him is that there's no treatment required.

That said, the slate they've used in the outdoor area is from China. They would like to have used local Castlemaine stone but at three times the price, they couldn't justify that expense.

Portables as shell

He's a big fan of the portables, too. "They're a good shell and easily insulated." It's labour intensive to use them, but most of that is less skilled labour, so that DIY is possible.

They had initially planned for this to be a 'spec' home, a design they could reproduce for low-cost, environmentally friendly housing. However, it turned out not to be as low cost as they'd hoped, so they've decided to live in this home for a while instead.

"I like the idea of living in houses you design," he says. "There are an infinite number of options when it comes to sustainable design and so it's a chance to experiment and see the results." He likes building for himself because he can make mistakes or try things out. "You're free to learn," he says.

↑ Half a portable being craned into position (above), and the two portables installed (right).

They sourced the portables from BRB Modular nearby in Kyneton; you can see the field of portables as you drive along the Calder Freeway towards Chewton. BRB specialises in modular construction and also provides second-hand schoolroom portables for use in schools and temporary buildings—and builds such as Andy's.

The portables he sourced were, he thinks, from around the 1970s, and most at BRB are about that age. One question that arises is that of asbestos in buildings of that vintage. Andy says, "Some of the portable designs did have asbestos in them, but BRB removes it before selling them. I think they're required to do that."

The two portables cost about $5000 each, and transportation plus craning them into position cost another $5000 each—so $20,000 total. In choosing a portable, he says that the quality of the roof is a good thing to consider. If the roof isn't damaged, you can expect a good saving on your building costs. He also notes that portables from coastal areas may have issues with rust in the metal used in the roof and sub-frame.

They did need to replace the ridge caps as, he says, "they get trashed during transportation." He adds, "You'll also usually need to replace the gutters and downpipes."

He is enthusiastic about the cleverness in the design of portable schoolrooms: "There's a lot of efficiency in the build. They'd really worked out their modular nature: the capacity to be moved in two halves, in 3.6 metre widths which fit on a semi-trailer."

There's a substructure of steel that bolts the two halves together. You do get damage around that join. For example, in these portables some of the floorboards near the join needed to be replaced.

Andy thinks that passive solar was part of the original design. The opposite sides are glazed, with the eaves perfectly proportioned to exclude summer sun, if they're oriented with windows north and south. Plus there's good cross-ventilation with the opening windows. We usually think of them as hot boxes in summer, and freezing in winter, but Andy says that's partly because schools always seem to place them with the windows facing east and west. (I think about it, and that's exactly right for my son's school!)

They're also not well-insulated, but, he says, as soon as you insulate and seal them properly, they perform fantastically.

He sees the portables as an example of "an engineering rather than a design mentality." That's something he's passionate about. He believes that the freedom that technology has given designers has meant that architecture has become wrapped up in being façade-driven; it's all about the impression rather than the function.

He says, "You look at this house and it's clearly a passive solar design, and I like that." As a design aesthetic, he thinks that's more humble, driven by intent rather than ego. He says, "Everything is driven by ego but…I look at a lot of architecture and reel. I love Gehry, but imagine if he had an intention to create human-scaled spaces, sensitive to breeze and sunlight, instead."

Encased in blocks, and rendered

The portables have been encased in concrete blocks. Andy believes these are a good choice, environmentally. "Blockwork—per kilo—is quite a moderate masonry unit in terms of embodied energy. Using mud bricks is ideal but as soon as you transport them you've got issues," he says. "Concrete blocks are incredibly quick to lay and simple to build a structural system from; I love them!"

"I like the idea of living in houses you design. It's a chance to experiment and see the results."

The block cladding creates a cavity for insulation. The 100mm cavity between wall and portable holds a 75mm R1.8 glass insulation blanket with a reflective surface to the exterior. The radiant barrier reflects heat rather than acting as a conductor, and thus reduces the influence from extreme temperatures. Its use requires an adequate air space (25mm in this case) and placement is dependent on climate. Bulk R2.0 Green Batts have also been placed in the 90mm cavity of the portables' timber-framed walls.

↑ The blockwork going on one of the portables, with foil insulation underneath.

↑ The PV system monitor is built-in—in a cupboard in the entry hall—with the hooks below it reused from the portable classrooms. The 2 kW PV system is generating around 10–14 kWh in October, against usage of about 5–6 kWh for this all-electric house (usage will be higher in winter with heater use).

↑ Cross-sawn timber kitchen cupboards and the recycled oregon timber benchtop are a feature of the open-plan kitchen/living space—along with just a small fridge space.

"The lime render changes colour according to the light; in the moonlight, Andy says, it glows a soft purple."

Radiant barriers are the "king of insulation" when placed correctly, Andy says. "Bulk insulation will eventually transfer heat, but radiant barriers are always working."

The exterior of the building is rendered with a 10 mm lime layer, which is "great at obscuring the substrate"—in this case, the concrete blocks.

One of the advantages of lime is that it remains reactive after application; it swells as it gets wet, protecting it to a degree. A concentrated flow of water would eventually erode the surface so Andy notes it's important to move the water away from the walls.

Lime also fixes its CO_2 contribution as it cures, Andy explains: "The process of kilning at 1100 °C and slaking to produce the lime paste releases CO_2, but as the lime render slowly turns back into calcium carbonate—limestone—after being applied, it fixes up to 90% of that CO_2."

It's a beautiful surface, with texture from the trowelling, sponged rather than smooth. It changes colour according to the light; in the moonlight, Andy says, it glows a soft purple. The sponged surface will reflect some heat, but it's been used more for aesthetic reasons.

Inside the house

The two portables are oriented offset from each other, with an airlock in-between. The airlock is the entry hall—an unconditioned space which prevents the outside hot/cold air from entering the living spaces and bedrooms, and the internal air from escaping.

One of the portables houses the open-plan living room and kitchen, and the other the bedrooms and bathroom. They've broken the roofline with parapets that allow the gutters to be continuous across the airlock: Andy says, "Simplicity has been key to this whole build."

The back and front entry doors use the old schoolroom doors. They're wider than your usual doors (perhaps to allow the hordes of children easy passage in and out in their original school use!) They've used recycled commercial closers so they close automatically on entry and exit. Andy says, "Sometimes I like the idea of conscious use [that you have to close the door behind you] and sometimes I like the idea of being without option, that the building just functions."

The doors are lovely, and are being painted in bright primary colours when I visit—perhaps also reminiscent of their heritage!

On the wall to the right as you enter is a row of hooks, also salvaged from the original portables. Above the hooks, in a purpose-built cupboard, is the PV system monitor. It's great to see it as you come in and get a readout of the kilowatt-hours generated by the 2 kW grid-interactive solar PV system. Yesterday the system produced 10.9 kWh, 14 kWh the day before. He says, "Not bad at all in mid spring."

To get to the living area you go through another door with recycled self-closing dampers. These internal doors are also lovely, made from recycled oregon, joined together in strips with metal T-junctions used to hold the pieces together at the top.

The kitchen cupboards use a recycled carcass: someone local was upgrading their kitchen, so Andy and Ambah scavenged it and the carpenter, Stuart Reed, reconfigured it, adding Tasmanian oak doors. The doors are new wood from an old sawmill that's closed down; wood that had been "sitting around for about 20 years." The timber on the doors and benchtop is streaked with black—it's cross-sawn, Andy explains. It's striking and beautiful, though Andy is starting to have his doubts—maybe it's too strong. He says, "We wanted something interesting, a real feature as you come in, but sometimes you get ambivalent about things." (He calls back after moving in to say they're both now very happy with it!)

They sourced the timber for the benchtops from Dunnolly wreckers. It had sap injuries, which they wanted to show rather than hide, to keep a sense of the wood's nature. They used a clear resin to fill in the knots, but it went a bit cloudy as it set. Andy says almost wistfully, "We could have put in red to make it really glow."

Andy got his carpenter to select the recycled timbers, and he recommends that

↑ Installing the false ceiling.

↑ The parapet cap sheds moisture away from the walls.

approach. The straighter and truer the better for recycled timbers: he says, "The carpenter has to work with them, and Stuart has an excellent eye. It's easy not to understand how much timber moves, and how where it comes from will influence that."

All-electric

They've gone all-electric with the appliances, including an induction cooktop, with a rangehood also from the reused kitchen. As an example of forcing energy efficient behaviour, they've left a space for only a small fridge.

The only cooling systems are fans and cross-ventilation from small sash windows. When I visit, Andy's concerned about the brush seals on these windows, with about 3 or 4 mm of play when sliding them up or down. (A couple of weeks later, after moving in, he emails to say that it's not a problem—the windows are working well, with very little air movement.)

Most of the other windows are Sunergy double-glazed, fixed (non-opening) windows. Double glazing becomes much more competitive in price when bought as fixed panes without frames, he notes.

The building doesn't have thermal mass to hold heat in the room, so they've installed two 2000 watt Nobo panels for heating. They don't anticipate prolonged use to heat the well-insulated space. Andy says, "Time will prove whether these heaters are an efficient choice." I ask him if he's thought about using a heat pump air conditioner for heating, but he prefers not to have moving air for space heating. "Blowing air is cold air as far as I'm concerned," he says.

They've put in a false ceiling to hide the trusses and provide a deep cavity to keep insulation clear of the recessed downlights. They've used LED downlights from LEDCentral which use Cree LEDs, produce 600 lumens and cost about $65 each. He says, "We've under lit this place a little, and we'll probably add some feature lights, but that's another behavioural thing, to reduce electricity use for lighting."

Other features

Other features of the build include separated grey/black water and a Quantum heat pump for hot water. Andy was interested to get a chance to trial the heat pump system. The heat pump HWS extracts and concentrates heat from the air to heat the water. They've sited it so that it draws air from the sub-floor garage, with the earth acting as a moderator of temperatures. Andy is interested to track how much energy it does use (and we hope to follow that up in a later issue of *ReNew*).

They installed a 270 litre tank for the HWS as they thought that size would be "more endearing to a mass market." He would have preferred the 150 litre unit for himself, given its lower energy use, but the lower volume would dictate usage patterns.

Costs and viability

Overall the build cost around $300,000. "A bit more than planned," he says. When they embarked on the project, he thought it would come out at around $150,000 to $200,000. But the site's been tricky, and they had a wet winter, so it's been a struggle.

Would he recommend reproducing the idea, or would he be doing that himself? "I'd dissuade people from doing it to save money unless they have the labour and skills to do it themselves."

From a commercial point of view, he thinks he could have a greater effect with regards to sustainability for less cost if building from new. "But if you can do it DIY, it's a great opportunity," he adds.

"I'd dissuade people from doing it to save money unless they have the labour and skills to do it themselves. But if you can do it DIY, it's a great opportunity."

There were site-specific difficulties, including the need for the garage retaining wall, and a complex footing system, all of which added to the costs.

But there were problems with using the portables, too. They get twisted from being transported and they had to wrack them back into plumb. They also needed to add external mullions so the glazing could sit square.

Could it have been done for $200,000 if they didn't have the site and basement issues? He says, "Yes ... maybe ... at a stretch." It's just a lot of labour, and he adds another problem: "The floor joists were loose and we had to pack and tighten those; there's still a small creak in the floor." It's clear there are issues that arise when trying to reuse something like this that's had a long former life.

On the way out, he points out the balustrade for the front steps. He scavenged it from eBay at a good price—$90. But he spent four hours each way in the car to get it. "One of the traps of eBay!": it was listed for pickup in Melbourne, but it turned out that meant the other side of Frankston.

At the front gate, there's also a pile of beautiful sandstone boulders excavated from the site. While I'm there, Andy gets a call: it's the project's carpenter, arranging to pick up a truckload of the rocks. "It's all part of the process of give and take in a small community like this," says Andy, "plus it means we don't have to double handle them."

Next to the rocks is another example of give and take: a stack of PVC tubes that someone had in their shed and passed on to Andy. The tubes are for earth-tube cooling in his next build. With so much reuse in this house, it seems apt as I leave to find another example of reuse just waiting to happen. ✷

Andy McLeod is an architect and the owner and builder of this home. solarchitecture.com.au.

Self-contained living
Shipping container reuse

From pop-up shopping malls to low-cost housing, shipping container construction offers creative and energy efficient possibilities, writes Kathryn Kernohan.

Photo: Peter Bennetts Photography

↑ Phooey Architects converted shipping containers into a children's activity centre in Skinners playground, South Melbourne. All building materials were scavenged, salvaged or recycled.

MORE than 420 million shipping containers set sail each year, criss-crossing the globe as they transport goods from port to port on ships the size of small countries.

But with little financial incentive for empty containers to be returned to their origin, many inventive businesses and architects are finding ways to recycle and reuse them. The idea makes sense on several levels—shipping containers are cheap, easily transported and provide a blank canvas for creativity.

Keeping business contained

From a business perspective, opening shop in a converted shipping container provides a clear point of difference to the usual high street stores.

East London is home to Boxpark, an eco-friendly shopping mall constructed of 61 shipping containers. Dubbed the world's first pop-up shopping mall, the moveable centre opened in late 2011 on a five-year lease. Its thickly insulated walls mean air conditioning is not required, and the entire centre was assembled on site, eliminating unnecessary waste.

Accessory manufacturer Freitag—well known for making bags from recycled truck tarps—implemented its environmental ethos in its flagship store in Switzerland, made of 17 reclaimed shipping containers stacked 26 metres high.

Closer to home, trendy Melbourne bar Section 8 sits in two containers in a quiet city laneway.

Self-contained and portable

The ever-constant search for affordable and sustainable housing has led to a spike in the number of Australians working with the form.

In 1985, Sean Godsell showed what was possible with FutureShack—a disused shipping container with an umbrella-style roof, made as a prototype for emergency accommodation. The design was entered into a competition to create housing for returning refugees in Kosovo and has been exhibited at New York's National Design Museum, but has yet to be put to practical use. Other shipping container projects have been used for temporary accommodation after natural disasters such as the 2010 Haiti earthquake, and even as portable classrooms.

Victorian architect Matthew Grace created the award-winning resPOD, which comprises up to four recycled containers and is priced from $36,000 for a small studio.

Each dwelling is built around the shipping container's steel structure and has five-star energy features such as double-glazed windows and doors, ample sun shading and water tanks to accommodate drinking, washing and irrigation.

Owners can opt to make their home autonomous by utilising a self-contained septic system, solar-generated electricity and grey water treatment, although the architect notes the prices involved can be off-putting. "While the idea of self sufficiency is great, the reality of implementing it comes down to cost."

DIY container unit

Others, such as Tony and Karina Rothacker, chose a more DIY path.

Photos: Karina and Tony Rothacker

↑ Karina and Tony Rothacker's two-bedroom container unit (above). At left, the container begins its transformation to a light-filled house with the holes cut out for doors and windows.

The couple, from Emerald Beach, 20 minutes north of Coffs Harbour, decided to build a two-bedroom unit for their teenage children using a shipping container.

They purchased a 40-foot container from Coffs Harbour for $6000, and paid an additional $250 to have it transported home.

"It cost a little bit more than other containers because it had a metal frame to extend the longevity of the building, had only been used once and was 'high cube' (providing an extra 30cm in height)," says Karina.

To ensure the dwelling is environmentally friendly, the pair have used local and recycled materials wherever possible. Hardwood salvaged from Karina's parents' 30-year-old verandah was used to make seven window frames for the building; locally sourced recycled beams support the deck. The dwelling is oriented for passive solar. Its long side faces north and with large trees to the west, "the sun is always perfectly positioned," says Karina.

The unit is close to completion, with the biggest issue the couple has encountered being how to adequately insulate it.

"We have a skillion roof over the structure and put insulation batts on top of the container, as well as ventilating holes in the cavity between the roof and container," she says.

The entire project is on track to be finished on budget and for less than $50,000.

Where to start

DIYers looking to start from scratch will find website Fabprefab (fabprefab.com) a great place to start. It has a page dedicated to container houses including links to technical resources and books.

Containers can be found on websites such as eBay and Gumtree for as little as $1800. Containers, and complete container-based accommodation, can be purchased or hired from Royal Wolf (www.royalwolf.com.au).

Thermal properties

Steel structures provide natural protection from wind and other elements but an appropriate level of insulation is vital to maintain comfortable temperatures in summer and winter. Insulation can be added to walls and ceilings via batts, foam panels or standard foam spray. A popular option to insulate floors is closed-cell polyurethane spray foam on the underside of the container Materials such as foam and fibreglass can also be added to the existing framework to increase thermal performance. Matthew Grace from resPod covers the outside container walls with timber framing and places Foilboard underneath for insulation. On the inside, he places plasterboard over another layer of Foilboard.

Another advantage is that the structures are extremely durable. One far-north Queensland family reported no damage after their house survived two category-five cyclones. They can also be moved when no longer required.

Tony and Karina plan to use their shipping container as a granny flat or guest accommodation when their teenage children eventually move out of home.

"Australia imports far more shipping containers than we export so it makes sense to work with one," says Karina.

"It's beautifully built, environmentally friendly and affordable. We can't wait until it is complete." ✸

More info:
resPod/Matthew Grace architects: www.resPod.com.au
FutureShack/Sean Godsell: www.seangodsell.com/future-shack

See next page for more container projects.

Container projects

Re:START mall, Christchurch, NZ

The devastating earthquake that hit Christchurch in February 2011 claimed 185 lives and severely damaged the city's infrastructure. Hundreds of buildings were destroyed or later demolished, leaving many business owners with nowhere to ply their trade. In response, the city last year welcomed Re:START, a pop-up shopping mall. More than 60 brightly coloured converted shipping containers now house 27 stores, with containers also providing the framework for popular open-air cafes. Project architect Anton Tritt was drawn to the containers not necessarily for their sustainability, but for their strong, modular design and the fact they exude a sense of safety in a city that has experienced a recent natural disaster. The transient nature of the containers also means they can be easily transported when a permanent shopping centre is built. The mall will remain open until at least mid-2013.

Photo: Kathryn Kernohan

Photo: Matthew Grace

Hurstbridge house / Matthew Grace

This beautiful two bedroom, two-storey house sits comfortably among the trees and hills in the leafy suburb of Hurstbridge in Melbourne's north. Designed by Melbourne architect Matthew Grace, the property features four recycled shipping containers as its core structure and is oriented for maximum solar gain. The house also features silvertop ash hardwood cladding, which conforms to the bushfire regulations in the area amended after the Black Saturday tragedy. Other sustainable features include double-glazed windows throughout, increased floor, wall and ceiling insulation, LED lighting and rainwater harvesting. www.resPod.com.au

Perth house / FULTON + SALOMON

Torquay architects FULTON + SALOMON have designed the SMALLisSMART house, built around a recycled shipping container and priced from $30,000 for buyers who wish to put the property together themselves (Geoffrey Fulton likens the instruction manual to those you receive from Ikea). The architects are working on a number of other container-based houses including this one in Perth. It features soy-based insulation, window shadings made from recycled milk bottles and gas-fired domestic hot water supplemented by a ground-source heat pump and solar tube. Even the swimming pool has a sustainable angle, made from an open-topped recycled shipping container. www.fultonsalomon.com, www.containerarchitecture.co

Image: FULTON + SALOMON

Radically sustainable homes
Evaluating earthship performance

Earthships are all about energy and resource efficiency. But just how well do they stack up against other housing types? Martin Freney is working it out.

I AM conducting research as part of a PhD at the University of Adelaide to quantify the environmental impacts of earthship housing compared to a range of conventional and other green approaches to construction.

Under the guidance of associate professors Terry Williamson and Veronica Soebarto, both experts in the field of sustainable architecture, I am conducting a life cycle assessment (LCA) to compare homes made with earthship tyre walls against those made with other wall materials including strawbale, rammed earth, mud brick, brick veneer, and reverse brick veneer.

In this article I'll briefly report on two aspects I'm comparing: the heating/cooling energy required in the homes and the embodied energy of the materials used.

Heating and cooling energy is a major contributor to the life cycle impacts of housing. To estimate the heating and cooling energy required, I am using a thermal modelling computer simulation based on weather data. To check the accuracy of the thermal modelling, I have monitored the indoor temperatures through the year of six earthships of various designs in the most recent earthship community, the Greater World in Taos, New Mexico, USA. The measured temperatures can be compared to the results predicted by thermal modelling to establish how accurate the modelling is.

Another interesting outcome of the monitoring is that the indoor temperature range of these homes can be observed. And it is quite amazing.

"The result is a home that provides all the essential services you need, yet subtly curbs your behaviour towards being more frugal with your energy and water use. "

Photo: Martin Freney

↑ A greenhouse on the north side is a common feature of earthships. The solar heat captured by the greenhouse can warm the entire house, or cool it in conjunction with a thermosiphon.

Four weeks compared

The graphs in Figures 1 to 4 show four typical weeks in one of the earthships—a current design called the Global Model—which relies purely on passive solar features for heating and cooling. The graphs demonstrate the accuracy with which the computer model is able to predict the performance of the home. It's not perfect but is close enough to be useful and to give confidence in the results for modelling an earthship in another climate.

The winter week shows outdoor temperatures are extremely cold (a minimum of -14 °C on day one), yet inside it is reasonably comfortable, even warm in the middle of the day (23 °C on day six while it was 11 °C outside). In the morning it is a little chilly for an hour or two but then the temperature picks up fast as the sun starts beaming into the greenhouse. There is a cloudy day where the indoor temperature remains stable at about 18 to 19 °C.

In early spring the outdoor night time temperature is still very cold (-6 °C), yet it is warming up nicely inside (20 to 22 °C). By late

What is an earthship?

Earthships were first developed in the 1970s by American architect Michael Reynolds in response to the problems caused by conventional housing and the centralised systems (energy, water and sewerage) needed to support them.

Reynolds argues that these systems are poisoning the world and that we have become far too dependent on them; that without them, conventional housing is non-functional. Although sustainable housing design has come a long way since earthships were first proposed, earthships are still arguably leading the way with their self-sufficient, low cost, passive solar designs.

Reuse is central. Old car tyres are used as the 'bricks' for wall construction with an optional 'berm' of about 100 tonnes of dirt piled against the walls to roof height, giving the advantages of an earth-sheltered home.

Rendered internally with adobe and externally with a cement-based render, the wall finish looks similar to that of a strawbale wall.

A greenhouse frontage is also a common feature. Double-glazed, angled glass on the north (sun-facing) side of the house provides the thermal engine of the home, along with a great place to grow food.

This can be combined with the berm for heating and cooling. Heat energy captured by the greenhouse gets stored in the thermal mass of the berm and then, when indoor temperatures drop, released back into the living space. The greenhouse not only traps heat but can also be used to drive a thermosiphon: hot air is exhausted out large vents in the greenhouse roof causing cool air to be drawn into the living space through 'earth tubes' buried in the berm (see *ReNew 110* for an article on earth tubes).

Earthship designs also include greywater reuse for plants in the greenhouse, blackwater treatment onsite, renewable energy systems, and water capture and storage.

The result is a home that provides all the essential services you need, yet subtly curbs your behaviour towards being more frugal with your energy and water use. If you are having trouble living within the limitations of your system you either need to upgrade the capacity of your system (e.g. add more batteries, solar panels, water tanks) or you need to become more resource efficient—the latter being the better bet for the environment and your bank balance.

Photo: Martin Freney

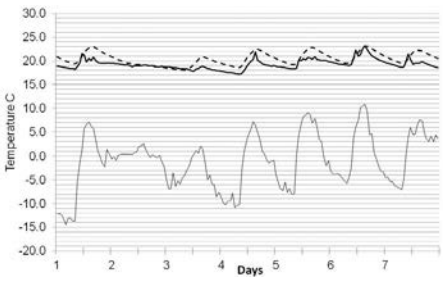
→ Tyre wall under construction in Taos with a metallic earth tube showing at bottom right.

"This is a remarkably stable indoor temperature range for a house with no active heating or cooling, built in a climate with an extreme temperature range."

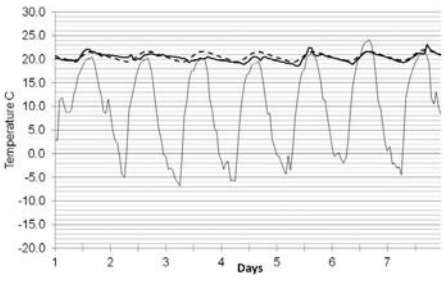
spring the indoor temperature has increased another degree or two and by summer it is up to 24 °C compared to the outside temperature where it is in the low to mid 30s for most of the week.

This is a remarkably stable indoor temperature range for a house with no active heating or cooling, built in a climate with an extreme temperature range. It supports the anecdotal evidence regarding the comfortable temperature range of the Taos earthships.

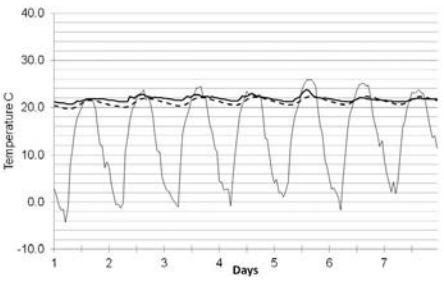
However, the question remains: how would an earthship perform in the Australian climate? This leads to the next area of my research.



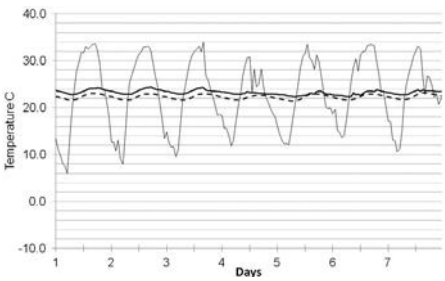
↑ Figure 1: winter week 15/01/12 to 21/01/12



↑ Figure 2: early spring week 26/03/12 to 1/04/12

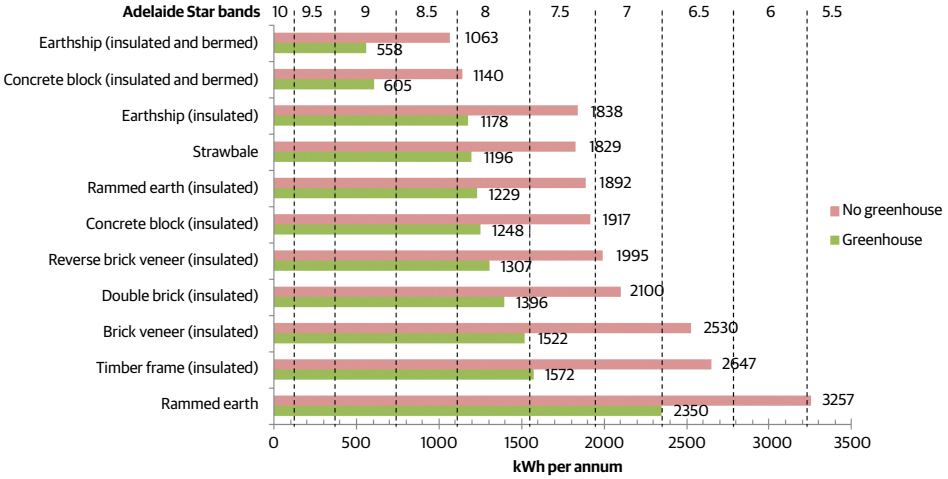


↑ Figure 3: late spring week 30/04/12 to 6/05/12



↑ Figure 4: summer week 25/06/12 to 1/07/12

↑ Graphs comparing measured to modelled temperatures for four weeks in winter, early and late spring, and summer, in an earthship in Taos, USA. The thin black line shows the measured temperatures outside, the thick black line shows the measured indoor temperature and the dotted line shows the indoor temperature predicted by the model.



← Figure 5: Annual heating and cooling load for each exterior wall type, with and without a greenhouse. NatHERS Star bands are indicated by dashed vertical lines.

Heating and cooling energy for various wall types

I've used thermal modelling for a range of wall construction methods to compare the heating and cooling energy required to keep a house in Adelaide between 18 and 26 °C year round.

Figure 5 shows the thermal performance for a variety of wall construction types including the typical earthship tyre wall with a berm, and an insulated tyre wall without the berm. Each construction type includes two bars, to compare energy use with and without a greenhouse. The results are in terms of annual heating and cooling energy load (kilowatt-hours) with the corresponding NatHERS star bands for the Adelaide climate also shown.

I have subsequently found that by increasing the indoor temperature range to 17–27 °C, the energy use for the earthship with berm and greenhouse drops to zero, which correlates with the demonstrated performance of many current Taos earthships (older models require small amounts of backup heating).

The graph indicates that an earthship with berm and greenhouse would work very well in Adelaide's Mediterranean climate, and I expect this to also be the case for similar Australian climates. However, a different design would be required for the tropics.

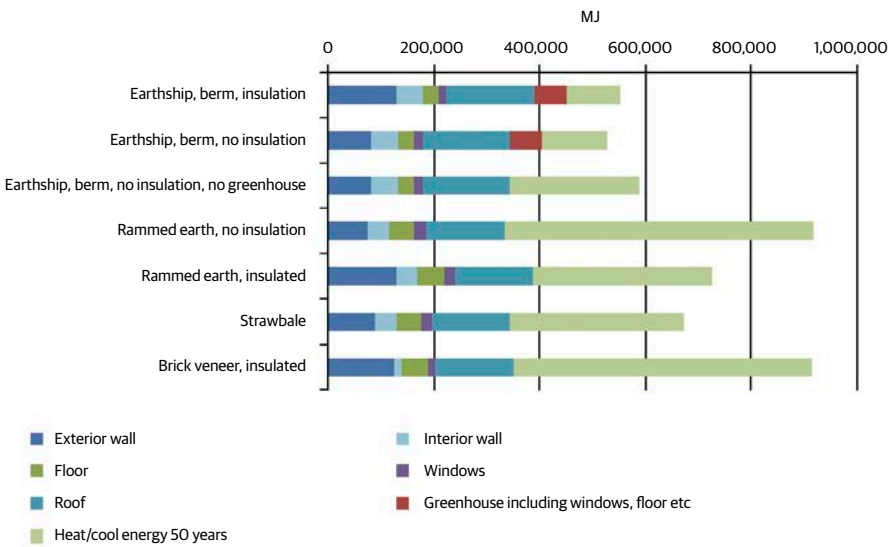
If the constraints of the site or council planning laws preclude the use of a berm, an earthship using only an insulated tyre wall (the third construction type in Figure 5) is also a good option, performing similarly to strawbale, insulated rammed earth and insulated concrete block.

Embodied and life cycle energy

My research also considers the embodied energy of the materials used in construction and maintenance, minus any credits for recycling at the end of the building's life. These will be estimated for each wall type and added to the heating and cooling energy to determine the life cycle impacts in terms of CO_2 emissions, land use and water use.

My research is not finalised on these impacts, but I have some preliminary results and remarks that I can make on the embodied energy of some wall types.

Figure 6 compares embodied energy and 50 years heating and cooling energy use (based on the results from Figure 5) for several construction types. The embodied energy is split into results for the exterior walls, windows, floor, roof, and in the case of the earthship, the greenhouse (which includes associated elements such as windows and floor).



↑ Figure 6: Embodied energy of various construction types plus 50 years worth of heating and cooling energy.

Key assumptions:

Brick-veneer: exterior walls 115 mm wide bricks with a timber-frame stud wall (pine) with 90 mm insulation glass wool batts, reflective foil, and plasterboard lining 13 mm thick; interior walls timber frame with plasterboard.

Rammed-earth: exterior walls 300 mm thick with 5% cement content; insulated version has 100mm thick expanded polystyrene foam with 10 mm of cement-based render; interior walls fired clay brick.

Strawbale: inside has 50 mm earthen render, outside has 40 mm earthen plus 10 mm lime render, and timber posts at 3 m spacing; interior walls fired clay brick.

Earthship: interior walls concrete mortar/render with aluminium cans.

Footings and top plates are included in the exterior wall category. The window embodied energy varies due to the different amount of glazing to optimise the energy efficiency of each exterior wall type. The size of the house is 22 m east-west and 5.5 m north-south with a 2.7 m ceiling height, based on the earthship floorplan: long and skinny, sun facing, one-room deep.

"So what is the wisest thing to do with an old tyre: recycle it into another rubber product, incinerate it to reclaim energy, disaggregate it into its constituent components, bury it, or reuse it in an earthship?"

Earthships downunder

Earthships designed by Reynolds are in the planning stages in Kinglake, Victoria, and Sydney, NSW. Martin is building an earthship for himself in Ironbank, SA, currently awaiting final building approval, and has designed earthships for friends in other parts of SA. In NZ, the Gubb Earthship has been built, including reuse of an agricultural greenhouse for the earthship greenhouse.

Some modifications may be needed for Australian conditions, including the design/use of the greenhouse in hotter climates, the need for drainage and waterproofing in wetter areas, and the need for termite protection or the use of termite resistant materials in some areas. Martin has documented the design changes he's made for his Earthship Ironbank design, along with some other possible approaches.

Planning issues

Martin also looks at planning issues, including planning/building approval, compulsory gas, water and sewerage connections (that you may not be using), use of the indoor greywater system, bushfire resistance level, the need to register tyre usage with the EPA and more.

He notes: "People think the council will reject an earthship proposal, but I have received development approval for a tyre retaining wall which is part of a fire bunker structure, and in October 2012 I received planning approval for my proposed earthship bed & breakfast in Ironbank, SA. At the time of writing I am still to obtain building approval. However, I have a great structural engineer, hydraulic (wastewater) engineer, energy assessor and private building certifier on board, so I am confident we can land this earthship!"

See www.renew.org.au/earthships

The earthship wall has an advantage as concrete footings are unnecessary. This is due to the extreme width of the tyre wall (700 mm), which distributes the load, and the rubbery nature of the tyres, providing a tiny bit of 'give' to absorb ground movements.

However, reinforced concrete is required in a bond beam that tops the external walls, and for buttresses on the inside of the walls to give them structural integrity. Although buttresses could be avoided by using the curved wall of the original 'U module' earthship, the results in Figure 6 take the worst case example, which includes the buttresses.

Another plus for the earthship is that old tyres are a waste material that would otherwise be disposed of by some other method, such as cut up and buried in landfill or shipped to China and incinerated to liberate energy for a kiln.

So what is the wisest thing to do with an old tyre: recycle it into another rubber product, incinerate it to reclaim energy, disaggregate it into its constituent components, bury it, or reuse it in an earthship? I am aiming to quantify this in my research.

Earthships do require a lot of excavation to prepare the site, stockpile dirt for the tyre wall and build the berm. However, my calculations indicate that the embodied energy in the 100 or so litres of diesel fuel required for the excavator is relatively minor. The greenhouse adds extra embodied energy but this is justified by the heating/cooling energy savings.

Strawbale also has an advantage as it uses a waste material, straw, which might otherwise be burnt. However, strawbale is a heavy construction method, with the bales combined with render, and substantial footings are required which increases the embodied energy. If earthen render is used, though, the embodied energy from the render will be low.

Fired clay bricks have very high embodied energy due to the heat needed to fire the kiln, the cement-based mortar used to lay them and the need for concrete footings.

For timber walls, the production method—growing trees—means that the embodied energy can be very low. However, many timber products are kiln-dried, which increases the embodied energy substantially. In addition, many other materials are used in a timber-frame home including insulation, exterior cladding, interior lining and reinforced concrete footings.

The point to make about embodied energy is that it must be 'spent' wisely. If embodied energy is increased due to design features that will reduce heating and cooling energy, such as additional insulation or north-facing glass, then it is embodied energy well spent. However, if the extra embodied energy relates to fashion or excess then it is difficult to justify, and doubly so in the case of large houses which necessitate additional heating and cooling energy.

Conclusion

Reynolds has demonstrated via his Greater World community—which houses more than 100 people—that it's possible to live comfortably in an extreme climate without the need for electricity, water and sewerage infrastructure.

Imagine if we could all achieve this level of self-sufficiency, building our walls with friends and family, growing much of our own food with greywater, and learning to live within the limits of our battery banks, water tanks and the natural forces that nature supplies. Imagine a world where you weren't stressed out by constant utility bills (although you'd have to budget for replacement batteries and solar cells), and all you needed to do to stay cool or cosy in your home was to open and close some vents or put on a jumper.

What would be required for this to happen? Not much really...just go build an earthship! ✱

Martin Freney is a lecturer in industrial design and sustainable design at the School of Art, Architecture and Design, UniSA.

More info:
www.renew.org.au/earthships
www.earthship.com/blog/Martin-Freney.html
Earthship Ironbank on Facebook

Mixing it up
Upscaling waste paper

Ben Wall describes how waste paper can be transformed into a useful building material, cheaply and easily.

WORKING at the Alice Springs Bowerbird Tip Shop for a couple of years, I was struck by the strangeness of all these discarded goods being shipped across the desert to our little town and then being buried like pirates' treasure beneath the beautiful MacDonnell Ranges.

We salvaged and sold household and building items from the tip, with profits going to the Arid Lands Environment Centre. But we couldn't harvest the vast quantities of raw and processed materials being buried every day.

I wanted to explore the practicality of upscaling waste materials into locally beneficial products using affordable and appropriate technologies. One waste stream was paper which couldn't be economically recycled in Alice at the time.

With the help of a small grant from the Northern Territory Litter and Recycling Fund, I built several paper-pulping machines to enable me to demonstrate the potential uses of large quantities of paper pulp. I used the pulp to make a building product called papercrete.

Papercrete is made from pulped paper combined with soil, water, air and sometimes binders, such as cement, lime and asphalt emulsion.

Papercrete is a highly insulative and structural material. It's easy and forgiving to work with; it can be cut, rendered, sculpted and painted, and is significantly lighter than cement or adobe. It is fire retardant and unattractive to termites (at least the local ones!) It can be cast into panels or bricks, poured in situ into formwork, and sprayed and pumped more easily than cement or adobe.

I built a 40 m x 2 m demonstration wall and was then able to gain approval from a local building certifier to use it as post-and-beam infill wall material for local housing and sheds.

Photo: Neridah Stockley

↑ Papercrete can be used to build almost anything that regular concrete can.

The main ingredient for the demonstration wall was about two tonnes of 2004/05 Alice Springs phone books, combined with soil and a small amount of waste asphalt emulsion.

Papercrete blender

I used two different designs for the papercrete mixing machine. The first was a large 2000 litre blender built around an old Toyota Corolla engine and a Toyota differential, with the engine driving a mixing blade attached to the diff.

Later I built a simpler, smaller version, the papercrete tow mixer—a nifty machine driven by a trailer. A 1000 litre tank sits on the trailer, with a differential attached to the blade and the trailer's wheels: as the wheels turn so does the blade. You just fill the tank with the materials, attach the trailer to your car and drive around the block at 10 km an hour.

As you drive, the tow mixer pulps and blends the material. When you have finished mixing, you can easily pour the papercrete mix out into formwork. The height of the trailer allows you to drive directly over the formwork; you then open up an outlet at the bottom of the tank and the material flows out.

← Papercrete bricks being made.

→ The tow mixer lets you mix papercrete using the power from any vehicle capable of towing the mixer.

Photos: Ben Wall

Rendering with papercrete

I am currently in the middle of rendering my shipping container home with papercrete. This is already decreasing the heat entering the container as well as enhancing its appearance.

Creative designs

Paper pulp has many useful design qualities other than for building. I started to explore these qualities in a recent exhibition called 'Adaption' at the Alice Springs desertSmart Ecofair.

The Adaption exhibition was housed inside two 'carbon cubes'. The larger cube had 3.5 m sides with its volume representing the daily CO_2 emissions by an average Australian (approximately 78 kg of CO_2). The smaller cube with 2.1 m sides represented the daily volume of CO_2 emissions by an average citizen of the planet (16 kg).

The exhibition included some of my recent inventions for the home, inspired by a hotter, resource-constrained world.

The Bush Fridge, inspired by the African 'pot in a pot' fridge is built with 15 cm thick paper and lime walls, with water reticulation embedded inside. The outer wall encases the food storage container with sand in-between. By wetting the walls and sand, heat is drawn away from the inner food chamber and food and vegies can be kept fresh for weeks.

The Wiggler is a combined worm farm and garden seat built for hot climates. Its thick paper and lime walls both support the seat and enclose the worms who are kept happy, productive and cool inside.

The Mush-Room follows a similar concept to the Wiggler: it acts as an outdoor table with a mushroom growing chamber inside, designed to keep humidity high and temperatures constant by wetting of the thick, insulative, structural paper walls.

The Sh@#t Brick is a mixture of paper, manure, seed and reticulation, which can be formed into vertical and roof gardens. The paper, manure and seed mixture provides a stable medium in which to grow plants hydroponically.

The Tower of No Power is a scale model of a passive cooling device inspired by wind towers and evaporative air conditioners. It is built using 10 cm reinforced paper and lime walls with embedded water reticulation, and at its base is an aquaponics system with LED grow lights. By wetting the walls, the air is drawn down the tunnel from the wind scoop and is cooled by the moist walls, the pond and the thermal mass of the aquaponics gravel grow-bed. This air is then funnelled into the house.

The value in materials

Working with waste materials allows you an inspiring, creative freedom.

One day we will see waste for what it is: highly valuable processed materials waiting to be transformed indefinitely.

In the meantime you can start experimenting and having fun with paper by just pulping it up with a drill and a paint mixer attachment. Experiment with different recipes for different designs and perhaps soon you'll work your way up to building a tow mixer and mixing enough papercrete to build a house. ✷

Ben Wall won the sustainable invention competition at the 2012 Alice Springs desertSmart Ecofair with his 'Adaption' designs.

→ This papercrete worm farm doubles as a seat. The thick papercrete walls will support heavy loads as well as keeping the worms cool and healthy.

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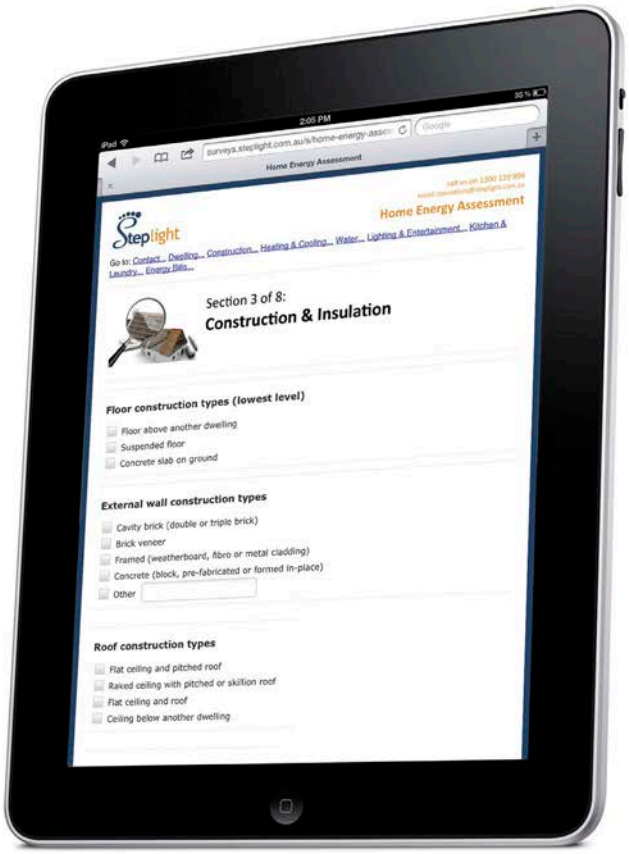

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Keeping your cool
Towards guilt-free cooling

When it comes to sustainable cooling, there is much conflicting advice. Alan Pears explores the options for increasing comfort without costing the earth.

A BUILDING needs cooling when its interior reaches a temperature that's uncomfortably hot. In humid weather, that's a lower temperature than in dry heat. And if there are hot radiant heat sources (such as an uninsulated roof heating the ceiling, which then radiates heat onto people, or halogen lamps or sunlit windows), discomfort will be greater at a lower air temperature.

The comfort principles

To improve comfort you can do one or more of a few things:

- **Move air around so people feel cooler:** a fan can make the temperature feel around 3 °C cooler
- **Reduce radiant heat input:** switch off hot lights, insulate, paint the roof and walls in light colours or shade the roof, walls and windows exposed to sun
- **Reduce air temperature:** use active cooling, seal out hot outdoor air and reduce heat flows through the building fabric, or draw in cool air from outside (e.g. from under the house or via underground pipes)
- **Dehumidify the air** so that our bodies' evaporative cooling systems work better
- **Have a high mass building** so that, for a given amount of heat input, the temperature rise will be much smaller. But when the high mass building eventually becomes uncomfortably hot, it will need a lot of cooling (either using cooler outdoor air or active cooling) to bring it back to a comfortable temperature.

It's all very well to map out these principles, but there are many products competing for our money, and many conflicting bits of advice. And things are changing rapidly.

Photo: Andy McLeod

↑ Insulation comes in many forms and is the first line of defence against heat transfer.

Climate change is making nights hotter and more humid, while also creating more extreme conditions. Appliance and building technologies are evolving rapidly, and changes in a building's performance can change the kinds of cooling needed.

New homes

If you are building a new home, look at the fine print of its energy star rating. In cooler climates, which can still have hot periods, the rating is dominated by winter performance. So a house can be great in winter and a hot box in summer. Raters are required to show the energy use for both winter and summer, so use this to tweak the design to work better in summer. Modern rating tools can also show you the temperature profile of each space during both a summer hot spell and a winter freeze. So you can identify the problem rooms and fix them during the design phase.

If you're building a two-storey home, remember that the upper storey works quite differently from the ground floor. It is exposed to high solar radiation and typically has low mass. Also, many builders do not get the insulation detail right: any wall exposed to the roof space must be insulated as if it is a ceiling, as it experiences the same heat loads. Careful design of windows and good natural ventilation are also important. But even if it is very well designed, it may still need some active cooling.

The basics for non-energy using cooling

Many articles will tell you the basics: shade windows and use advanced glazing products, insulate, seal out draughts, use natural ventilation when it's cooler outside than inside. All of these are very important, but there are some tricks and traps.

WINDOWS

Windows exposed to sun can allow an enormous amount of heat into a room: each square metre in direct sun collects up to the same heat as a dozen halogen lamps emit. If you're installing or replacing windows, consider advanced glazing products: double glazing and a variety of heat control coatings can dramatically improve glazing performance in both summer and winter. See www.wers.net for details of specific products. Different glazing solutions can be compared in specific situations using the energy rating tools.

Even the best advanced glazing still cannot match effective shading for summer performance. A combination of shading and advanced glazing can work very well all year round.

If you're not sure whether a particular window is causing overheating, you can tape cooking foil (shiny side out) on the inside of about three-quarters of the window for a few hot days to see if it makes much difference to the temperature or cooling energy required. If it does, consider more permanent solutions.

For external shading, a light-coloured material that allows air to pass through, such as 90% shade cloth, is most effective. It reflects a lot of heat, allows the hot air next to the window to escape, and lets more light into the room.

There are many other options for shading. Low sun on east, west and even south windows can be blocked by carefully placed vertical shading at a distance from the building. This can be vegetation, fixed vertical panels, or vertical blinds fixed to the edge of a pergola. Of course, you can use a combination of these strategies. It is less important to protect windows from glancing sun than 'full-on' sun.

While many people believe that carefully designed eaves provide a good solution for shading north windows, this is not necessarily ideal. Adjustable horizontal shading can shade the ground in front of the windows, and can also manage sun better in late summer and autumn, when the sun is lower in the sky but it can still be hot. A combination of eaves and adjustable shading, or just adjustable shading, can work very well.

→ Deciduous plants can provide shade in summer as well as food. Like an evaporative air conditioner, they can provide a cooling effect through evaporation of moisture from their leaves, creating local microclimates.

UPSTAIRS WINDOWS

To shade upstairs windows is always a challenge, because of access problems. Motorised external blinds offer one option. Some external blinds can be controlled by internally operated winders. European-style external roller blinds are very effective in both summer and winter, although they are not to everyone's aesthetic taste.

Window films are improving, and spectrally selective films can reject a high proportion of heat while allowing quite a lot of daylight in. But even the best films are not as effective as shading. Note that some films work well in both summer and winter.

Internal blinds or curtains (with a white or reflective outward facing surface) can be useful—if they are carefully selected and installed. It is important to create an insulating still air layer between the blind and the window across the top and along the sides. The material should not allow air to percolate through it. Multi-layer blinds, some with reflective surfaces, are available that work well. But effective internal window coverings can be expensive. An energy rating scheme for blinds is under development, hopefully to be launched in 2013.

A more extreme but very effective option is to use internal insulated panels to cover windows when they are exposed to the sun. Such panels can clip onto the window frame or be built-in so that they slide over the window and create a tight air seal around the edges. They should have white or reflective surfaces facing outwards. These can work well in winter, too. It is possible to include a small area of transparent or translucent multi-layered polycarbonate or similar material to provide some light, but it should be located where it is shaded by the window frame, and should have a heat rejecting film on the surface facing the window. In most rooms some windows will be in shade at any given time, so they don't need sun protection, and can provide daylight.

ROOFS AND WALLS

Dark-coloured walls (unless well insulated) exposed to sun can cook the occupants of a house. If the walls are uninsulated cavity-brick, the heat will be delayed a few hours, but it is still a problem. Painting walls and roofs white or light colours, including using the recently developed heat-rejecting paints, can be very effective. These paints reduce the temperature of a surface exposed to sun, so they reduce the temperature difference driving heat flow into the house. The better insulated the building fabric, the less important is the colour, especially if there is reflective foil under the roofing.

In winter, these paints can increase heating requirements for poorly insulated walls or roofs: in this situation, a removable shading solution may be preferable. Shade cloth hung from the eaves can work quite well, but make sure it's well secured to withstand high winds.

VENTILATION

In the quest for good ventilation, many homes create problems for themselves. Use of louvre windows or poorly sealed ventilating panels can increase uncontrolled air leakage. Use of large openable windows can add to heat gain and loss unless they are well sealed.

Many people leave some windows partly open all the time, as well as leaving doors to permanently ventilated spaces such as laundries and bathrooms open. This allows large amounts of hot air to pass through the house, especially on hot windy days. Close them up.

Ventilation should be secure and safe. Small, high windows or windows that can be locked while slightly open are good options. Noise is also a consideration. Active ventilation systems (see below) can also be effective.

ROOF VENTILATION

The importance of roof ventilation is hotly debated. Effective ventilation of a roof space can lower its temperature and reduce heat flow into a building. However, for a given amount of ventilation, the temperature reduction will be greater if reflective foil is installed under the roofing, or the roof is painted a light colour. It is very important that substantial air flows of 150 litres/second (and preferably more) are achieved, as the temperature reduction in a given situation is closely linked to the air flow.

MICROCLIMATES

The microclimate in which a building operates can also make a big difference to performance. Shading of the ground around a building, as well as transpiration from vegetation and funnelling of cool breezes, can reduce the local temperature and enhance the effectiveness of ventilation. This can also affect the efficiency of cooling equipment, as the lower the temperature, the more efficient cooling equipment is, as discussed below. Careful positioning of trees just south of west can block summer sun, while allowing access to winter afternoon sun, which sets north of west in cooler parts of Australia.

Active energy-consuming cooling

By using the non-energy consuming cooling options outlined so far, we can minimise our need to use energy to drive cooling. We can also manage cooling equipment to use less energy: for example, not leaving equipment running when no one is around, setting the thermostat at a higher temperature, limiting the area cooled, wearing light clothing and cooling parts of the home that are away from the hot sun.

Photo: Kristoferb at en.wikipedia.org

← Heat pumps work better in summer when they are protected from direct sunlight, so correct placement of the outdoor unit is crucial.

"Cooling a large uninsulated house on a hot afternoon could require an expensive 10 kilowatt (electricity) 25 kilowatt (cooling) air conditioner costing $2.50 an hour to run, but also driving investment in energy supply capacity of up to $30,000—subsidised by other users."

Cooling equipment can use very little or an enormous amount of energy, depending on user behaviour and circumstances. Cooling energy use has grown rapidly in recent years, as more households and businesses have installed mostly inefficient air conditioners in inefficient buildings. For example, cooling a large uninsulated house on a hot afternoon could require an expensive 10 kilowatt (electricity) 25 kilowatt (cooling) air conditioner costing $2.50 an hour to run, but also driving investment in energy supply capacity of up to $30,000—subsidised by other users.

In contrast, a high efficiency home (7 to 8 Stars with good shading) using the most efficient air conditioners would need cooling for much less time and use less than 1.5 kilowatts of electricity at the hottest times. This could be offset by efficient lighting and appliances, as well as solar electricity and storage, so no extra load is put on the electricity grid.

Over the next few years, smart meters and time-of-use pricing are likely to extend to most households with large air conditioners: they will pay much higher prices at times of high electricity demand as the electricity industry tries to recover its enormous investment in energy supply infrastructure. So upgrading building and equipment cooling efficiency will be increasingly attractive over time.

FANS

Fans cool people by increasing evaporation from their skin—enhancing the effectiveness of sweating as a way of losing heat. For example, evaporating 100 grams of water over an hour is equivalent to about 70 watts of continuous cooling. Fans also increase the rate of heat transfer from surfaces by reducing the thermal resistance of the thin air film next to the surfaces and by moving cooler air past them. For example, a fan blowing air across a cool concrete slab floor increases its effectiveness at absorbing heat from a room.

Most people think fans are very efficient. That's not necessarily the case. Recent tests reported in *Choice* show a range of 48 to 100

"If your main need for cooling is at night, then the cooling load will be much lower than indicated by rules of thumb or calculators, because there is no solar radiation: that is the biggest contributor to cooling load."

watts for typical ceiling fans. The recently developed Haiku ceiling fan (www.bigassfans.com) uses 30 watts at full speed and as little as 4 watts on low speed. Older-style fan controllers are crude, and may use as much energy on low speeds as on full speed. In India, fans have energy rating labels because they are a major contributor to electricity demand. In some parts of Australia, people may run five or more fans almost continuously for long periods: they could use as much electricity as an electric hot water service.

Fans can be used with an air conditioner to provide the same level of comfort at a higher thermostat setting, potentially reducing cooling energy use by around a third if the thermostat is set 3°C higher.

REFRIGERATIVE AIR CONDITIONING

A variety of conventional refrigerative air conditioning products and systems are available, using air-sourced heat pump technology. These include cooling-only and reverse-cycle units. The latter can be used for both heating and cooling, and cost little more than cooling-only units.

These heat pumps work like a fridge: refrigerant absorbs heat from its surroundings, and is then compressed. This process heats the refrigerant (like using a bike pump to pressurise air). The hot refrigerant loses heat to its surroundings, either heating indoors or dumping heat outside. The refrigerant is then depressurised and becomes cold, and the cycle starts again.

The efficiency with which a heat pump can provide heating or cooling ranges from 200 to 600%: that is it can provide up to six times as much heat or 'coolth' as the amount of electricity it uses. This is because it does not create heat (which could not exceed 100% efficiency), but simply shifts and concentrates heat. The energy efficiency depends on the design of the compressor and associated components. The ratio of heating or cooling produced divided by the amount of electricity used is called the Coefficient of Performance (COP) or the Energy Efficiency Ratio (EER): the higher the number, the better.

Other factors such as fan energy, electronics energy use and even heaters for the internal lubricant (often called crankcase heaters) can add to energy use. The energy rating label (since 2010) takes all these factors into account in rating products. You can compare products at www.energyrating.gov.au. The mandatory Minimum Energy Performance Standards now require COPs of at least 2.75 to 3, but note that the most efficient products are almost twice as efficient as the MEPS!

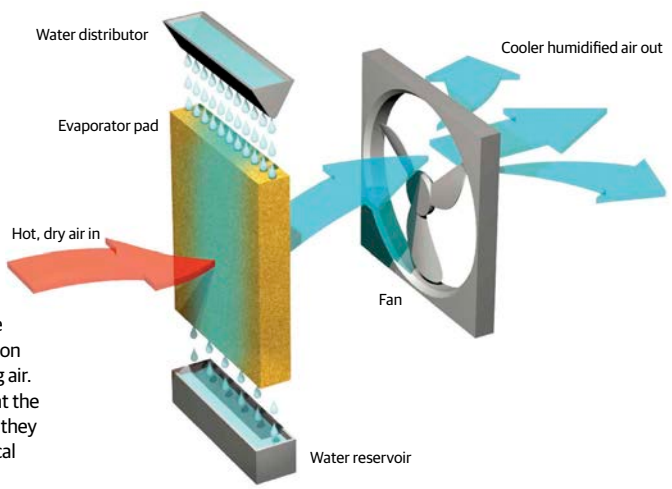
If you have an older air conditioner, it is worth checking to see if it has a crankcase heater by monitoring its standby power consumption. Some units draw up to 30 watts, which can cost $60 each year. A crankcase heater can usually be switched off unless it's very cold, but check with the manufacturer.

The smaller the temperature difference against which air conditioning operates, the more efficiently it works. Typically, efficiency varies by 2 to 3% per degree as temperature difference varies. So the hotter the environment for the outdoor unit in summer, the less efficient the cooling: ensuring the outdoor unit is in a shady and breezy area improves summer performance.

Other ways of supplying cooler air include drawing the supply air from under a house with a suspended floor or through an earth-linked labyrinth. The surface area needed to cool air using earth temperature is large, so just using underground pipes won't achieve much (see ATA forum www.ata.org.au/forums/topic/262 for a discussion on this). Geothermal or ground-source heat pumps use loops of pipe under the ground to provide a stable temperature source, but installation of the long lengths of pipe needed can be quite expensive. Evaporative pre-cooling can also be used.

Many modern air conditioners have 'inverter control': instead of cycling on at full power, then off until a room warms up a bit, inverter units vary the compressor speed to try to closely match the desired indoor temperature. In moderate conditions, inverter units are more efficient as they avoid or reduce the losses associated with starting and stopping the compressor. Also running at lower output means the heat exchangers are effectively oversized, so they work more efficiently at part load. At full load, they may be less efficient than a single speed unit, because of the electronics losses, but good design usually avoids this.

Many air conditioners are oversized. This not only adds to purchase and installation costs, but means they are more likely to cycle on and off, even if inverter controlled. The shorter running time also means they are less effective at dehumidifying the air as water has less time to condense. The independent website www.fairair.com.au provides a useful calculator to estimate the appropriate size unit. Improving building efficiency through shading, insulation and other measures discussed earlier also reduces the size of unit needed. Also keep in mind that an undersized air conditioner will still work on a very hot day: it may just not cool your home to 22°C. It may also require some cooled spaces to be closed off, or windows to be shaded. Or you may need to sit closer to it to feel really cool. If your main need for cooling is at night, then the cooling load will be much lower than indicated by rules of thumb or calculators, because there is no solar radiation: that is the biggest contributor to cooling load.



→ Evaporative coolers are quite simple and use the evaporation of water to cool the incoming air. The main disadvantage is that the air becomes more humid, so they don't work very well in tropical climates or on humid days.

Diagram: www.pinnacleint.com

"The dry bulb temperature may be 30 °C while the wet bulb temperature is 20 °C; a typical evaporative cooler might then deliver air at 22 °C."

Relative Humidity—RH (%)								
Difference between Dry Bulb and Wet Bulb Temperatures Tdb - Twb (°C)	Dry Bulb Temperature - Tdb (°C)							
	15	18	20	22	25	27	30	33
1	90	91	91	92	92	92	93	93
2	80	82	83	84	85	85	86	87
3	71	73	75	76	77	78	79	80
4	62	65	67	68	70	71	73	74
5	53	57	59	61	64	65	67	69
6	44	49	52	54	57	59	61	63
7	36	42	45	47	51	53	55	58
8	28	34	38	41	45	47	50	53
9	21	27	31	34	39	41	45	48
10	13	20	25	28	33	36	40	43

Source: Engineeringtoolbox.com

→ This chart shows how the difference between dry bulb and wet bulb temperatures decreases with increasing humidity. Select a dry bulb temperature and read down to the approximate current relative humidity. The difference between dry and wet bulb temperatures can be read in the same row in the left column.

Portable air conditioners have been tested by *Choice*. They are not covered by the energy labelling or mandatory standards schemes, and seem to be relatively inefficient compared to split systems. They are also fairly noisy. They must be close to a window, as hot exhaust air must be vented to outdoors via a duct through the wall or a window adaptor. A poorly sealed air outlet can allow hot outdoor air to leak into the room. These units draw some outdoor air into the room as they exhaust the hot air they produce: on the one hand, this ensures some fresh air but, on the other hand, this fresh air brings some heat with it.

Ducted cooling systems are typically less efficient than good split systems, because ducting is not usually highly insulated, and it is usually installed in a hot roof space. Also, if there are not separate thermostats in each room, it is difficult to balance the cooling to respond to the wide variation in cooling requirements in each room over the day.

EVAPORATIVE COOLING

When a litre of water evaporates, it absorbs around 2.4 megajoules of heat. Evaporating one litre per hour provides a continuous cooling effect of about 670 watts. However, the resulting water vapour makes the air more humid, so evaporative coolers have to draw in outdoor air and the air it replaces must escape from the building. So evaporative cooling provides a useful source of fresh air. It can also pressurise a home to some extent, reducing ingress of dust and hot outdoor air, and helping to keep out flies and other bugs.

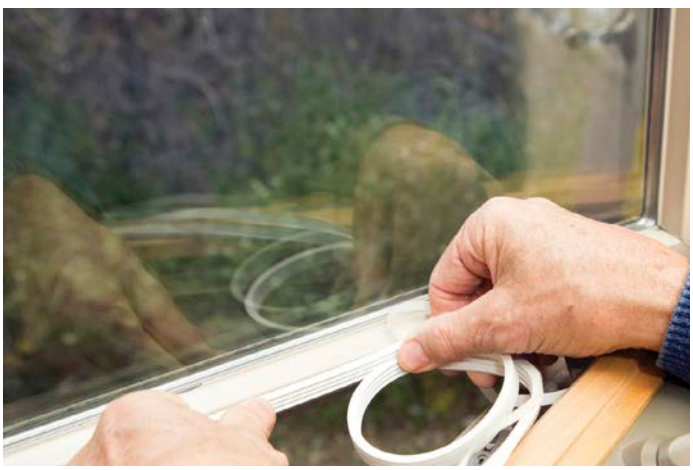
An evaporative cooler can't cool air to a temperature below the 'wet bulb' temperature: effectively the temperature when the air is at 100% relative humidity, measured by a thermometer with its bulb encased in a wetted fabric cover. In reality, most units cool air from the dry bulb temperature (what we usually measure) by about 80% of the gap between dry and wet bulb temperature.

For example, the dry bulb temperature may be 30 °C while the wet bulb temperature is 20 °C. So a typical evaporative cooler might deliver air at 22 °C (cooling inlet air by 8 °C of the 10 °C difference between dry and wet bulb temperatures).

When ambient air is very humid, the wet bulb temperature is quite close to the dry bulb temperature, so an evaporative cooler doesn't do much more than an ordinary fan would, although it will prevent the building from heating up above outdoor temperature! This is why evaporative coolers don't work very well in humid conditions. Also, as the temperature drops at night in summer, humidity tends to increase and the cooling effectiveness of an evaporative cooler declines.

The Bureau of Meteorology (www.bom.gov.au) observations website shows various indicators of humidity, including the 'Delta T C' which is the difference between dry and wet bulb temps. Dew point (which is the temperature at which dew forms through condensation of water vapour from the air) also indicates humidity—the closer it is to the dry bulb temp, the more humid it is. By looking at typical data for your location you can gain a sense of what temperature air an evaporative cooler would deliver in the conditions when you most value cooling.

Since an evaporative cooler just uses a fan to drive air through a wet pad, then through ducts, as well as a small pump to move water to the top of the pad, its energy consumption should be very low. Indeed, recent developments have lead to the use of high efficiency motors and fans, along with variable speed drives and improved control of pumping and water usage. Some manufacturers claim consumption of around 100 watts: so they deliver 10 or more times as much cooling effect as the electricity they



← Sealing out draughts can help keep a home cool in summer and warm in winter and make an enormous difference to energy consumption.

"For an efficient house with an efficient air conditioner, a PV system can offset cooling running costs. However, the solar system output doesn't match the typical daily household cooling profile very closely."

use. That makes them three or more times as efficient as the least efficient refrigerative air conditioners now on the market (which provide 2.75 to 3 times as much cooling as the electrical energy they use).

However, evaporative coolers can consume quite a bit of water, which can be an issue in parts of Australia. Also, it is very important to ensure that the cooler is fitted with an automatic damper (or flap) that closes when it is not running. Without this, air will escape through the cooler unit, so winter heating bills could skyrocket, and the house will tend to heat up faster on a hot day, leading to a need for more cooling. In addition, if windows are left open in summer for the air to escape when the cooler is running, they will also allow more hot air to enter when it's not running.

Neighbours may not be thrilled if you install an evaporative cooler on your roof: some are quite noisy.

Recently we have seen the re-emergence of indirect evaporative coolers, with products such as the Coolerado and Climate Wizard. Improvements in heat transfer and fan efficiency have made these more viable than in the past. Basically these use evaporatively cooled air to cool a separate stream of air without increasing its moisture content. While they don't add more water vapour to the air entering the building, the relative humidity of the air does increase to some extent as it cools. They also use much more energy to run fans than conventional evaporative coolers.

Some of these units use quite subtle design so that they can cool incoming air towards the dew point, which is typically cooler than the wet bulb temperature that limits the temperature output of conventional evaporative coolers. However, as relative humidity increases and the wet bulb temperature moves closer to the dry bulb temperature, the dew point moves closer to the wet bulb temperature too.

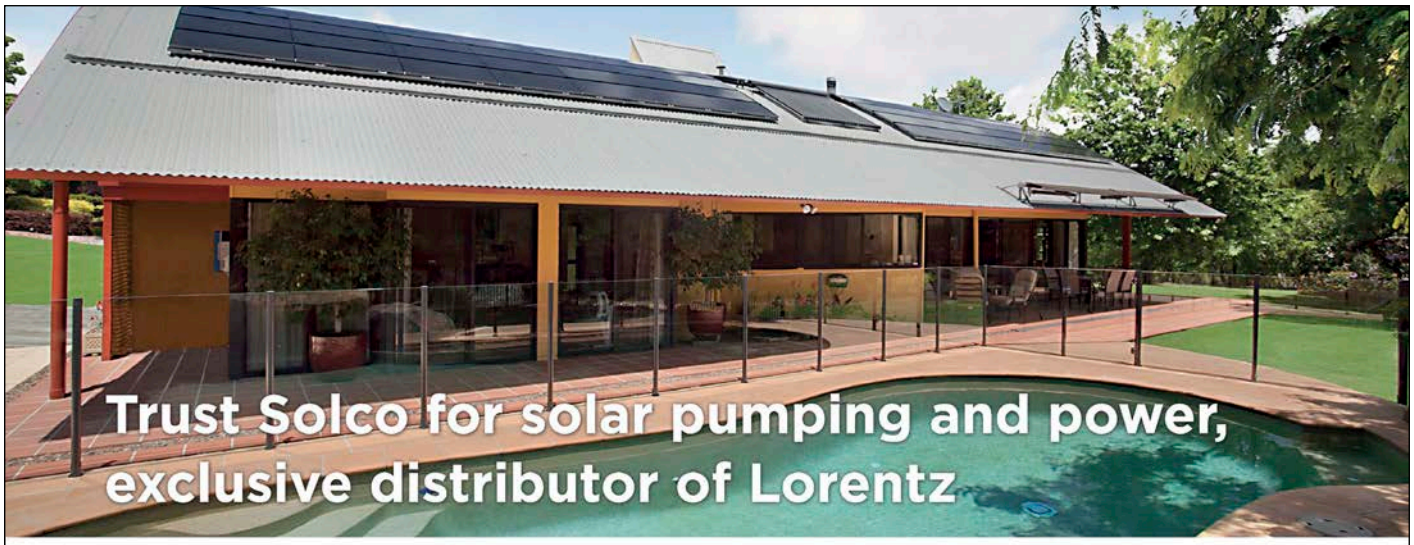
PV AND AIR CONDITIONING

Many households are installing solar electricity systems. For an efficient house with an efficient air conditioner, a PV system can certainly offset cooling running costs. However, the solar system output doesn't match the typical daily household cooling profile very closely. Energy storage systems are rapidly improving, and will soon allow demand to be more closely matched by stored electricity.

Conclusion

Combining efficient behaviour, improvements to buildings and high efficiency conventional cooling options with renewable electricity and, soon, energy storage, makes zero or beyond zero emission cooling with minimal impact on grid supply infrastructure financially and practically feasible today. Ongoing developments will further improve the potential for lower cost, guilt-free summer comfort! ✸

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.
Alan also provides comments on emerging cooling technologies, cooling in the tropics and the interaction between thermal mass and cooling. You can find these on our website at: www.renew.org.au/cooling



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	Energy Cost @ $0.38 / hr	$277.00

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Reducing your pool's carbon footprint
A pool pump buyers guide

As pool owners soon discover, pool pumps can be big energy users. But some pool pumps are more efficient than others. Lance Turner examines the options.

ENVIRONMENTALLY, there are issues with pools. Pools contain high embodied energy materials such as concrete, tile and fibreglass, and they use large quantities of water and toxic materials such as chlorine. In addition, the pool pumps needed to keep them clean use a great deal of electricity.

Pools can be the largest user of electricity in the home, accounting for up to 30% of household energy consumption—that's more than a clothes washer, clothes dryer and dishwasher combined, or about two and a half refrigerators. And the pump can contribute up to 76% of that figure—that's a big chunk of your electricity bill. In Australia, with the predominance of coal-fired electricity, this also means the average pool has a large CO_2 footprint.

Despite the costs, more than 12% of Australian households have a pool, with that number likely to rise in the future. So what can be done to reduce some of these impacts? A good place to start reducing your pool's carbon footprint is to reduce the energy used by the pumping and filtration system.

Voluntary energy labelling standard

At the moment there are no mandatory energy efficiency requirements for pool pumps. However, there is a voluntary minimum energy performance standard (MEPS), with participating suppliers required to test and label their pumps as per the Australian Standard *AS5102-2009—Performance for household electrical appliances—Swimming Pool Pump units*.

To date, around 30 pumps have been tested and labelled to the standard, and these appear in the table accompanying this guide.

Photo: Vic Brincat, Keswick, Ontario, Canada

↑ Selecting the right pump can greatly reduce energy use and associated greenhouse gas emissions from your pool.

Measuring pump efficiency

The efficiency of a pump is basically the amount of energy used to pump a set volume of water under particular conditions. The less energy used, the more efficient the pump. The energy used will depend on a number of factors, but prime considerations are the size of the pump and the power rating.

Pump sizing

When a pool is installed, the installer should provide an appropriately sized pump and filter system. But it's worth checking as there does seem to have been a trend to supply pumps larger than is necessary.

So what size pump do you need? With the average pool, you should aim to turn over the entire pool volume every four to eight hours. For example, for an eight-hour turnover of a 50,000 litre pool, your pump should be able to pump 6250 litres per hour, or around 100 litres per minute. The specified flow rate will be approximate, however, as the actual flow rate will depend on a number of factors including pipe sizes and filter quality. But ensure that the pump is not excessively oversized or it will use more energy than is necessary.

The filter, chlorinator and other accessories should also be sized to match the flow rate. Don't take the path of buying whatever is

cheapest, or spending more than you need to on an oversized system. Doing either will cost you, one in excessive pool maintenance, the other in running costs.

Pump power

The other specification that's important is the power rating. Some pumps have the power expressed in horsepower (hp), whereas others have it in watts or kilowatts. One horsepower is around 750 watts, so the conversion is straightforward.

Pump power plate ratings don't tell the whole story, however. How much power and hence energy the pump actually draws will depend on a number of things, including how restrictive the pipework and filter system are.

When evaluating pumps, you need real world figures showing energy use for given flow volumes, something the manufacturer should be able to supply. Check the pump datasheets, as they often contain this sort of information.

Single versus variable speed

Until recently, most pool pumps used single speed AC induction motors. These vary in efficiency, with higher quality pumps usually using less energy per litre of water pumped. However, running a pump motor flat out is often not necessary and, due to frictional losses in pipes and filters, slowing the pump speed can result in an increase in efficiency. It is usually more efficient to run a pump at a slower rate for longer rather than flat out for a shorter period of time.

To cater for this, pumps with variable speed drives have found their way onto the market. Most have a number of speeds that can be chosen by the user or by the pump controller itself, depending on the seasonal requirements. Generally these sorts of pumps are more efficient than the common single speed units. The pumps listed in the table are all capable of more than one pumping rate.

Reducing running costs

If you don't want to get rid of your current pool pump, you can reduce its energy use in a number of ways.

The first method is to reduce the run time of the pump during the months when the pool is not being used. You may be able to run the pump for as little as two hours per day in winter, compared to six hours a day during the summer months.

Another way to reduce pool pump running costs is by making your single speed pump into a variable speed unit using an add-on variable speed drive system. We found two systems while researching for this guide: the Future Wave unit (www.future-wave.com) and the Eco Logic Controller (www.ecocontrollers.com).

Both of these enable you to vary the speed of the pump motor to better match your requirements, and so reduce energy consumption considerably, at least according to the manufacturers. For pool pumps that are oversized for the pools they are filtering, reducing the running speed should mean that they still work correctly but with reduced running costs.

If you decide to go down this path, it's worth checking the claimed savings: ask around, do research and check out relevant forums; there are numerous comments on these sorts of devices to be found if you look.

Another method of reducing pump run times is with ionising devices such as the Aquatronic Solar Pool Ioniser (www.aquatronic.com.au), which uses a small solar panel to electrolyse a copper electrode and release copper ions into the pool water. The ions perform the same function as chlorine, killing bacteria and viruses, and so allowing you to reduce filtration and chlorinator run times.

Another way to reduce or even eliminate pool pump energy use is to turn your pool into a natural pool or swimming pond. Natural pools use plants and biological systems to keep the water healthy. There are a number of companies that can convert existing pools into something more eco-friendly, including Aquaviva (www.mynaturalpool.com.au), BioNova (www.bionovanaturalpools.com.au), gartenART (www.gartenart-australia.com) and Riverwater Pools (www.riverwaterpools.com.au), but there are numerous others. Search 'natural pools' to find your closest supplier.

↑ Pool pumps are not the most exciting things to look at, but selecting the right one can make getting an energy bill a lot less stressful.

About the tables

The table headings are fairly self-explanatory. Table 1 includes many of the pumps currently available in Australia that have been tested to meet the voluntary MEPS requirements. Note that the Balboa pump is considered to be a spa pump, but its flow rate could well be adequate for small pools as well. Table 2 is a brief roundup of solar pool pumps. ✱

Resources

The Energy Ratings website has a pool pumps page: www.energyrating.gov.au/products-themes/other/swimming-pool-pumps/

Go solar for your pool

Most people are aware of solar pool heating systems, but many don't realise that the main pool pump can also be solar powered, with no mains electricity required at all.

While solar pool pumps are not common, they are available. One example is the Combo Pump from Solazone. It is a 600 watt, 48 volt DC pump that can run from a battery bank or directly from a solar array without batteries, using a suitable maximum power point tracking pump controller, such as the MPPT 800 from Solazone.

Table 1: Mains-powered MEPS rated pool pumps

Brand	Model number	Type	Rated power (W)	Rated flow rate (L/min)	Projected annual energy consumption (kWh)	Star rating	Warranty (years)	RRP ($)
Astral Pool ph:(03) 9554 2200 info@astralpool.com.au www.astralpool.com.au	P600 EVO 11553	VSP	147–1582	122–307	367	8	3	1,910 + GST
	Viron P320 EVO 11554	VSP	153–1086	121–252	386	8	3	1,360 + GST
Balboa Australian Spa Parts 1300 736 025 sales@spaparts.com.au www.spaparts.com.au	Model 1030017 spa circulation pump	Single	0.25hp	120 typical	460	7	1	685
Davey PowerMaster Davey Australia ph:1300 232 839 sales@davey.com.au www.davey.com.au	PMECO	Multi	165–1109	370 max	408	8	3	1,205
	SLSECO	Single	334	154	659	6	3	705
	SLLECO	Single	337	157	654	6	3	814
Hayward Pool Products ph:1300 766571 sales@hayward-pool.com.au www.hayward-pool.com.au	Tristar	Multi	184	135.3	414	8	3	1,399
	Super II	Multi	192.9	128.2	457	7	3	1,399
Pentair Australia ph:1300 137 344 au.sales@pentairwater.com www.pentair.com.au	Intelliflo VF 011014	VSP	2200 (156 @ 8 Star rate)	800 max, 120 @ 8 Star rate	396	8	5	2,999
	Intelliflo VS 011018				396	8	5	2,749
	Intelliflo VS+SVRS				396	8		2,849
	Intellipro VS		2200 (159 @ 8 Star rate)		402	8		CALL
	Intellipro VS+SVRS				402	8		
	Eco800		800 (158 @ 8 Star rate)	450 max, 123 @ 8 Star rate	392	8		
Poolrite ph:(07) 3323 6555 info@poolrite.com.au www.poolrite.com.au	SQ Gemini Twin	Dual	211 (7 Star rate)	123 @ 7 Star rate	519	7	3 years motor, 2 years other components	928
Reltech ph:(03) 9459 3838 office@reltech.com.au www.reltech.com.au	Ecoflo V3	Multi	319 @ 1900 rpm, 600 @ 2400 rpm 970 @ 2850rpm	157.5 @ 7 Star rate, 380 max	622	6	3	1,160
Speck ph:1300 166 253 info.usa@speck-pumps.com www.continentalwater.com.au	Badu Eco Touch 2	Multi	-	400 max	625	6	2/5	POA
	Badu Eco Touch 3	Multi	400/700/1050	500 max	413	8		
	Speck 90-500DS	Dual	300/1400	570 max	625	6		
Waterco ph:(02) 9898 8600 administration@waterco.com www.waterco.com.au	Waterco Hydrostorm Eco 100	Multi	320/620/980	320 max	589	6	2/3	POA
Zodiac ph:1800 688 552 www.zodiac.com.au	Flo Pro ePump WZEP	VSP	0.25 - 1.5hp	470 max	447	7	3 years (2 years on seal)	1,697 for pump, 141 for controller

Table 2: Solar-powered pool pumps

Brand	Model number	Type	Rated power	Max rated flow rate (L/m)	Warranty (years)	RRP ($)
Lorentz Solco Solar Products ph:1800 074 007 www.solco.com.au	PS600 CS-17-1	DC	600	316	2	POA
	PS1800 CS-37-1	DC	1200	600		
Solazone ph:(07) 5448 7010 qld@solazone.com.au www.solazone.com.au	Combo Pump	DC	600	250	3	1,100
Sun Saver Solar City Enterprises ph:1300 52 42 51 www.solarandenergy.com.au	Sun Saver 600	DC	600	250	-	POA

Selecting PV panels in a buyers market

There are many factors to consider when looking for solar panels. Stephen Ingrouille from Going Solar explains how distributors evaluate panels.

GOING Solar recently conducted an intensive investigation into various brands of PV panels as part of the process of widening our range. The problem we faced was an overabundance of choice. There appear to be over 870 PV panel manufacturers in China alone with another 670 in the rest of the world. They can't all be producing the best quality and the reality is that some won't be around in a few years time. This article details how we refined our search.

The first selection factor is that PV panels sold in Australia and eligible for rebates must have Clean Energy Council (CEC) approval. Manufacturers need to submit paperwork demonstrating that their panels have been tested and meet Australian and international standards.

For our second step, we chose to look at the German *Öko-Tes*t magazine, a magazine similar to Australia's *Choice*. In April 2010 *Öko-Test* engaged Photon Laboratory, an internationally recognised testing facility, to test 15 different PV brands. The tests included power measurement and deviation from the manufacturer's stated performance tolerance, along with tests for imperfections and defects.

The final ratings were not based on panel price. Four brands—Aleo, Schott, Sovello and Upsolar—received the highest overall rating of 'very good'. Three of these are German panels, but it caught our attention to see that the Chinese-made Upsolar brand was competing favourably with the best German products. On the other hand, a number of well-known brands rated as 'satisfactory', 'fair' or 'poor'. The lesson here is that brand awareness does not necessarily equal quality.

Our next point of reference was to look at the results of the regular tests conducted by Photon Laboratory themselves. In their 2011 test round, they put 46 PV panels to the test for more than 12 months. Several of the brands tested were of interest to Going Solar: NexPower, rated at #3; Winaico, at #7; Upsolar, at #11; and Aleo, at #15. It is important to note that only a small number of manufacturers were represented in the 2011 tests and that more should be rated in 2012. Also be aware that with the industry moving so rapidly, tested panels are likely to be superseded. However, manufacturers striving for excellence in production are likely to have their products listed towards the top of the table, say in the top 20.

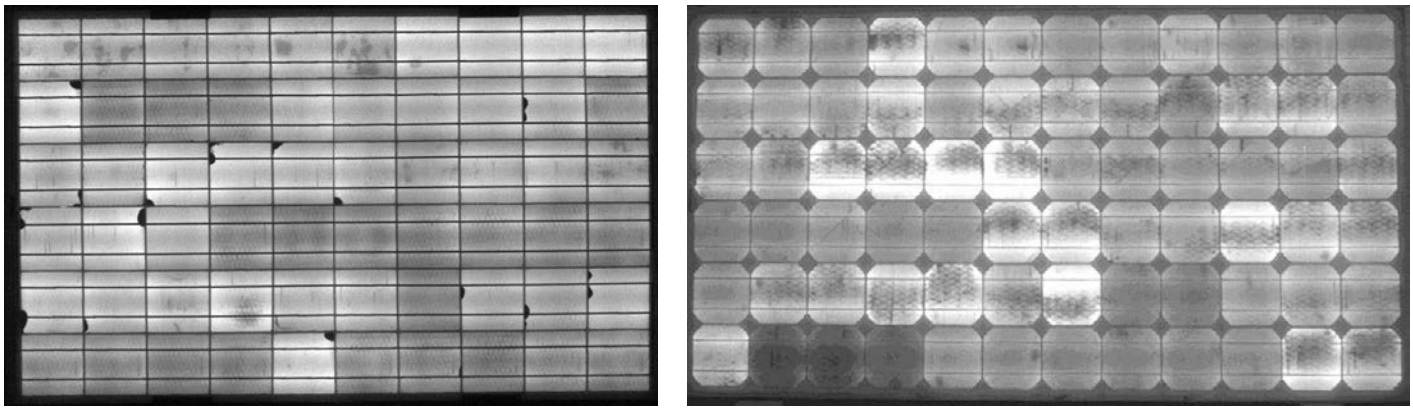
Photo: Zep Solar

↑ Solar panels are expected to last 25 years or more, so selecting quality panels is important.

Different panels for different uses

Another consideration is the type of PV technology. Most current panels are one of three types: monocrystalline, polycrystalline or amorphous. To confuse matters these panel types are also known as single-crystalline, multi-crystalline and thin-film, respectively.

Different panel types will suit different projects. For example, it may be desirable to cover a whole roof, for aesthetic reasons, with lower cost panels even though they have lower output. On the other hand, sometimes a client is looking for the most efficient panel to generate the greatest output from a limited roof area.



Photos: Winaico

↑ Electroluminescence testing shows a solar panel's defects. On the left we see a panel with cracks where the chips show up as black spots. On the right, the panel should be a consistent shade of grey; the variations indicate problems.

Specialised panel technologies suit projects where flexibility, vandal resistance or building integration is required. Flexible panels can be used on curved roofs or walls, or if vandalism is a perceived issue, as there is no glass to break. Another approach to reduce vandalism or theft is to use amorphous rigid modules as these are not necessarily recognisable as PV panels.

Integrated panel laminates can even be used to form part of the building envelope, for example as part of north-facing windows or an atrium roof.

The choice of panel type is a decision to be discussed with the PV system designer. It is preferable if a supplier can offer a range of panel technologies so that the most suitable technology can be used; beware of suppliers trying to pass off their one and only technology for every application.

Panel efficiency

Panel efficiency, also known as module efficiency, is another way to compare PV products. Panel efficiency is based on the output of the panel in relation to its collection area, or aperture.

At the time of our research, panels such as the Panasonic HIT panel had a panel efficiency of 18.6%. For comparison, Winaico offered a monocrystalline panel at 15.34% and Upsolar had a monocrystalline panel at 15.4%. Since then—and as a demonstration of how fast the technology is advancing—Winaico has released a panel with an efficiency of 17.13%.

As a general rule, the higher the efficiency the better, as long as the result is not a panel that's uncompetitive in price.

Power tolerances

Another way of evaluating PV panels is to compare the listed power tolerances for each module. Each panel with a particular size, type and number of cells is tested after manufacture and is classed depending on output power. For instance, panels from the same production run might be listed, for example, as 240 W, 245 W, 250 W, 255 W or 260 W.

However, when panels are sold they will have a power tolerance rating such as '+ or - 5%'. This means that you might buy, say, a 250 W panel, thinking it will give you 250 W in ideal conditions, but it may in fact give you up to 5% more power—or 5% less! Over a system lifetime, hopefully in excess of 25 years, the difference between the rated power and actual power could be considerable.

The better brands of panels tend to be under-rated and should therefore produce more power than stated. They are sold with what's called a positive power tolerance. For example, Topsun has a rating of +2%, Winaico has +5% and Panasonic has +10%.

Another approach is to certify each panel. Upsolar and Winaico, for example, test and provide 'flash data' (see 'Flash testing' box) for each panel. This means that the customer knows the exact output, under ideal conditions, for each panel.

The relationship between the distributor and the manufacturer is as important as the relationship between the end user and their chosen distributor. The distributor represents the manufacturer but there is also a responsibility for the distributor to represent the customer, particularly in matters of warranty and after-sales service. As distributors we look at what kinds of support (training, brochures, warranties etc) the manufacturers can offer us so we in turn can pass that on to our customers. This is an important component of selecting a PV manufacturer.

Warranties

In Australia, warranties for products are carried either by the manufacturer or the importer. Photovoltaic panels usually have two types of manufacturer's warranties. The first is a product warranty which is typically included on brochures and quotes and provides from five to ten year coverage for defects in the manufacture of the panel. Good panels undergo a number of tests before they leave the factory including a flash test. They also sometimes undergo an electroluminescence test, which picks up faults and tiny cracks. With quality PV panels, problems are extremely rare but should they arise customers would expect them to be covered under warranty.

The second manufacturer's warranty relates to performance. PV panels tend to de-rate slightly when exposed to sunlight. The performance warranty guarantees the output over a number of years; for example, 90% after 10 years, 85% after 20 years and 80% after 25 years. Many PV panels offer similar performance warranties but there are some variations.

Flash testing

Panels are tested by flashing them at 1 kW/m² of insolation for 100 ms at 25 °C. Note that this produces unrealistically high output figures as panels always run hotter than 25 degrees. However, it can be used to provide a base for comparison of panel efficiencies.

Photo: Zep Solar

← Some panels have special features, such as the ZS Wave mounting system on Zep Solar panels.

A key issue is that regardless of the warranty period, the guarantee only has value if there is someone around to honour it. Worldwide, the solar industry is currently very fluid, with many manufacturers going out of business. In Australia several of the distributors—sometimes quite well-known names—have also gone into liquidation, which can mean the end of any warranty coverage. It is very much a case of 'buyer beware': this applies as much to the distributor as it does to the end customer.

Another warranty that should be provided is the installation warranty which is carried by the installer or distributor.

In our research, we also came across insurance provided by some manufacturers on their PV products without additional charge. For example, Upsolar offers PowerGuard insurance which protects against design defects, delaminating modules and power output, within the warranty terms. Paid in advance by Upsolar, the insurance covers the panels for 25 years regardless of what happens to Upsolar. In a turbulent world this provides comfort for the end customer.

Another type of insurance we liked was the policy offered by Winaico. This is a comprehensive policy that covers just about everything, from theft to failure, for two years, with an option of purchasing an extension for a further three years. In some cases such comprehensive insurance could be useful, while other customers may prefer the longer term PowerGuard insurance.

A warning here: be wary of manufacturers who offer insurance on their product warranty. Such policies tend to be paid annually which means that if the manufacturer becomes insolvent you are likely to lose not just their warranty coverage but any apparent insurance.

Looks can be important

In comparing PV panels, the factor of personal preference also comes into play. Aesthetics may be important if the panels can be seen. Some panels have black frames and a black backing sheet whereas others have silver frames and a white backing sheet. The former tend to look better but the latter are likely to be slightly more efficient in high temperature conditions as they run a bit cooler. Some people like the reputation that a country carries—e.g. German manufacture—and if that is the case you should make sure the panels are actually manufactured in that country.

Another factor can be special features. Some panel manufacturers (including Upsolar) offer special framing methods such as the Zep framing system which adds slightly to the cost of each panel, but substantially reduces the framing requirements, installation time and therefore the overall cost.

We also considered the awards or certifications won by some manufacturers, as these demonstrate that they are striving hard to produce the best products. For example, earlier this year Panasonic received a corporate innovation award for its work on the high-efficiency HIT panel. Last month Upsolar won a solar industry award in the industry development category for its work on life cycle assessment: tracking a product from the raw materials to the end of its life. And in May 2012, Winaico received a certification for its work in occupational health and safety in the manufacture of panels.

Price can be the decider

The final issue is cost. For some, price might be the primary concern, but as you can see from this article, there are many factors that should be to be taken into account. It is really the relationship between all these factors that indicate whether a price is fair. While PV panel prices are falling quite dramatically, the offer of really cheap prices should set off alarm bells. Are such panels sub-standard? Are they being dumped? Will the supplier be around to carry the warranty? On the other hand, expensive panels—when compared dollar per watt—may indicate a manufacturer is unable to keep up in a competitive marketplace.

We all want to receive a good price but the onus is on the buyer to do the homework, compare like-for-like and take into account the factors mentioned above. Quality equipment will rarely be the cheapest, yet the cost of a product is soon forgotten if it provides long and reliable service . ✸

Stephen Ingrouille, Principal, Going Solar, has worked in the solar industry for over 34 years.

15 points to consider when comparing PV panels

1. Do they have Clean Energy Council approval?
2. How do they rate on the 2010 German Öko-Test?
3. How do they rate on the Photon Laboratory tests?
4. How does the PV product quality compare to the brand awareness?
5. Does the supplier offer a range of PV module types?
6. How does the panel efficiency compare?
7. What power tolerances are offered?
8. What support is offered by the manufacturers and suppliers?
9. How does the manufacturer's product warranty compare?
10. How does the manufacturer's performance warranty compare?
11. How does the supplier's installation warranty compare?
12. Is pre-paid independent insurance provided?
13. Are special features (such as a Zep frame) included?
14. Has a product Life Cycle Assessment been conducted?
15. Price?

Wind power works
Doing small wind right

Small wind energy systems have the potential to provide all of your energy needs—if you have a suitable site and install the right system. Katie Ross explains the truths behind small wind system design.

ON a recent trip through rural Australian countryside I saw quite a few small wind electric systems on the properties of rural homes and farms. The sight of wind systems dotting the landscape is incredibly heartening. These small wind systems represent energy independence, a hedge against increasing energy prices, decreased carbon emissions and, importantly, support for the local economy.

Seeing small wind systems in the countryside is also heartening because wind systems produce negligible, if any, energy in urban areas. I see five of these urban turbines in Sydney on my bike ride into work and it still makes me cringe to think about these poor investment decisions (and inherently bad marketing for renewable energy).

However, on my drive through rural Australia I also saw many poorly sited wind electric systems. The owners of poorly sited systems have the best of intentions, but unfortunately these good intentions may not come to fruition when the installer does not locate or design the system appropriately. It was the drive through the countryside that prompted me to revisit some of the small wind siting truths in order to provide some guidance for those interested in installing a small wind energy system.

Photo: Katie Ross

↑ While this turbine appears to be close to the trees, the turbine is sited above the majority of turbulence created by the surrounding trees and is 'in front' of the trees to have first exposure to the predominant wind direction.

Why is siting important?

Small wind energy has a significant role to play in helping countries meet their goals for distributed energy and carbon reduction. According to the World Wind Energy Association's *2012 Small Wind Report*, the market for small wind turbines has seen dynamic growth this year and the total capacity worldwide has reached 440 MW: about the same as the combined capacity of all Victoria's wind farms at the start of 2012.

However, it is no use installing wind electric systems if they are not sited correctly. A wind system, like a solar PV system, needs access to the resource.

Truth #1: Installing a wind system on a tower that is too short is akin to installing a solar electric panel in your basement. Both would be interesting to observe up close, but totally useless in terms of energy production.

The wind turbine needs to be at a height where the wind blows at a sufficient speed for energy production. Wind turbines are rated with a 'cut-in' wind speed, but this is often much lower than what's needed to provide useful amounts of energy. While the blades of a wind turbine might appear to spin rapidly, you need an average wind speed of at least 5 m/s to generate enough energy to make a wind system worthwhile. More useful amounts of energy will be generated at average wind speeds above about 6 m/s, although this occurs much less frequently.

If you do not have access to average wind speeds of 5 m/s or greater at your site—even with a tower height of 40 metres—install solar PV instead.

Check wind maps or consult with a wind installer to see what the wind speeds might be at your site. If the wind installer tells you that you have a wind speed of 5 m/s, ask the installer, "At what height is this wind speed?" Wind speed

Photo: Katie Ross

← This wind system appears to have great access to a wind resource, but it actually needs another 12 metres in height to get above turbulence created by the rough topography.

increases with distance from the ground and it's no use installing a system on an 18 metre tower if the wind speed only just reaches 5m/s at a height of 24 metres. Investing in a taller tower to access faster wind speeds will always pay off for small wind systems. Why?

Truth #2: The power available in the wind is proportional to the cube of the wind speed.

What Truth #2 means is that for every doubling in wind speed, the potential power your turbine is able to capture increases eight-fold! Wind systems are gluttons for fast-moving wind. The faster the wind blows, the happier they are. Every incremental increase in a tower height will exponentially increase the power output of your turbine (and result in a faster return on investment)!

But having fast wind isn't the only thing a wind system requires. In particular, a wind system needs access to 'laminar' wind—that's smooth, straight-flowing wind—to produce electricity. Turbulent wind puts substantial wear and tear on the turbine and thus significantly reduces the turbine's lifetime. Rough wind also prevents the wind system from extracting much usable energy. The wind system just won't work.

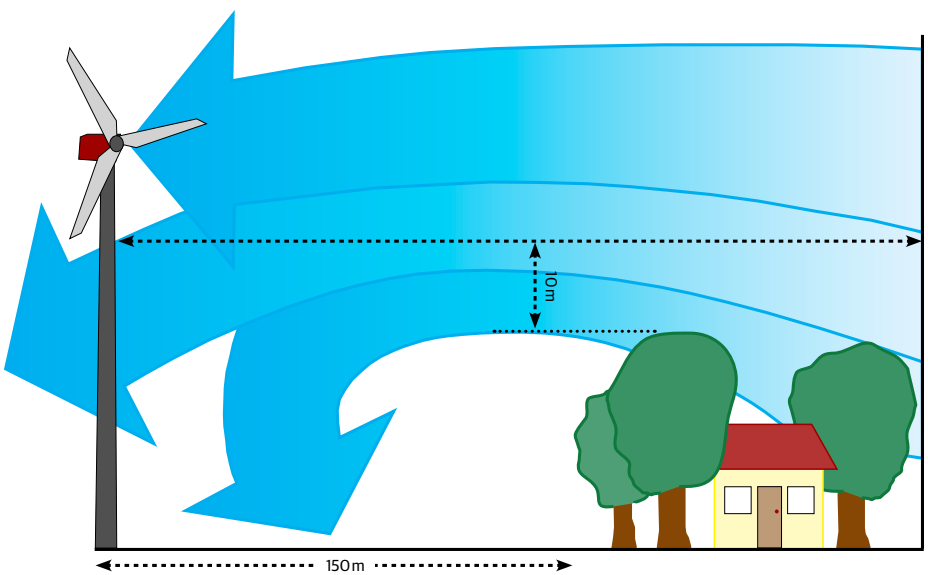
Wind is turbulent near the ground and even more turbulent around trees, buildings and steep topographical features. In order to access smooth wind, a system needs to be on a tower that is well above these turbulent areas.

Truth #3: Your turbine should be on at least a 20 metre tower to avoid turbulence caused by ground friction. Further, if your site has obstacles within 150 metres, you need a minimum of a 10 metre buffer between the top of the obstacle and the bottom of the wind turbine blades (in most cases).

The 20-metre rule of thumb is just a minimum. It almost always pays to go higher, even if there are no obstacles within 150 metres. Any additional money that you spend on investing in a taller tower will have a return on that incremental cost, many, many times over. Tower heights of 36m and 42m are the norm in countries such as the USA that have more developed small wind markets and better regulation of incentive schemes.

When investigating potential small wind installers, one of the most important questions to ask is, "What tower heights do you offer?" I would suggest that if the installer does not offer anything taller than 20 metres, you look elsewhere, especially if your site has any obstacles.

In addition to the 20-metre rule, Truth #3 explains that the tower height should take into account the height of the site's obstacles.



↑ Wind turbines should be sited at least 10 metres above the highest close obstruction, or at least 150 metres away.

And remember—trees grow. Calculate your tower height based on the mature height of any surrounding trees.

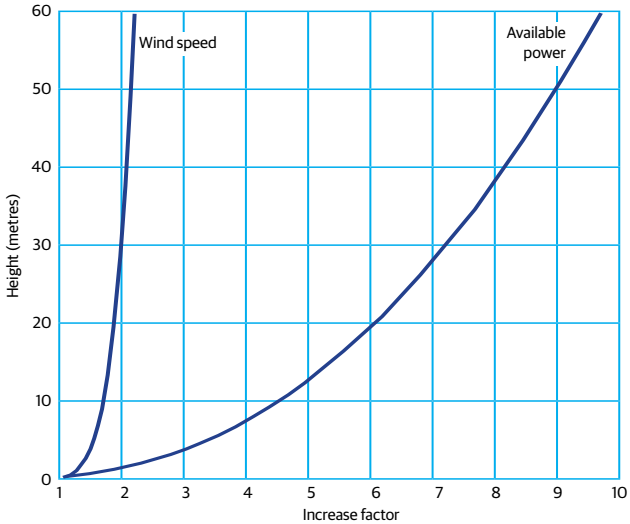
But sometimes it may not be possible to get a tower tall enough to get the bottom of your blades 10 metres above nearby obstacles. Which leads to Truth #4.

Truth #4: When you can't install your wind system 10 metres above an obstacle, or more than 150 metres away from it, site it upwind.

Siting 150 metres away or 10 metres above a nearby obstacle is not always possible. For example, if you have a 40 metre tree nearby, you'd need a tower height of 50 metres, which is probably not going to be economical or possible.

However, most of the turbulence caused by an obstacle occurs downwind of it, as shown below. So if your site has a predominant wind direction, you can install the wind turbine upwind of the obstacle and still get access to good amounts of smooth wind. The Bureau of Meteorology provides wind roses, which can tell you your predominant wind direction.

This list of four basic truths is just a start for assessing your site for small wind systems. If you are keen to learn more, pick up any book by Paul Gipe or check out the Small Wind Toolbox: www.bit.ly/TwtjmL



→ Theoretical increase in wind speed and energy with increasing height above ground. The X axis scale represents the increase factor between wind speed and available power.

What systems should I consider?

Now of course, even the most perfect site will not result in the production of any wind energy if the technology is poor. There are many reliable, proven and verified small wind manufacturers in the market. However, as the *2012 Small Wind Report* will tell you, there are over 330 small wind manufacturers in the world today, and I would feel comfortable purchasing from maybe 20 of them (granted this is because of my own professional experience installing these specific brands that have been in the market for a while).

The quickest way to cut down on the number of choices is to select a horizontal axis system—a turbine with two or three blades that spin around like a pin-wheel. There are many reasons for encouraging this, but an in-depth discussion will have to wait for the next article.

Any system that you purchase should be certified, or be in the process of getting certification. Certification may be through the Small Wind Certification Council or the wind turbine certification scheme being introduced in Australia by the Clean Energy Council.

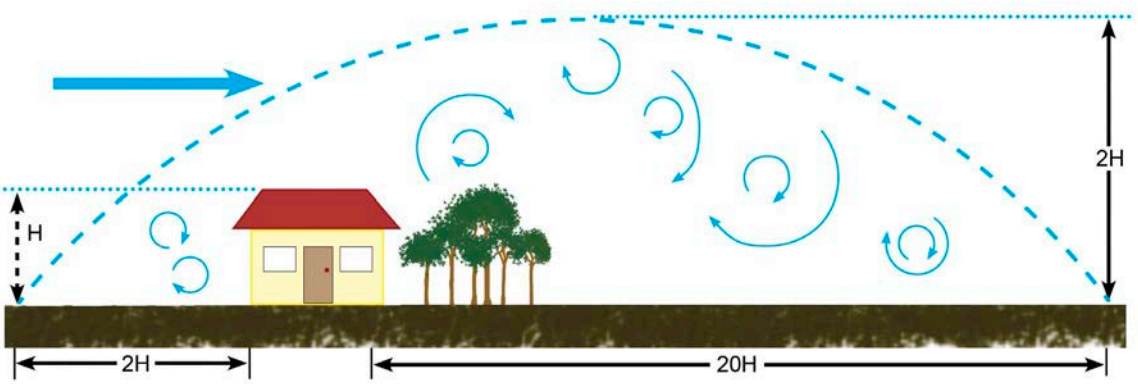
Most importantly, the power curve, which tells you how much energy the wind system will produce in a variety of average wind speeds, should be independently tested and verified. I would recommend *Home Power* magazine's yearly 'Small Wind Turbine Buyer's Guide' as an informed, regularly updated guide for comparing wind turbines.

Where do I start?

Small wind turbines are a reliable technology if selected and sited properly. Aside from all of the positives mentioned earlier, the turbine spinning high in the sky on its tall tower is also an important educational and advocacy tool.

If you are interested in small wind, you have many resources at your finger tips. Call the ATA, whose wind turbine experts give free advice to members. Find a Clean Energy Council accredited installer (I would avoid non-accredited installers) or an independent site assessor. Talk to other owners of small wind energy systems. The American Wind Energy Association and British Wind Energy Association are also invaluable resources. The most important factor is to be thoroughly informed before making a decision to invest. And if you do invest—let us know and we'll stop by next time we're travelling through. ✸

Katie Ross is a senior research consultant at the Institute for Sustainable Futures, University of Technology Sydney. Katie is a certified small wind site assessor and, before joining ISF, she worked for a non-profit organisation in the USA conducting small wind site assessments and installing small wind systems. If interested in attending any upcoming small wind site assessment courses, run jointly between ATA and ISF, please contact the ATA at craig@ata.org.au



← Turbulence caused by obstacles can reach twice the height of the obstacles themselves, and the turbulent zone can extend 20 times the length of the obstacle's height. But most of this turbulence occurs downwind of the obstacle, as shown in this diagram.

Mains power anywhere
An inverter buyers guide

Whether you live off grid or have a grid-interactive generation system, the right inverter can make all the difference. We check out what's available, where to get them and which one is right for you.

ONE of the most important components in a 240 volt renewable energy system is the inverter. In stand-alone systems, this is the device that converts the DC electricity from the battery bank into 240 volt AC mains power* to run standard appliances. In grid-interactive systems, this device converts the energy from solar panels into mains power and feeds it into the house's electrical wiring.

It is important to have a good inverter—if your home relies solely on 240 volt power from a stand-alone inverter and the inverter fails, you will have no power, even though it is still being generated and stored.

Inverters are divided into two main types depending on the type of power they provide—modified squarewave and sinewave.

Modified squarewave inverters (sometimes referred to as modified sinewave to make them sound better!) are the cheaper of the two, but some appliances (such as VCRs, TVs and computers) may not run as efficiently using this type of power, and some may not run at all.

Sinewave inverters, on the other hand, provide the same type of power as the mains grid. Indeed, the power from a good quality sinewave inverter will usually be of higher quality and have better voltage stability than power from the grid.

Modified squarewave inverters are becoming rare in renewable energy systems as the difference in price between the two types steadily reduces, so in this guide we only look at sinewave inverters.

* In fact, it will usually be 230 volt power as Australia has officially used 230 volts for some time, but most people still refer to mains power as 240 volts, so we will use the more common term in this guide.

← Modern inverters, such as this grid-interactive unit from CMS, have a huge range of features. This unit not only has a graphical display but records both energy production and household consumption. It even includes a webserver so that owners can log into it from anywhere in the world and access the stored data.

Independent or grid-interactive?

Sinewave inverters themselves can be divided into three broad groups—grid-interactive inverters, stand-alone units, and inverter-chargers. There is also a fourth type—sometimes called a hybrid inverter—that combines both grid-interactivity with the ability to take energy from and put charge into a battery bank.

Grid-interactive inverters are connected to both the power source (usually a solar array but sometimes a wind or hydro turbine) and the mains power grid. Power generated by the energy source is converted to AC mains power of the correct voltage and frequency, and fed directly into the grid. This supplements the power drawn from the grid by the home's appliances. At times there will be more energy generated than being used and the excess is fed into the mains grid. At these times the power meter may actually run backwards (this will depend on the agreement with your power company and the types of meters they use). In effect, the system is using the mains grid as a battery bank.

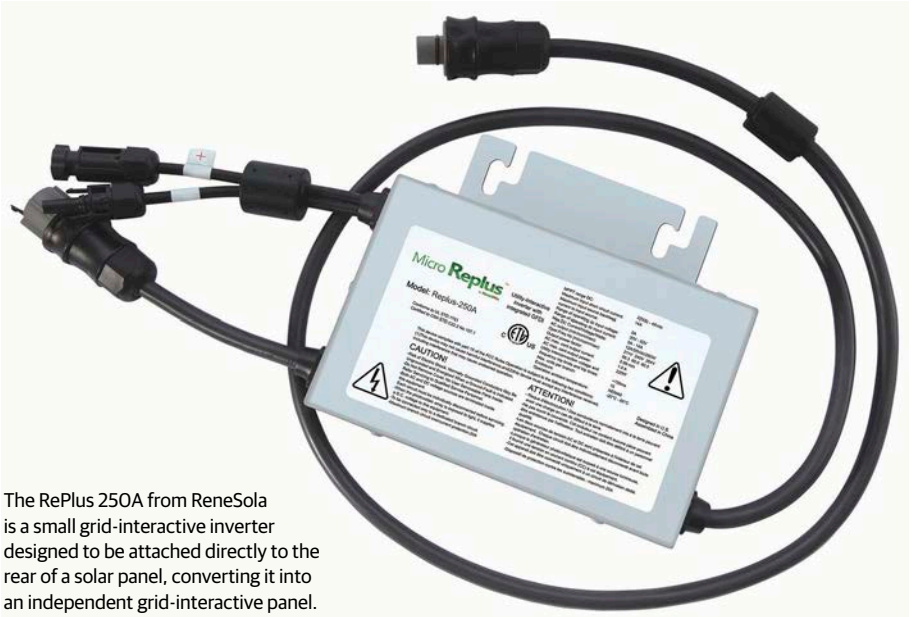
Grid-interactive inverters vary enormously in size, from 10 kW or larger units for big domestic and small commercial systems,

down to tiny 250 watt models—some are even designed to be mounted on the back of a solar panel to make the panel itself a grid-interactive module. These are ideal for those who want to start small and increase their systems over time, or for people who rent and can't install a permanent system.

Stand-alone systems require the use of a large battery bank to store the energy generated by solar panels or other energy sources for use at a later time, such as at night or during overcast weather. While some people opt for stand-alone systems for grid-connected homes, these systems usually appear in areas without grid power, such as remote properties.

Another feature of some stand-alone inverters is that of battery charging. This allows the inverter to charge the battery bank from another power source, such as a 240 volt AC backup generator, when there is insufficient renewable energy being generated. These devices are now considered a complete sub-class of their own and are called **inverter-chargers**.

Most stand-alone inverters are not designed for grid connection. However, the previously mentioned **hybrid inverters** feature the capabilities of grid-interactive inverters combined with either a stand-alone inverter or an inverter-charger. The Selectronic SP-Pro is a good example of these, and we looked at several others in *ReNew 119*.



↑ The RePlus 250A from ReneSola is a small grid-interactive inverter designed to be attached directly to the rear of a solar panel, converting it into an independent grid-interactive panel.

Sizing your inverter

When deciding on an inverter for a battery-based energy system it is important to get a unit that can do the job asked of it without being overloaded. The inverter you will need will depend on your power and energy requirements.

If you have only small appliances, up to, say, 500 watts per appliance, then you should be able to get by with a 600 to 1000 watt inverter with few problems. However, if you have a large washing machine or microwave oven, or you use a lot of power tools, then you will need a bigger unit, say with a 2000 watts continuous rating or greater.

It is just a matter of looking at the power rating of the appliances, taking into account how many appliances are likely to be running at one time, and choosing an inverter in that power range, with the options and features you want.

Sizing your grid-interactive inverter depends on two things—the size of your solar array and whether you want to expand it in the future using the same inverter. If you have no plans to expand then you simply need an inverter that can handle the full output of the array, plus around 10%, to allow for certain conditions when the array will actually output greater than its rated power (e.g. on cool days with white broken cloud).

Stand-alone specs

There are a lot of specifications applicable to stand-alone inverters and inverter-chargers, so let's look at a few.

Power output: There are three figures to consider here: continuous power, the half-hour rating, and the surge capacity. The first is the maximum power that the inverter can supply to appliances continuously.

The half-hour rating is the power the inverter can supply for half an hour without overloading or overheating.

Most inverters have a high surge capacity, typically two to four times their continuous rating, to allow them to start difficult loads such as fridges and other motor-powered appliances. The surge capacity is usually rated for between one and five seconds, but some are rated for up to a minute.

Autostart: Many inverters have the ability to consume very little power when no appliances are being used in the house, and will only start when they sense that an appliance has been switched on. They generally do this in a fraction of a second, so the autostart, or standby mode, is almost transparent to the homeowner. The minimum load that needs to be switched on for autostart to be triggered is usually below 20 watts. For many inverters this figure is adjustable to suit the loads in the house.

Total harmonic distortion: The waveform from a sinewave inverter is never perfect, but contains what is known as harmonic distortion. The total harmonic distortion (THD) figure of any inverter should be below 5%, and this is the case for most, if not all, sinewave inverters available.

Power factor: The cosine of the difference in phase angle between the AC waveform's current and voltage, or the ratio of the real power flowing to the load to the apparent power in the circuit. This is a much misunderstood area—not surprisingly, as it can be hard to understand how current can be flowing through a device and yet no power is being used. All you need to understand is that an inverter should be able to handle all power factors that it is likely to encounter. The power factor of appliances rarely goes beyond ±0.5, so all of the inverters listed should be able to handle most loads thrown at them.

Efficiency: The efficiency of an inverter is the ratio of the power output compared to the power input. If an inverter uses 250 watts from the battery to provide 200 watts to an appliance, then it has an efficiency of 80% at this load.

The efficiency will vary at differing loads, usually being lower at very low load levels (below 10%). You must consider this when buying an inverter. Don't buy a 2500 watt

← Most stand-alone inverters, like this 3000 W unit from Redarc, are quite simple affairs—on the outside at least.

inverter if you will be running only 100 watts worth of lighting most of the time and have few large appliances. A smaller inverter with a decent half-hour rating could do the job more efficiently.

It should be remembered that all of the figures apply only when the inverter is being run within a specific temperature range. This is usually zero to 40 °C, but some manufacturers use other ranges. Any inverter rated to 25 °C should be derated (i.e. the rating is reduced by an appropriate factor) for temperatures above this, as it is likely to be subjected to higher temperatures during summer.

Idle power: This is the power the inverter uses while it is on but with no load connected. This is effectively wasted power, so if the inverter is likely to be left on for long periods, look for a unit with a low idle-power figure.

Standby power: This refers to the power used by the inverter when it is in standby mode and waiting for an appliance to be switched on. It is generally much lower than the idle power.

Grid-connect specs

Fortunately, the specifications for grid-interactive inverters are a bit simpler than for stand-alone units.

For grid-interactive inverters, there is the maximum power input and output (pretty self explanatory) and also the activation power. This is the power level from the renewable energy source at which the inverter starts feeding power into the mains grid.

Another specification is the maximum and minimum solar array voltage. The array voltage at maximum power must fall well inside this range, and the maximum array voltage with no load, on a cold, sunny day (when panel voltages are at their maximum) must not exceed the maximum allowable voltage.

Indicators and connectivity

All inverters have indicators, ranging from a few coloured LEDs up to LED displays or LCDs that display all of the parameters of the inverter, including battery voltage and current, array voltage and current, output voltage and current, and various status and mode displays. Some inverters now even have graphical displays.

Many inverters, particularly grid-interactive units, have the ability to log data for export to a computer at a later date. Some even have network connectivity and can upload data to web portals for the whole world, or just those allowed by the owner, to see. They may even be able to be controlled remotely. For many people this is not an important feature, but if you are a data junkie then look for connectivity options when buying an inverter.

Safety

All grid-interactive and stand-alone 240 volt systems must be wired by a qualified installer and/or electrician. Attempting to wire these systems yourself can be dangerous if you do not understand what you are doing. Correct earthing of 240 volt systems is a must for legal and safety reasons. Some inverters use only a two-wire system and should not be used on earthed systems, as they have no earthing connection provisions. These types are only designed for temporary use, such as when camping or on the road, and shouldn't be used in permanent installations.

The inverter should have full isolation between the DC input and 240 volt AC output, as well as current-limiting or other forms of safety features and protection devices on its inputs and outputs. These features not only help protect your appliances from damage, but the inverter as well.

Approvals and certification

While electronic devices sold in Australia are legally required to have C-Tick or equivalent approvals, some inverters may not, so you would be wise to ask for this before purchasing, or just look for the C-Tick label.

Grid-interactive inverters must also have ESAA (Electricity Supply Authority of Australia) approval before they can be connected to the grid, so you need to check for this also.

It is unlikely that you would find any inverters for sale in Australia without these approvals, but it is very easy to buy inverters and other equipment online from almost anywhere nowadays, so if you intend to claim a rebate for your system, the inverter will need to meet all approval requirements.

The tables

Table 1 describes grid-interactive inverters and Table 2 describes stand-alone inverters designed to supply power to independent power systems. Table 3 covers inverter-chargers.

The range of grid-interactive inverters has improved considerably since we last looked at them in *ReNew 105*. Not only are there more models available but, in real terms, prices have dropped, making them more affordable. ✱

ReNew buyers guides provide general information about the types of devices available on the Australian market. Unfortunately we are unable to test each make and model available.
ReNew does not endorse any particular device over other similar units, and the appearance of information and photos of particular products should not be seen as a promotion of that device over any other.

Table 1: Grid-interactive inverters

Manufacturer/supplier	Model	Solar input voltages	Operating voltage range	Power output (watts) Continuous	Surge	Efficiency (%)	Display	Size (mm) W x H x D	Weight (kg)	RRP ($)	Warranty
Bosch Solar Energy / Voltwerk Locked Bag 66 Clayton South, VIC 3169 Ph:(03) 9541 3912 www.bosch-solarenergy.com.au	VS 3	250–940	250–750	3000	3000	97.7	LCD and LED indicators	390 x 675 x 229	22	TBA	5 years, extendable
	VS 4	250–940	250–750	4000	4000						
	VS 5	275–940	275–750	5000	5000						
	VS 8	350–1000	350–800	8000	8000	98		510 x 790 x 245	44		
	VS 11	400–1000	400–800	11000	11000						
	VS 15	450–1000	450–800	15000	15000						
Carbon Management Solutions ph:1300 902 110 info@carbonmanagement.com.au www.carbonmanagement.com.au	CMS 1500SS	100–550	200–450	1500	1600	96	LCD interactive display with touch buttons	330 x 375 x 180	11.9	707	5 years, 10 years optional
	CMS 3000SS			3000	3200	97		330 x 485 x 190	17.6	1,320	
	CMS 5000SS			5000	5300	97		418 x 485 x 190	26	2,499	
Delta Energy Systems (Australia) ph:(03) 9543 3720 sales.australia@solar-inverter.com www.solar-inverter.com	Solivia 2.5 APG3	125–540	150–450	2500	2640	96	2 line pixel LCD	410 x 410 x 180	21.5	POA	10 years
	Solivia 3.0 APG3			3000	3170	96					
	Solivia 3.3 APG3			3300	3485	96					
	Solivia 5.0 APG3			5000	5240	95.6		510 x 410 x 180	32.0		
	15TL	200–1000	350–800	15000	15750	98.05	Graphical LCD pixel matrix	952 x 625 x 275	67.2		
	20TL			20000	21000						
Fronius Australia Melbourne ph:(03) 8340 2900 www.fronius.com.au	IG 15	150–500	150–400	1300	1500	94.2 max	LCD + LED with push buttons	435 x 500 x 225 (outdoor) 344 x 366 x 220 (indoor)	12 (outdoor) 9 (indoor)	POA	5 years, 10 years, 20 years, optional
	IG 20			1800	2000	94.3 max					
	IG 30			2500	2650						
	IG 40			3500	4100			435 x 733 x 225 (outdoor) 344 x 610 x 220 (indoor)	20 (outdoor) 16 (indoor)		
	IG 60HV	150–530		4600	5000						
	IG Plus 25 V-1	230–600	230–500	2600	2600	95.7 max	LCD + LED with push buttons	434 x 673 x 250	23.8		
	IG Plus 30 V-1			3000	3000						
	IG Plus 35 V-1			3500	3500						
	IG Plus 50 V-1			4000	4000						
	IG Plus 55 V-3			5000	5000			434 x 1263 x 250	49.2		
	IG Plus 60 V-3			6000	6000						
	IG Plus 70 V-2			6500	6500			434 x 968 x 250	36.9		
	IG Plus 80 V-3			7000	7000			434 x 1263 x 250	49.2		
	IG Plus 100 V-2			8000	8000			434 x 968 x 250	36.9		
	IG Plus 100 V-3			8000	8000			434 x 1263 x 250	49.2		
	IG Plus 120 V-3			10000	10000						
	IG Plus 150 V-3			10000	10000						
	IG TL 3.0	350–850	350–700	3000	3000	97.7 max	LCD matrix + LED with push buttons	413 x 597 x 195	19.1		
	IG TL 3.6			3680	3680						
	IG TL 4.0			4000	4000						
	IG TL 4.6			4600	4600						
	IG TL 5.0			5000	5000						
	CL 36	230–600	230–500	36000	36000	95.9 max	LCD + LED with push buttons	1105 x 1803 x 722	248		
	CL 48			48000	48000				276		
	CL 60			60000	60000				303		
HexPower Solar Power Australia ph:(02) 4954 3310 info@solarpoweraustralia.com.au www.solarpoweraustralia.com.au	PV-C103LX	150–500VDC	150–450VDC	3000	3000	95.5	LCD	480 x 370 x 150	16	1,479	5 years
JFY-TECH / Top Energy Solution ph:(03) 9574 0050 0403 215 996 www.autes.com.au	JSI-1500TL	100–450	100–450	1500	1650	96.5	LCD, LED indicators. Optional RS485/232 and wireless interface	345 x 152 x 315	12	500	5 years standard, 10 years optional through TES
	JSI-2000TL	100–500	100–450	2000	2200	97		345 x 162 x 354	15	600	
	JSI-3000TL	100–500	100–450	3000	3400	97.3		345 x 162 x 384	17	700	
	JSI-5000TL	100–550	100–500	4600	5000	97.6		345 x 152 x 505	18.1	1,100	
	JSI-6000TL	100–550	100–500	6000	6000	97.6		345 x 162 x 573	26	1,200	
	Suntwins 3300TL	100–500	100–450	3300	3300	97.4		345 x 152 x 435	18	800	
	Suntwins 4000TL	100–500	100–450	4000	4000	97.6		410 x 285 x 555	22	900	
	Suntwins 5000TL	100–500	100–450	4950	4950	97.5		410 x 285 x 555	22	1,200	
	Suntree 10000TL	200–900	200–800	10000	10000	98.2		470 x 165 x 585	35	2,500	
	Suntree 12000TL	200–900	200–800	12000	12000	98.3		470 x 165 x 586	35	2,900	
Ladder Technologies ph:(02)-8005 6908 info@laddertech.com.au www.laddertech.com.au	LT-SWEA GTI-250	20–56	20–56	200	250	93 max	LED and RS232 PC interface	240 x 220 x 110	3.4	250	2 years
Latronic Sunpower PO Box 73 Moffat Beach QLD 4551 ph:(07) 5491 6988 info1@latronics.com www.latronics.com	PV Edge 1200	48	54–100	1200	-	94 max	LEDs & LCD: Live Watts, 2 x kWh meters (1 resettable), Volts, Amps, Hz, PF	330 x 296 x 150	11	POA	5 years + 5 year optional extension
	PV Edge 2500	96	108–200	2500		95 max		370 x 286 x 180	22	POA	
Outback Power Systems mpower ph:1300 733 006 www.mpower.com.au	Radian GS7048E	40–64	40–64	7000	16261	93	LCD with Mate 3	All	57	7,772	5 years
ReneSola 18 Corporate Blvd Bayswater VIC 3153 mob:0402 413 115 www.renesola.com	Micro Replus-250	22–52	22–52	220	220	95.9	LED	230 x 138 x 35	2	TBA Dec 2012	25 years limited warranty

Table 1: Grid-interactive inverters (continued)

Manufacturer/supplier	Model	Solar input voltages	Operating voltage range	Power output (watts) Continuous	Surge	Efficiency (%)	Display	Size (mm) W x H x D	Weight (kg)	RRP ($)	Warranty
Rich Electric Co. "SolarWorx" Jaycar Electronics Orders: 1800 022 888 techstore@jaycar.com.au www.jaycar.com.au/powertech www.richelectric.com.au	MI5192, GTI-2000-122	Battery	10-16VDC	2000 @ 50°C	2200	86	LEDs, LCD	256 x 424 x 368	26	1,799	2 years, optional 3 year extension
		MPPT Range	16.5-32VDC								
		Max	40VDC / 180A								
	MI5194, GTI-2000-242	Battery	20-32VDC	2000 @ 50°C	2200	90				1,799	
		MPPT Range	32-64VDC								
		Max	80VDC / 90A								
Schneider Electric - Xantrex ph:(08) 8161 0511 www.clipsal.com	GT2.8	195-550	195-550	2800	3070	95	LCD	597 x 403 x 136	19.5	POA	5 years
	GT5.0	240-550	240-550	5000	5300	96		692 x 518 x 262	22.3		
Selectronic/KACO (Germany) Selectronic Australia freecall:1800 006 474 ph:(03) 9727 6600 www.selectronic.com.au	Powador 2002	125-510	125-510	1650	1650	95.3% EU	LCD and LED	340 x 450 x 200	14.5	POA	7 years + up to 18 years optional extension
	Powador 3002	200-510	200-510	2500	2500	95.4% EU		340 x 500 x 200	20		
	Powador 4202			3500	3500	95.1% EU		340 x 600 x 240	26		
	Powador 5002			4200	4200	95.3% EU			28		
	Powador 6002			5000	5000	95.3% EU			28		
	Powador 10.0 TL3	200 - 800	250-800	9000	9000	97.4% EU	Graphical LCD and LED	420 x 690 x 200	40		
	Powador 12.0 TL3			10000	10000	97.5% EU					
	Powador 14.0 TL3			12500	12500	97.5% EU					
	Powador 18.0 TL3			15000	15000	97.5% EU					
Selectronic (Australia) Selectronic Australia freecall:1800 006 474 ph:(03) 9727 6600 www.selectronic.com.au	SP PRO SPMC240	Not applicable	20-34	3000	7500	90	22 LEDs + graphical remote display option	690 x 375 x 220	35	POA	5 - 8 years
	SP PRO SPMC241		20-34	4500	10500	91			39		
	SP PRO SPMC481		40-68	5000	12000	93			40		
	SP PRO SPMC482		40-68	7500	18000	93			42		
	SP PRO SPMC1201		100-170	7500	18000	94			42		
	SP PRO SPLC1202		100-170	20000	44000	95.5		870 x 540 x 290	115		
Si Clean Energy ph:1300 876 771 wholesaleinfo@sicleanenergy.com.au www.sicleanenergy.com.au	PVI2000in	120 - 600	90 - 580	2000	-	95	50 x 50 LCD	440 x 465 x 57	6	POA	5 + 5
	PVI2000out			2000		94.4	2 line LCD	420 x 326 x 141	14.5		
	UNO2.0-I			2000		95.1	Graphic	518 x 367 x 161	17		
	UNO2.5-I			2500		95.4	Display				
	PVI3000			3000		96	2 line LCD	617 x 325 x 222	17.5		
	PVI3600			3600		96					
	PVI4200			4200		96					
	PVI5000			5000		96.4		810 x 325 x 218	26		
	PVI6000			6000		96.4			26		
	PVI10.0			10000		97.1		716 x 645 x 222	41		10 + 10
	PVI12.5			125000		97.2			41		
SMA Australia ph:(02) 9491 4200 info@SMA-Australia.com.au www.SMA-Australia.com.au	SB 1200	100-400	100-320	1200	1200	92.1	2 line LCD	434 x 295 x 214	22	POA	5 years; optional 10, 15, 20 or 25 years
	SB 1700	147-400	139-320	1550	1700	93.5			25		
	SB 2500	224-600	224-480	2300	2500	94.1			30		
	SB 3300	200-500	200-400	3300	3600	95.2		450 x 352 x 236	41		
	SB 3800			3800	3800	95.6			41		
	SMC 5000A	246-600	246-480	5000	5500	96.1		468 x 613 x 242	62		
	SMC 6000A			6000	6000	96.1			63		
	SB 4000TL-20	125-550	125-440	4000	4000	97	Full graphical	470 x 445 x 180	25		
	SB 5000TL-20			4600	5000	97			25		
	SMC 6000TL-10	333-700	333-500	6000	6000	98	2 line LCD	468 x 613 x 242	31		
	SMC 7000TL-10			7000	7000	98			32		
	SMC 8000TL-10			8000	8000	98			33		
	SMC 9000TL-10			9000	9000	98			35		
	SMC 10000TL-10			10000	10000	98			35		
	SMC 11000TL-10			11000	11000	98			35		
	SB 1300TL-10	125-600V	125-480	1300	1300 VA	96		440 x 339 x 214	16		
	SB 1600TL-10	125-600V	155-480	1600	1600 VA	96		440 x 339 x 214	16		
	SB 2000HF-30	175-700	175-560	2000	2000 VA	96.3	Full graphical	348 x 580 x 145	17		
	SB 2100TL	125- 600	200-480	1950	2100 VA	96	2 line LCD	440 x 339 x 214	16		
	SB 2500HF-30	175-700	175-560	2500	2500 VA	96.3	Full graphical	348 x 580 x 145	17		
	SB 2500TLST-21	125-750	180-500	2500	2500 VA	97		490 x 519 x 185	23		
	SB 3000TLST-21	125-750	213-500	3000	3000 VA	97		490 x 519 x 185	23		
	SB 3000HF-30	210-700	210-560	3000	3000 VA	96.3		348 x 580 x 145	17		
	SB 3000TL-20	125-550	188-440	3000	3000 VA	97		470 x 445 x 180	24		
	SB 3000TL-21	125-750	175-500	3000	3000 VA	97		490 x 519 x 185	26		
	SB 4000TL-21	125-750	175-500	4000	4000 VA	97		490 x 519 x 185	26		
	STP 5000TL-20	150-1000	245-800	5000	5000 VA	98		470 x 730 x 240	37		
	SB 5000TL-21	125-750	175-500	4600	5000 VA	97		490 x 519 x 185	26		
	STP 6000TL-20	150-1000	295-800	6000	6000 VA	98		470 x 730 x 240	37		
	STP 7000TL-20	150-1000	290-800	7000	7000 VA	98		470 x 730 x 240	37		
	STP 8000TL-20	150-1000	330-800	8000	8000 VA	98		470 x 730 x 240	37		
	STP 8000TL-10	150-1000	320-800	8000	8000 VA	98.1		665 x 690 x 265	59		
	STP 9000TL-20	150-1000	370-800	9000	9000 VA	98		470 x 730 x 240	37		
	STP 10000TL-10	150-1000	320-800	10000	10000 VA	98.1		665 x 690 x 265	59		
	STP 12000TL-10	150-1000	380-800	12000	12000 VA	98.1		665 x 690 x 265	59		
	STP 15000TL-10	150-1000	360-800	15000	15000 VA	98.2		665 x 690 x 265	59		
	STP 15000TLEE-10	570-1000	580-800	15000	15000 VA	98.5		665 x 690 x 265	45		
	STP 17000TL-10	150-1000	400-800	17000	17000 VA	98.2		665 x 690 x 265	59		
	STP 20000TLEE-10	570-1000	580-800	20000	20000 VA	98.5		665 x 690 x 265	45		
	SB 3000	268-600	268-480	2750	3000	95	2 line LCD	434 x 295 x 214	32		

Table 1: Grid-interactive inverters (continued)

Manufacturer/supplier	Model	Solar input voltages	Operating voltage range	Power output (watts)		Efficiency (%)	Display	Size (mm) W x H x D	Weight (kg)	RRP ($)	Warranty
				Continuous	Surge						
Solar Energy Australia ph:(02) 9457 2277 sales@solaraustralia.com.au www.solaraustralia.com.au	SEA 3000SS	125–500	125–450	3000	3000	97	Full graphical LCD	330 x 350 x 125	13	POA	5 years
	SEA 3600DS	125–580	125–550	3600	3800	97.8		390 x 417 x 165	20		
	SEA 4000SS	125–580	125–550	4000	4400			390 x 417 x 142	18		
	SEA 4200DS	125–580	125–550	4200	4200			390 x 417 x 165	20		
	SEA 4600SS	125–580	125–550	4600	5000			390 x 417 x 142	18		
	SEA 4600DS	125–580	125–550	4600	5000			390 x 417 x 165	20		
	Orion SPG-360-2K0-1	125–500	150–450	2000	2000	95	1 line LCD	350 x 300 x 120	11.2		
	Orion SPG-600-4K0	100–750	125–750	4600	5000	96		430 x 531 x 130	27.85		5 years, 10, 15, 20 years optional
	Sunways AT2700	181–680	181–600	2700	2700	96	Full graphical LCD	590 x 350 x 210	29		
	Sunways AT4500	214–680	214–600	4500	4500				29		
	Sunways AT5000	236–680	236–600	5000	5000				29		
	Sunways NT3000	340–900	340–750	3000	3000	98			26		
	Sunways NT4200	340–900	340–750	4200	4200				26		
	Sunways NT5000	340–900	340–750	5000	5000				26		
	Sunways NT10000	340–900	340–750	10000	10000			840 x 530 x 210	31		
	Sunways PT33000	460–900	460–800	33000	33000			940 x 530 x 400	26		
SolarMax Australia ph:(02) 8867 3168 info-au@solarmax.com www.solarmax.com	2000S	100–600	100–550	1980	1980	97	Backlit LCD	545 x 290 x 185	13	POA	5 years, upgradable to 25 years
	3000S			2750	2750				13		
	4200S			4180	4180				15		
	6000S			5060	5060				15		
	8MT2	250–900	250–750	8000	8000	98	Backlit LCD	550 x 750 200	39		
	10MT2			10000	10000				39		
	13MT2			13000	13000				39		
	15MT2			15000	15000				39		
	13MT3			13000	13000				42		
	15MT3			15000	15000				42		
Solar River Samil Power Ausco ph:(02) 9643 7788 1300 134 793 australia@samilpower.com www.samilpower.com	Solar River 1100TL	100–500	120–425	1000	1000	96.6	2 line LCD	285 x 385 x 145	15	POA	5 years standard plus extension option
	Solar River 1600TL		160–425	1500	1500	96.8			15		
	Solar River 2300TL	100–550	200–500	2000	2200	96.8		332 x 450 x 161	17.5		
	Solar River 3000TL		210–500	2600	2800	97			17.9		
	Solar River 3300TL		200–500	3000	3300	97.4		329 x 433 x 180	18.9		
	Solar River 4400TL			4000	4400	97.6			19.2		
	Solar River 5200TL			4600	5000	97.6			19.4		
	Solar River 3400TL-D		160–500	3000	3200	97.4	3.5 inch full graphical	520 x 380 x 175	26		
	Solar River 4500TL-D		165–500	4000	4300	97.6					
	Solar River 5200TL-D		175–500	4600	5000	97.6					
	Solar Lake 10000TL	210–1000	320–800	10000	10000	97.9		520 x 716 x 230	50		
	Solar Lake 12000TL		380–800	12000	12000	97.9					
	Solar Lake 15000TL		380–800	15000	15000	98					
	Solar Lake 17000TL		430–800	17000	17000	98					
Solco Solar Products (Motech) www.solcosolarproducts.com.au	F-MOT-2500	100–500	130V startup (adjustable)	2800	-	96.3	LCD (RS2323 or 485 communications)	580 x 422 x 182	22	POA	5 years - extendable to 10
	F-MOT-3300MS	100–450		3800					22.5		
	F-MOT-3800MS	100–450		4400					22.5		
	F-MOT-4600MS	100–450		5000					23		
	F-MOT-15E-AU	320–460	-	16000		96.7		890 x 751 x 182	245		
	F-MOT-20E-AU	320–460	-	20000					245		
Solco Solar Products (SolarEdge) www.solcosolarproducts.com.au	SE3000	184–830	Up to 20 panels in one string, independent of string length and temperature	3000	-	97.6	-	315 x 540 x 172	23	POA	12 years, extendable to 25
	SE3300			3300		97.6					
	SE3500			3500		97.6					
	SE4000			4000		97.6		315 x 540 x 191			
	SE5000			5000		97.6					
	SE6000			6000		97.6					
	SE10K	320–460		10000		98.0		315 x 540 x 260	24		
	SE12.5K			12500		98.0			32		
Sungrow Power Supply Co. Ltd Sungrow Power Australia ph:1300 201 106 www.sungrowpower.com.au info@sungrowpower.com.au	SG1K5TL V31	150–450	200–400	1500	1580	95	LCD + LED indicators	318 x 460 x 151	14	POA	5 years, optional 10-20 year extension
	SG2K5TL V31	150–500	180–450	2500	2630	97.3		420 x 555 x 179	20		
	SG3KTL V31			3000	3150						
	SG4KTL V31		210–450	4000	4200						
	SG10KTL	250–1000	250–800	10000	11100	98		648 x 695 x 243	50		
	SG3KTL-M	125–550	125–500	3000	-	97.4		415 x 533 x 179	24		
	SG4KTL-M			4000	-	97.4					
	SG5KTL-M			5000	-	97.6					
T-Sol / DC Solutions www.dcsaustralia.com.au	TSG1.6KTL	180–420	Up to 450Voc	1600	1600	97.4	LCD and LED	335 x 460 x 135	17	1,499	5 years
	TSG2.5KTL	210–420		2500	2500			335 x 460 x 135		1,699	
	TSG3KTL	180–420		3000	3000			335 x 460 x 135		1,899	
	TSG4KTL	210–420	Up to 520Voc	4000	4000			415 x 530 x 176	35	2,599	
	TSG5KTL	260–420		5000	5000			415 x 530 x 176		2,899	

Table 2: Stand-alone inverters

Manufacturer/supplier	Model	Input voltage	Operating voltage range	Power output (watts)			Efficiency (%)	Idle power (watts)	Standby power (watts)	Auto start	Indicators	Size (mm) W x H x D	Weight (kg)	RRP $	Warranty
				Cont	1/2 hr	Surge									
Altronics ph:(08) 9428 2199 www.altronics.com.au	M 8010	12	10.5–15	150		300	90	<6	<6	Yes	LEDs	200 x 115 x 36	0.8	165	1 year
	M 8018	24	20–30	1000		3000	90	<40	-			405 x 320 x 125	11	699	
	M 8017	12	10–15	1000		3000	90	<40	-			405 x 320 x 125	9	699	
	M 8012A	12	10.5–15	400	-	800	85	<4	<4			200 x 108 x 60	1	239	
Cotek mpower ph:1300 733 006 www.mpower.com.au	SK350212	12	10.5–15.0	350	390	700	91	14.4	3	Yes	LEDS and optional remote panel	147 x 62 x 214	2,7	332	1 year
	SK350224	24	21.0–30.0				93								
	SK700212	12	10.5–15.0	700	770	1400	91					180 x 72 x 296	2,7	545	
	SK700224	24	21.0–30.0				93								
	SK700248	48	42.0–60				94								
	SK1000212	12	10.5–15.0	1000	1100	2000	91					182 x 88 x 4383	4	610	
	SK1000224	24	21.0–30.0				93								
	SK1000248	48	42.0–60				94								
	SK1500212	12	10.5–15.0	1500	1650	3000	91	17	3.4			191 x 88 x 415	4.8	908	
	SK1500224	24	21.0–30.0				93								
	SK1500248	48	42.0–60				94								
	SK2000212	12	10.5–15.0	2000	2200	4000	90	32	6			208 x 166 x 452	9	1,078	
	SK2000224	24	21.0–30.0				93								
	SK2000248	48	42.0–60				94								
	SK3000212	12	10.5–15.0	3000	3300	6000	90	33.6	6			208 x 166 x 452	9.8	1,485	
	SK3000224	24	21.0–30.0				93								
	SK3000248	48	42.0–60				94								
ePOWER Enerdrive ph:(07) 3390 6900 sales@enerdrive.com.au www.enerdrive.com.au	ePOWER 400i	12	10–16	400	400	800	90	10	10	Yes	LED with remote control panel with on/off control	200 x 177 x 90	2	299	2 years
	ePOWER 1000i	12	10–16	1000	1000	2000		15	15			325 x 177 x 90	3	650	
	ePOWER 2000i	12	10–16	2000	2000	4000		15	15			416 x 230 x 110	6	950	
Excelsior Power ph:(03) 9775 1590 enquiries@inverter.com.au www.excelsiorpower.com.au	PSU200	12	10–16	200	-	600	>90	<6	-	No	LEDs	119 x 71 x 230	2.8	249	2 years
	PSU350/12	12	10–16	350		1050	>90	<10						349	
	PSU350/24	24	20–32	350		1050	>90							349	
	PSU700/12	12	10–16	700		2000	>90				4 digit LED	179 x 81 x 298		649	
	PSU700/24	24	20–32	700		2000	>90							649	
	PSU1000/12	12	10–16	1000		3000	87	<15				179 x 81 x 334	3.8	795	
	PSU1000/24	24	20–32	1000		3000	90							795	
	PSU1500/12	12	10–16	1500		4500	87		<1.5	Yes		278 x 102 x 413	7.2	1,095	
	PSU1500/24	24	20–32	1500		4500	90							1,095	
	PSU1500/48	48	40–64	1500		4500	92							1,295	
	PSU2000/12	12	10–16	2000		6000	87							1,295	
	PSU2000/24	24	20–32	2000		6000	90							1,295	
	PSU3000/12	12	10–16	3000		9000	87					283 x 101 x 454	10.6	2,195	
	PSU3000/24	24	20–32	3000		9000	90							2,195	
	UPSU2000/12	12	10–16	1500		4500	Up to 90				Bargraph LED	270 x 120 x 470	8	1,595	
	UPSU2000/24	24	20–32	1500		4500								1,595	
	UPSU4000/12	12	10–16	3000		9000						270 x 190 x 530	13	2,695	
	UPSU4000/24	24	20–32	3000		9000								2,695	
Ladder Technologies Ph:(02) 8005 6908 info@laddertech.com.au www.laddertech.com.au	LT-STI 200/12-220	12	10.5–16	200	200	400	84	<5	2.64			315 x 166 x 101	4.5	210	2 years
	LT-STI 300/12-220	12	21–32	300	300	600	84	<5					5.3	235	
	LT-STI 300/24-220	24	10.5–16	300	300	600	85	<7					5.3	236	
	LT-STI 500/24-220	24	21–32	500	500	1000	85	<7	2.67			325 x 187 x 112	7.3	269	
Latronic Sunpower ph:(07) 5491 6988 info1@latronics.com www.latronics.com	LS512	12	10.5–17	500	550	1500	90	5	0.26	Yes	LEDs	260 x 160 x 100	5.5	836	2 years
	LS624	24	21–34	600	750	2000	92	6.5	0.43					891	
	LS648	48	42–68	600	750	2000	93	6.3	0.79					1,078	
	LS1012	12	10.5–17	1000	1150	3000	91	5.4	0.44			330 x 296 x 150	11	1,452	
	LS1224	24	21–34	1200	1600	3600	92	6	0.67					1,496	
	LS1248	48	42–68	1200	1600	3600	94	6.3	0.92					1,716	
	LS1512	12	10.5–17	1500	1600	4500	91	8	0.5				14	1,892	
	LS1824	24	21–34	1800	2200	5400	93	8	0.72					1,980	
	LS1848	48	42–68	1800	2200	5400	94	7.6	1.0					2,167	
	LS2012	12	10.5–17	2000	2200	6000	90	13	0.9			370 x 386 x 180	22	2,673	3 years
	LS2324	24	21–34	2300	2800	7000	94	13	1.08					2,695	
	LS2548	48	42–68	2500	3000	7500	94	14	1.68					2,882	
	LS3024	24	21–34	3000	3700	9000	93	14	1.2				24	3,190	
	LS3548	48	42–68	3500	4100	10500	94	16	1.92					3,399	
	LS4024	24	21–34	4000	4500	12000	94	26	1.44			475 x 458 x 187	30	4,290	
	LS5048	48	42–68	5000	6000	15000	95	23	2.64					4,994	
	LS7048	48	42–68	7000	8500	20000	95	24	2.88				34	5,995	
Meanwell/ Power Supplies Australia Ph:1800 632 693 www.power-supplies-australia.com.au	TS-200-212	12	10.5–15	200	200	400	88	15	<0.02	Yes	LED	158 x 59 x 205	1.63	231	3 years
	TS-200-224	24	21–30												
	TS-200-248	48	42–60												
	TS-400-212	12	10.5–15	400	400	800	88					158 x 67 x 205	1.73	248	
	TS-400-224	24	21–30												
	TS-400-248	48	42–60												
	TS-700-212	12	10.5–15	700	700	1400	90	<6	<0.02		LEDs	184 x 70 x 295	3.8	462	
	TS-700-224	24	21–30												
	TS-700-248	48	42–60												
	TS-1000-212	12	10.5–15	1000	1000	2000	92					184 x 70 x 345	4.3	524	
	TS-1000-224	24	21–30												
	TS-1000-248	48	42–60												

Table 2: Stand-alone inverters (continued)

Manufacturer/supplier	Model	Input voltage	Operating voltage range	Power output (watts)			Efficiency (%)	Idle power (watts)	Standby power (watts)	Auto start	Indicators	Size (mm) W x H x D	Weight (kg)	RRP $	Warranty
				Cont	1/2 hr	Surge									
Powertech Jaycar Electronics Orders: 1800 022 888 techstore@jaycar.com.au www.jaycar.com.au	MI5160	12	10.5 - 15.5	180	-	300	>80	-	5	-	LED status indicators for power and protection	240 x 119 x 60	1	189	1 year
	MI5162	12	10.5 - 15.5	380	-	650	>83	-	6	-		240 x 119 x 60	1.1	239	1 year
	MI5164	12	10.5 - 15.5	600	-	1000	>85	-	8	-		300 x 119 x 60	1.4	349	1 year
	MI5170	12	10.5 - 15.5	1000	-	2000	>90	-	11	-	LED status indicators for power, protection and over temp	323 x 200 x 88	3.2	599	1 year
	MI5172	12	10.5 - 15.5	1500	-	3000	>90	-	15	-		420 x 200 x 88	4.2	899	1 year
	MI5174	24	20 - 32	2000	-	4000	>90	-	23	-		520 x 200 x 88	5.5	1,199	1 year
Projecta ph:(03) 9730 6000 www.projecta.com.au	IP150	12	10-15.5	150	140% for 3 min, 200% 3 sec	300	85-90	6	-	No	LED	232 x 108 x 63	1.1	269	2 years
	IP300	12	10-15.5	300		600	85-90	6	-	No		252 x 108 x 63	1.25	319	
	IP600	12	10-15.5	600		1200	85-90	8	-	No	LCD and remote control	250 x 168 x 81	2.2	499	
	IP1000	12	10-15.5	1000		2000	85-90	14.5	-	No		360 x 168 x 81	3.2	799	
	IP2000	12	10-15.5	2000		4000	85-90	12	0.06	Yes	LCD	452 x 250 x 105	7.9	1,499	
Redarc Electronics Ph:(08) 8322 4848 Power@redarc.com.au www.redarc.com.au	R-12-350S	12	10.5 - 15	350	385	700	91					185 x 147 x 60	1.4	446	2 years
	R-24-350S	24	21.0 - 30				93								
	R-12-700S	12	10.5 - 15	700	770	1400	91					295 x 180 x 72	2.7	1,032	
	R-24-700S	24	21.0 - 30				93								
	R-12-1000S	12	10.5 - 15	1000	1100	2000	91					383 x 182 x 88	4	1,161	
	R-24-1000S	24	21.0 - 30				94								
	R-12-1500S	12	10.5 - 15	1500	1650	3000	90.0					415 x 191 x 88	4.8	1,724	
	R-24-1500S	24	21.0 - 30				93								
	R-12-2000S	12	10.5 - 15	2000	2200	4000	91					422 x 208 x 166	9	2,287	
	R-24-2000S	24	21.0 - 30				94								
	R-12-3000S	12	10.5 - 15	3000	3300	6000	90.0					452 x 208 x 166	9.8	3,459	
	R-24-3000S	24	21.0 - 30				93								
Selectronic Australia freecall:1800 006 474 ph:(03) 9727 6600 www.selectronic.com.au	SP PRO SPMC240	24	20-34	3000	4200	7500	90.0	8	-	Yes	22 LEDs + graphical remote display option	690 x 375 x 220	35	POA	5 - 8 years
	SP PRO SPMC241	24	20-34	4500	6750	10500	91.0						39		
	SP PRO SPMC481	48	40-68	5000	7000	12000	93.0						40		
	SP PRO SPMC482	48	40-68	7500	11250	18000	93.0						42		
	SP PRO SPMC1201	120	100-170	7500	11250	18000	94.0						42		
	SP PRO SPLC1202	120	100-170	20000	29000	44000	95.5					870 x 540 x 290	115		
Solar Energy Australia ph:(02) 9457 2277 sales@solaraustralia.com.au www.solaraustralia.com.au	SEAP-12-150	12	9.5-16	150	180	400	90	2	-	No	LEDs	110 x 90 x 190	1.8	POA	2 years
	SEAP-24-250	24	19-32	250	330	675	92	2.4					2.5		
	SEAP-12-500	12	9.5-16	500	620	1500	93	5.4	0.48	-		275 x 185 x 97	7		
	SEAP-24-700	24	19-32	700	900	2100	94	9.6	0.6				8		
	SEAP-12-850	12	10.5-16	850	960	2400	93	6	0.6			364 x 264 x 124	13		
	SEAP-24-1K1	24	21-32	1100	1450	3000	94	8.1	0.6						
	SEAP-12-1K3	12	10.5-17	1300	1800	4000	91	7.2	0.5	Yes		400 x 300 x 165	20		
	SEAP-24-1K7	24	21-34	1700	2400	5000	94	8.4	1				19		
	SEAP-12-2K0	12	10.5-16	2000	2400	5000	91	13.4	1.2			456 x 300 x 243	23		
	SEAP-24-2K2	24	19-32	2200	2400	6000	94	11.3	1	Yes			23		
	SEAP-48-2K4	48	38-64	2400	3000	6000		14	2						
	SEAP-24-3K0	24	19-32	3000	3800	9000		19				510 x 300 x 243	33		
	SEAP-48-3K8	48	42-64	3800	4500	10500									
TBS Electronics Enerdrive ph:(07) 3390 6900 sales@enerdrive.com.au www.enerdrive.com.au	A-200i-12	12	10.5-16	175	200	400	90	<2.8	0.6	Yes	LED status indicators for voltage, standby and temperature	130 x 98 x 154	2.3	320	2 years
	A-200i-24	24	21-31	175	200	500	91	<3	0.8			131 x 98 x 154		320	
	A-300i-12	12	10.5-16	250	300	700	91	<3	0.7			130 x 98 x 184	3.5	425	
	A-350i-24	24	21-31	300	350	800	93	<3.5	0.8			131 x 98 x 184		435	
	A-450i-12	12	10.5-16	450	550	900	92	<4	<0.4			163 x 108 x 225	6	700	
	A-600i-24	24	21-31	600	700	1500	94	<4.6	<0.7			163 x 108 x 225	6.5	750	
Victron Energy ph:(02) 9863 1052 salesaustralia@victronenergy.com www.victronenergy.com	Phoenix 12/180	12	10.5 - 15.5	175	180	350	87	2.6	n/a	Yes	LEDs and a connector for a remote on/off switch	132 x 72 x 200	2.7	178	2 years
	Phoenix 24/180	24	21.0 - 31.0				88	3.8						178	
	Phoenix 12/350	12	10.5 - 15.5	300	350	700	89	3.1				155 x 72 x 237	3.5	229	
	Phoenix 24/350	24	21.0 - 31.0				89	5.0						229	
	Phoenix 48/350	48	42.0 - 62.0				90	6.0						257	
	Phoenix 12/800	12	10.5 - 15.5	700	800	1600	91	6				165 x 108 x 305	6.5	603	
	Phoenix 24/800	24	21.0 - 31.0				93	6						603	
	Phoenix 48/800	48	42.0 - 62.0				94	6						648	
	Phoenix 12/1200	12	10.5 - 15.5	1000	1200	2400	92	8				165 x 108 x 305	8.5	932	
	Phoenix 24/1200	24	21.0 - 31.0				94	9						932	
	Phoenix 48/1200	48	42.0 - 62.0				94	8						997	
	Phoenix C 12/1200	12	9.5 - 17	1000	1200	2400	92	8	5		LEDs, an optional remote panel and multi-purpose relay drivers	214 x 375 x 110	10	1,052	
	Phoenix C 24/1200	24	19 - 33				94	10	8					1,052	
	Phoenix C 12/1600	12	9.5 - 17	1300	1600	3000	92	8	5					1,425	
	Phoenix C 24/1600	24	19 - 33				94	10	8					1,425	
	Phoenix C 12/2000	12	9.5 - 17	1600	2000	4000	92	9	7			255 x 520 x 125	12	1,609	
	Phoenix C 24/2000	24	19 - 33				92	11	9					1,609	
	Phoenix 12/3000	12	9.5 - 17	2500	3000	6000	93	15	10			258 x 326 x 218	18	2,534	
	Phoenix 24/3000	24	19 - 33				94	15	10					2,534	
	Phoenix 48/3000	48	38 - 66				95	16	12					2,534	
	Phoenix 24/5000	24	19 - 33	4500	5000	10000	94	25	20			328 x 444 x 240	30	4,223	
	Phoenix 48/5000	48	38 - 66				95	25	20					4,223	
Xantrex Enerdrive ph:(07) 3390 6900 sales@enerdrive.com.au www.enerdrive.com.au	Prosine 1000i	12	10-16	1000	1500	2530	90	<22	<1.5	Yes	LCD remote control panel with on/off and battery status	280 x 115 x 390	7	1,400	2 years
	Prosine 1000i	24	20-32	1000	1500	2530						281 x 115 x 390		1,500	
	Prosine 1800i	12	10-16	1800	2200	4600						282 x 115 x 390	7.5	1,900	
	Prosine 1800i	24	20-32	1800	2200	4600						283 x 115 x 390		2,000	

Table 3: Inverter–chargers

Manufacturer /supplier	Model	Input voltage	Operating voltage range	Power output (watts)		Charge current (amps)	Efficiency (%)	Idle power (W)	Standby power (watts)	Auto start	Min start load	Indicators	Size (mm) W x H x D	RRP ($)	Warranty
				Cont	Surge										
Altronics ph:(08) 9428 2199 www.altronics.com.au	M 8139	12	10–15	800	-	40	>80%	<40	-	Yes		LCD with remote mounting option	400 x 300 x 150	1,099	2 years
	M 8144	24	20–27	1600	3200	50	>80%	<70	-				450 x 300 x 190	1,995	
	M 8145			2400	3500			<90						2,690	
Excelsior Power ph:(03) 9775 1590 enquiries@inverter.com.au www.excelsiorpower.com.au	ICISS2000/12	12	9.5–16	1500	4500	70	82–89	10	<10–18	Yes	<5	LED and LCD	285 x 190 x 494	2,695	2 Years
	ICISS2000/24	24	19–32			35								2,695	
	ICISS4000/12	12	9.5–16	3000	9000	140		18					285 x 190 x 700	3,990	
	ICISS4000/24	24	19–32			70								3,990	
	SS4000CI/12	12	9.5–16	3000	9000	140	84	<18	<18				285 x 424 x 370	3,990	
	SS4000CI/24	24	19–32	3000	9000	70	86							3,990	
	SS4000CI/48	48	36–64	3000	9000	40	89							4,490	
MagnaSine Enerdrive Pty Ltd ph:(07) 3390 6900 sales@enerdrive.com.au www.enerdrive.com.au	MS2712E	12	9–17	2700	4100	125	>90	~34	~9	Yes	0 to 200W (adj)	LEDs. LCD remote panel included	321 x 349 x 203	3,600	2 years
	MS4124E	24	18–34	4100	6300	105	>92								
	MS4348E	48	36–68	4300	7500	55	>93	~30							
Meanwell/ Power Supplies Australia Ph:1800 632 693 www.power-supplies-australia.com.au	ISI-500212	12	10.5–15	500	500	1000	88	9.6	<0.02	Yes	n/a	LED	158 x 67 x 205	264	-
	ISI-500-224	24	21–30												
	ISI-500-248	48	42–60												
Outback Power Systems mpower ph:1300 733 006 www.mpower.com.au	Radian GS7048E	48	40–64	7000	16261	100	93	30	10	Yes	10W adj	None, use with Mate 3	406 x 711 x 221	7,772	5 years
	GFX1312E	12	10.5–17	1300	4600	70	90	18	6		6W adj	LEDs. Optional Mate and Mate 3 LCD remote panel available	210 x 415 x 292	1,990	
	GFX1424E	24	21–34	1400	5700	40	92								
	GFX1448E	48	42–68		5700	20	93								
	FX2012ET	12	10.5–17	2000	4600	100	>90	~20	~6					2,695	2 years
	FX2024ET	24	21–34		5750	55	>92								
	FX2348ET	48	42–68	2300		35	>93	~23							
	VFX2612E	12	10.5–17	2600		120	>90	~20						3,114	
	VFX3024E	24	21–34	3000		85	>92	~20							
	VFX3048E	48	42–68			42	>93	~23							
	FX2012EMT	12	10.5–17	2000	4600	100	>90	~20	~6					2,695	
	FX2024EMT	24	21–34		5750	55	>92								
	FX2348EMT	48	42–68	2300		35	>93	~23							
	VFX2612EM	12	10.5–17	2600		120	>90	~20						3,114	
	VFX3024EM	24	21–34	3000		85	>92	~20							
	VFX3048EM	48	42–68			42	>93	~23							
Powertech Orders: 1800 022 888 techstore@jaycar.com.au www.jaycar.com.au	MI5260	12	10–15	1500	3000	20A	>90	-	15W	-	-	LED – charge, AC power, over temp, overload, AC power	520 x 200 x 88	1,099	1 year
	MI5262	12	10–15	2000	4000	20A	>90	-	24W	-	-		615 x 200 x 88	1,399	1 year
Rich Electric Co. "Invertek" Distributed by Jaycar Electronics Orders: 1800 022 888 techstore@jaycar.com.au www.jaycar.com.au/powertech www.richelectric.com.au	MI-5270, CP-1500-122	12	9.3–17VDC	1500	3000	70	82	12	8	Yes	-	LEDs, LCD, optional remote panel. Ratings at 70°C. Three programmable relays	258 x 362 x 370	1,799	2 years, optional 3 year extension
	MI-5250, SC-1500-122												258 x 362 x 370	1,999	
	MI-5252, SC-3000-122			3000	6000	140	84	18	12				258 x 424 x 370	2,899	
	MI-5251, SC-1500-242	24	18.6–34VDC	1500	3000	40		12	8				258 x 362 x 370	1,999	
	MI-5273, CP-3000-242			3000	6000	70	86	18	12				258 x 424 x 370	2,499	
	MI-5253, SC-3000-242												258 x 424 x 370	2,899	
Schneider Electric - Conext ph:(08) 8161 0511 www.clipsal.com	XW4024-230-50	24	20–32	4000	4400	8000	94	24	<7W	Yes	Adj	LCD and optional remote panel	588 x 410 x 230	POA	5 years
	XW4548-230-50	24	40–64	4500	4800	9000	95	26							
	XW6048-230-50	48	40–64	6000	6400	12000	95	28							
Selectronic Selectronic Australia freecall:1800 006 474 ph:(03) 9727 6600 sales@selectronic.com.au www.selectronic.com.au	SP PRO SPMC240	24	20–34	3000	7500	125A	90.0	8		Yes	5 - 50W adj	22 LEDs + Computer based graphical remote display with free SP LINK software	690 x 375 x 220	POA	5–8 years.
	SP PRO SPMC241	24	20–34	4500	10500	188A	91.0								
	SP PRO SPMC481	48	40–68	5000	12000	104A	93.0								
	SP PRO SPMC482	48	40–68	7500	18000	156A	93.0								
	SP PRO SPMC1201	120	100–170	7500	18000	63A	94.0								
	SP PRO SPLC1202	120	100–170	20000	44000	167A	95.5						870 x 540 x 290		
SMA Australia ph:(02) 9491 4200 info@SMA-Australia.com.au www.SMA-Australia.com.au	Sunny Island 2224	172.5-250	203–253	2200	3900	-	93.6 max	21	6			3 LEDs, ext display	470 x 445 x 185	POA	5 years; optional 10, 15, 20 or 25 years
	Sunny Island 5048		207–253	5000	12000		95 max	25	4			2 LEDs, integrated display	467 x 612 x 235		
	Sunny Island 5048U		208–253	5000	11000		95 max								
	Sunny Backup 5000		208–253	5000	12000		95 max	40	5				467 x 612 x 235		
	Sunny Island 6.0H	172.5-264.5	202–253	4600	11000	100	95	26	4			3 LEDs, ext display	467 x 612 x 242		
	Sunny Island 8.0H			6000	11000	115	95	26	4						
Studer Innotech Solar Power Australia ph:(02) 4954 3310 info@solarpoweraustralia.com.au www.solarpoweraustralia.com.au	XTS 900-12(-01)	12	9.5–17	500VA	2300VA	35	93	7	1.4	Yes	2	7 LEDs	410 x 215 x 124	1,600	2 years
	XTS 1200-24	24	19–34	650VA	2500VA	25	93	8	1.5					1,720	
	XTS 1400-48	48	38–68	750VA	2800VA	12	93	8	1.6					1,745	
	XTM 1500-12	12	9.5–17	1500VA	3400VA	70	93	8	1.4			17 LEDs. Power meter. Charge current meter	480 x 215 x 124	3,015	
	XTM 2000-12	24	19–34	2000VA	4800VA	100	93	10	1.4					3,320	
	XTM 2400-24	48	38–68	2000VA	6000VA	55	94	9	1.6				670 x 215 x 124	3,160	
	XTM 2600-48	12	9.5–17	2000VA	6500VA	30	96	10	2				480 x 288 x 242	3,250	
	XTM 3500-24	24	19–34	3000VA	9000VA	90	94	12	1.6					3,910	
	XTM 4000-48	48	38–68	3500VA	10500VA	50	96	14	2.1					4,100	

Table 3: Inverter-chargers (continued)

Manufacturer /supplier	Model	Input voltage	Operating voltage range	Power output (watts)		Charge current (amps)	Efficiency (%)	Idle power (W)	Standby power (watts)	Auto start	Min start load	Indicators	Size (mm) W x H x D	RRP ($)	Warranty
				Cont	Surge										
Studer Innotech Solar Power Australia ph:(02) 4954 3310 info@solarpoweraustralia.com.au www.solarpoweraustralia.com.au	XTH300012	12	9.5-17	2500VA	7500VA	160	93	18	1.4	Yes	2 to 25	Multifunction LEDs	500 x 290 x 220	4,920	2 years
	XTH500024	24	19-34	4500VA	12000VA	140	94	22	1.8					6,050	
	XTH600048	48	38-68	5000VA	15000VA	100	96	22	2.2					7,240	
	XTH800048			7000VA	21000VA	120		30	2.4				500 x 310 x 220	9,050	
TBS POWEsine Combi Enerdrive Pty Ltd ph:(07) 3390 6900 sales@enerdrive.com.au www.enerdrive.com.au	PS1600/60	12	10.5-16	1300	2600	60	92	~10	~2	Yes	0 to 200W adj	LEDs	351 x 210 x 114	2,300	2 years
	PS1800/35	24	21-32	1800	3000	35	94	~12	~3.5				351 x 210 x 114	2,400	
Victron Energy ph:(02) 9863 1052 salesaustralia@victronenergy.com www.victronenergy.com	MultiPlus 12/800/35	12	9.5-17	700	1600	35	92	8	2	Yes	Adj	LEDs, an optional remote panel and multi-purpose relay drivers	214 x 375 x 110	1,222	2 years
	MultiPlus 24/800/16	24	19 - 33			16	94	10	3					1,222	
	MultiPlus 12/1200/50	12	9.5-17	1000	2400	50	93	8	2					1,609	
	MultiPlus 24/1200/25	24	19-33			25	94	10	3					1,609	
	MultiPlus 12/1600/70	12	9.5-17	1300	3000	70	93	8	2					1,931	
	MultiPlus 24/1600/40	24	19-33			40	94	10	3					1,931	
	MultiPlus 12/2000/80	12	9.5-17	1600	4000	80	93	9	3				255 x 520 x 125	2,415	
	MultiPlus 24/2000/50	24	19-33			50	94	11	4					2,415	
	MultiPlus 12/3000/120	12	9.5-17	2500	6000	120	93	15	4				258 x 362 x 127	3,355	
	MultiPlus 24/3000/70	24	19-33			70	94	15	5					3,355	
	MultiPlus 48/3000/35	48	38-66			35	95	16	5					3,355	
	MultiPlus 24/5000/120	24	19-33	4500	10000	120	94	25	5				328 x 444 x 240	4,828	
	MultiPlus 48/5000/70	48	38-66			70	95	25	6					4,828	
	Quattro12/3000/120	12	9.5-17	2500	6000	120	93	15	4	Yes	Adj	LEDs, an optional remote panel and multi-purpose relay drivers	258 x 362 x 127	4,079	
	Quattro 24/3000/70	24	19-33			70	94	15	5				258 x 362 x 127	4,079	
	Quattro12/5000/200	12	9.5-17	4500	10000	200	94	25	5				350 x 470 x 280	6,350	
	Quattro 24/5000/120	24	19-33			120	94	25	5				328 x 444 x 240	5,311	
	Quattro 48/5000/70	48	38-66			70	95	25	6				328 x 444 x 240	5,311	
	Quattro 24/8000/200	24	19-33	7000	16000	200	96	35	10				350 x 470 x 280	8,301	
	Quattro 48/8000/110	48	38-66			110	96	35	10				350 x 470 x 280	7,886	
	Quattro 48/10000/140	48	38-66	9000	20000	140	96	35	10				350 x 470 x 280	8,691	

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How to build an electric vehicle (or how not to!)

Building an EV takes some planning and requires certain safety rules be followed. Leigh Hateley of the ATA Geelong Electric Vehicle branch explains.

THIS article is not intended as an instructional guide on how to convert a car to electric or as a set of safety rules, but rather is about my experiences and that of others with respect to working on electric vehicles and how much trouble you can get yourself into.

Welcome to the workshop

"OK, Leigh, here we go: take off the bonnet and disconnect the 12 V battery (*oops! Take off metal band watch and rings*). OK, the battery is out; unplug all the engine wiring (*and label it*), remove air cleaner and radiator (*should have emptied it first! Clean up the wet, slippery floor*).

"Now disconnect the fuel line (*must remember no smoking here*), undo all bolts from the engine mounts and drive shafts (*oops! Quick where's the oil pan!*) Drain transaxle and clean up oil from the floor. OK, time to lift the engine out using an engine crane (*no straining the back here*). Put on the chains and lift out the engine. Definitely need to look out for oil on the floor and clear an area to put motor down before starting this one.

"Beauty, that's done. Now put the car up on ramps (*hmm, should have done that before pulling engine*). Now, got to jack the car up and put axle stands and ramps underneath (*don't want to be a pancake!*). Out with the fuel tank (*should have emptied that first—don't want to be a Roman candle*). Now remove the fuel lines, exhaust pipe and mounting bits and pieces. We got that done with no injuries to self. Woo hoo!"

Does this sound familiar? In our haste we sometimes forget about safety—one of the perils of rushing in!

Now that I have dismantled my car without becoming a fireworks spectacular, just maybe I should overcome the innate desire to forge on regardless of life and limb. That's the trouble with being so keen to get the car done and cruise on down the road in my nearly silent electric driving machine.

I wonder what could really be involved in doing this? Maybe I might have to admit that Mum was right: "Why don't you make a plan? It could save some cost, headache and heartache later."

So while I kind of know how I'm going to do it in my head, it's time to down tools and make a plan.

Photo: Amy Rolfe

↑ EV battery packs, like this lithium unit, can be extremely dangerous if accidentally short circuited. Insulative mats, battery covers and tools with insulated handles are a must when working on EVs.

Planning the build

Weighing everything that comes out of the car is useful for keeping an eye on how much weight you can put back in.

To mount the electric motor I'll need metal for the frame. That means some cutting, welding and lifting. So I'll need safety glasses, a welding helmet, leather gloves and a fire extinguisher or sand bucket (a water bucket is not a good idea—it might be a little bit electrifying).

Good enclosed footwear is important—the last thing I need is the hot shoe shuffle; red hot sparks from welding and grinding can burn through runners, and feet when wearing

→ Working under a car can be a cramped experience, so it's important to raise the car as high as possible. Car ramps are the safest method, unless you own your own automotive hoist!

thongs (I learnt that the hard way—it's not easy digging out a chunk of red hot metal and it takes ages to heal!).

To build the battery boxes I'll need metal sheet, angle iron and similar tools and safety gear. Here's a hint—after cutting sheet metal, don't run a finger along it to check how smooth the cut is! The sharp edge will cut your fingertip much worse than a paper cut. That also goes for drilling holes: always remove the burrs first.

Battery hazards

When working with batteries, just remember: if you drop a spanner across the terminals you have an instant heating element! Resist the urge to pick it up bare-handed otherwise the maker's name will be permanently branded into your palm. Wearing safety glasses and gloves is a good idea when working on batteries. It's also recommended to have insulated tools and an insulating mat to cover the battery while you're connecting the terminals.

All electric vehicles use high voltage wiring; anything above 48 volts DC can kill! If you have no master fuse on the battery bank, a fault can melt cables and cause expensive problems. It's also very dangerous, and you want to avoid possible injury (or death!). A fuse is sometimes called "a safety device to protect people from themselves". We like to say they also stop smoke leaking out of a wire and causing a fire.

High voltage wire must be coloured orange and double insulated by placing it in plastic conduit, securely attached with saddle clamps. Cables need to be kept away from mechanical damage that could be caused by tail shafts, drive shafts or drive belts. Also, use grommets for running cables through holes. Anything that can wear away insulation is a problem.

In a friend's electric car, the cables shorted out on the gear lever housing and the gearbox casting caught fire while he was driving. Luckily he had a manual shut-off switch and was able to stop and put the fire out with his fire extinguisher (not a bad idea to have in any car). Once ignited, magnesium-based castings are self-sustaining and very hard to put out. The lesson in his case was that there was no main fuse, no main contactor, the cable was not in an insulated conduit and wasn't properly clamped. The batteries in that car were capable of 1000+ amps at 72V. With over 72kW of potential destructive force it could have been a tragedy. No vehicle with that sort of wiring will pass inspection by your VASS engineer!

↑ EV batteries can give a lot of kick. This is what happens when a 36 volt battery pack is shorted with a spanner. The result is one ruined spanner and one unusable battery—an expensive and dangerous 'oops' moment.

Photos: Doug Rolfe

Auxiliary wiring in a car is usually 12 V. This is retained to run the lights, indicators, instrumentations etc. All wiring for the electric heater, additional EV instrumentation, air conditioning (if fitted) and whatever else you install must be fused. It's a good idea to have a wiring diagram for your chosen conversion car.

The main motor contactor is like a remote 'fuel tap'; it's energised when the key is switched on and connects the main battery pack to the motor controller.

DC motors can be tested using a 12 V battery, but resist the urge to rush in and test your brand new high-powered electric motor (designed to push a 1500 kg car at more than the speed limit). Guess what happens when you connect a battery to a motor while the motor is loose on the ground? It takes off like a bowling ball and, if you're lucky, it won't run you down. Electric motors produce enormous torque (twisting force) when they start rotating—that's why they are great for cars.

Appropriate motor testing is done by putting the car on ramps, chocking the non-drive wheels and testing at low speeds. You don't want your car to become a 1.5 tonne projectile. I can see the headlines now: "Man run over by own electric car."

Skills and resources

Local TAFE institutions often run courses in basic metalworking and welding. You need to be sure that your skills are up to the job, especially in welding structural components such as the motor and battery mounts. You can find engineering workshops in the Yellow Pages. You may want to ask others for their recommended engineer. Expect to pay well for their skills and abilities to get a good result.

One of the joys of converting a vehicle to electric is working with a small team. Great resources are your local ATA branches and forums (including the Electric Vehicle branches in Melbourne and Geelong), local Men's Sheds and the Australian Electric Vehicle Association (www.aeva.asn.au). You can also find useful design information in the EVWorks technical library (www.evworks.com.au/tech) and EV Album (www.evalbum.com).

All the regulations for EV conversions can be found in NCOP14: *National Guidelines for the Installation of Electric Drives in Motor Vehicles*. www.infrastructure.gov.au/roads/vehicle_regulation/bulletin/pdf/NCOP14_Guidelines_Electric_Drive_01Jan2011.pdf

The last thing, after checking the wiring multiple times, is to connect all the battery cells and main cables. If everything is done correctly, when the ignition switch is turned on and the accelerator pressed, the car moves in the right direction! A DC 'clamp meter' can be used to directly measure currents flowing in battery cables.

What it comes down to in the end is building a silent, efficient car to show what can be done in a garage with time, work and appropriate skills. That first drive can have you grinning from ear to ear with the famous 'EV grin'. ✸

WARNING As this article shows, there are many dangers in converting an EV, including exposure to potentially dangerous voltages. If you are the least bit unsure about being able to safely work on your EV project, then you should contact your local EV group for guidance and the support of experienced EV converters. See contacts in the Skills and Resources box above.

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, or fill out and return the form at the bottom of the page.

Valvecosy

Price: $20

An elegant solution for a largely hidden problem, this insulating cover is designed to fit neatly over the pressure/temperature relief (PTR) valve on your hot water service. It reduces heat loss, conserves energy and saves you money.

Ecoswitch remote power point

Price: $19.95

Easily turn off standby power with this accessible ecoswitch. The ecoswitch consists of a small extension lead with a branched on-and-off switch. It allows you to control devices without having to crawl under desks or behind cabinets.

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 5 W yet produce the light equivalent of an average 60 W 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.

Dimmable LED halogen replacement bulb

Price: $39.50

This LED downlight is perfect for an energy efficiency retrofit. It uses just 5 watts and produces light equivalent to a 40 watt standard halogen. At three hours use per day, these should last over 25 years and are dimmable. They can be used almost anywhere a 12 volt (low voltage) halogen fits.

Fridge/freezer thermometer

Price: $18

Keep your fridge at the right temperature all year round. You can set an alarm to sound if the temperature goes above or below the set temperature range.

Sanctuary: modern green homes issue 21

Price: $11.95

Green roofs, building materials and houses that place the outside at the core of their design feature in *Sanctuary 21*. A great summer read showcasing a range of amazing sustainable houses from around Australia.

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.)

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ATA members receive a 15% discount on ATA products, except where noted. Ask for your discount when you order!

Adjustable solar
Panels that move

Fixed and roof-mounted solar arrays are not ideal for everyone. Adam Thomson describes the solution he's evolved for his holiday home.

WE have an off-grid bush block and although there is, as the real estate agents say, "power at property boundary", as part-timers there we felt that our electricity demands were modest—lighting, fridge and music—and could be met with 12 volts from a small PV panel and battery setup. With the grid powerline over 200 metres away, connection would have required a transformer as well as our preference of a buried cable.

Photo: Adam Thomson

↑ Smaller solar arrays can be mounted on mobile frames, which have a number of advantages over fixed arrays.

Take 1: panels on the roof

We first investigated an approach using roof-mounted solar PV combined with an inverter-charger and generator. The inverter-charger would supply 240 volts to a powerboard for minor mains voltage needs, such as occasional power tool use and the recharging of battery devices such as mobile phones, laptops and battery-powered tools. A generator would recharge the four 12 V, 200 Ah batteries (connected in parallel to form a 800 Ah bank) during extended cloudy periods and supply power directly for the vacuum cleaner and washing machine. The main load—a fridge/freezer—is a 12 volt DC unit, so runs straight from the batteries. It consumes around 70 Ah (840 Wh) per day. Lights are also all 12 VDC.

Our small rectangular house has a flat roof with the main axis oriented about 30 degrees east of south and west of north. To mount the panels, I bought some aluminium standard sections from Aluminium Express (www.aluminiumexpress.com.au). I mounted one panel on the roof and viewed it from above, further up the block. I was surprised at how large it looked relative to the roof.

At about the same time, I discovered the wind rating for the area—N3, which I believe includes gusts of up to 147 km/hr. Intimidated by the occasional ferocity of the wind and uncertain about the strength of the roof's own attachments, I abandoned the roof mounting until our planned, but as yet unscheduled, renovations and extensions were made.

The four 130 watt PV panels rested in the shed and the generator was being run for up to two hours each day to recharge the batteries. In June last year, just as the inverter-charger brought the batteries to full charge, unpleasant electronic-smelling smoke came from the unit. Discussions with the supplier were unsatisfying. Maybe its price was too good to be true, but up until then it had performed perfectly well.

We bought a replacement switchmode charger—one that is tolerant of generators—and it has worked well, with a couple of provisos: it gets pretty hot, even though we run it within its rating, and it doesn't have provision for tailoring the bulk/absorption/float levels or setting the battery type. However, it has been reliable.

Take 2: panels on the ground

A local tradesperson who was building our shed suggested mounting the panels on the ground. I wasn't keen at first, as such a setup would need to be dismantled eventually. Also, wherever it was, being close to the house, it would at some time get in the way.

Eventually, though, it dawned on me that putting a frame on wheels would give several advantages: a ground location, the freedom to move the panels around if they were in

the way, the ability to follow the sun during the day and the option of storing the system in the shed when we're away for prolonged periods or extreme weather is forecast.

Construction

I constructed a rectangular base frame from 3.6m lengths of 90 x 90mm treated pine, bolted together using galvanised coachbolts. It took visits to two stores to find absolutely straight pieces. At each corner a galvanised steel plate stiffens the joint and helps ensure the frame stays square. The wheels are industrial castors, two fixed and two swivelling (from G&R Industrial Products, Collingwood VIC), with 200mm pneumatic tyre wheels.

I mounted the panels at a 45 degree angle, using the aluminium sections I'd bought for the postponed roof mounting. A 50 x 50 x 3mm aluminium angle let into a 45 degree rebate on each longitudinal timber rail supports the panels' bottom edges and the rear of the frame.

To ensure the sides, apex and panels were held to straight lines, the timber frame longitudinals were supported at their midpoints while all the bolts were tightened. A tie with a turnbuckle adjustment tensions the two long sides together at the centre point, with the result that there is negligible sag.

The pine frame is sufficiently stiff and heavy to make it unlikely the wind will move it. In addition, a length of threaded rod can be lowered to the ground to hold slotted weights, each around 29kg, to hold the frame down in wind, although our experience has been that the system stays steady in high winds and the weights are unnecessary. The contraption is chained to a star post when we're away.

At night, the frame is parked on the eastern side of our house, oriented with the fixed castors to the north and the swivel castors to the south. Pulling on the swivel castors' end makes the panels follow the sun.

Although I had bought fairly expensive 6mm² cable for solar connection, a surplus length of 6mm² mains cable has been used for the initial connection through to the PV controller mounted beside the battery bank.

The PV regulator, panels, connection wires and plugs all came from Jaycar. The All About 12 Volt shop in Somerton (www.allabout12volt.com.au) supplied plugs, fuses and an Arrid expanded scale voltmeter and were very helpful in making up battery cables and plugs.

Performance

The setup has exceeded my hopes. On first connection at mid-morning, the batteries began bulk charging at around 30 amps—comparable to the 40 amps from the generator—and after about four hours had moved to absorption. The following day, after about three hours daylight, the batteries had reached absorption charge without the panels being moved.

Over the following two days, I noticed that the batteries seemed to be holding a higher fully charged voltage overnight than they had when using the generator, and this has continued to be the case. Perhaps the lower amperage charge is kinder to the batteries and, because of its long duration, is able to better fully charge them.

The Powertech regulator provides a continuous readout on the status of the system, including charging status, battery and PV voltage, PV amps, and amp-hours today, yesterday and the day before. The amp-hours used seem consistent with the rating and running time of the fridge, which is the main consumer of electricity.

During January and February, with the panels facing east at the start of the day, our batteries were largely charged before the sun had reached a point where it would fully illuminate a north-facing panel. We have since had a winter, and the system has continued to power our fridge and lighting. The fridge consumes noticeably less energy in winter, and even with a series of dull days, we have not had to run the generator (just).

Are mobile panels worth it?

Given a reasonably flat area, one should consider mobile ground-mounted panels. It's a lot easier just bolting a frame to castors than setting out and making footings in the ground. It's also convenient to be able to build the unit inside a shed and just wheel out the completed unit. It takes little effort to move it and if there's no one there to do so, there's probably minimal electricity being consumed.

Orientation versus elevation

I suspect that, by-and-large, orientation is more important than elevation, and if the elevation is steep and more suited to a lower sun at the early and later parts of the day, then the greater intensity of the sun during the middle hours of the day will compensate for the steeper panel angle. As pointed out earlier, the moveable panels collect sunlight for some hours both before and after north-facing panels would receive direct sun.

"Our batteries were largely charged before the sun had reached a point where it would fully illuminate a north-facing panel."

Improvements

Instead of mounting the base of the panels on a fixed rail, I considered using a large piano hinge to allow elevation changes. You would then need a strong but easily-adjusted elevation arrangement. Alternatively, it would be worthwhile including the simple adjustment originally planned for the roof installation, where the elevation would be set and fixed for the summer or winter six months. I have since discovered that telescopic backstays for adjusting panel angle are available (for example, www.bit.ly/ROxHAJ).

The panels are connected in parallel for 12 volts, as required by the regulator already bought. Ideally they should be connected for 24 or 48 volts to reduce power loss in the cable, and fed into a MPPT controller, minimising losses and maximising collection efficiency.

Finally, if one of the swivel castors was replaced by a fixed wheel driven by a stepper motor, could the frame follow the sun around, powered by itself, instead of my needing to move it mid-morning and early afternoon?

Economy

Whether we used a diesel or petrol generator, it took a surprising amount of fuel to keep the batteries charged. In addition to the noise, smell, supervision and maintenance needs, and the constant ferrying of fuel, generator-sourced electricity is downright expensive.

Just a comment on another cost issue: I've been amazed at the price of aluminium fittings for mounting solar panels, which is why I used standard angle sections. Otherwise, frames can be a significant part of the overall system cost.

In conclusion, with eight months use, the installation has been such a success that the wheeled mounting will probably become permanent, and we're considering a second row of panels. ✷

Like all electrical projects, there's potential for safety hazards if done incorrectly. It is important that anyone building their own renewable energy system have appropriate knowledge and skills. To brush up on your electrical skills, you might want to take a short course in renewable energy systems. See our guide in *ReNew 121*: www.renew.org.au/renewable-energy-courses-guide

Browser

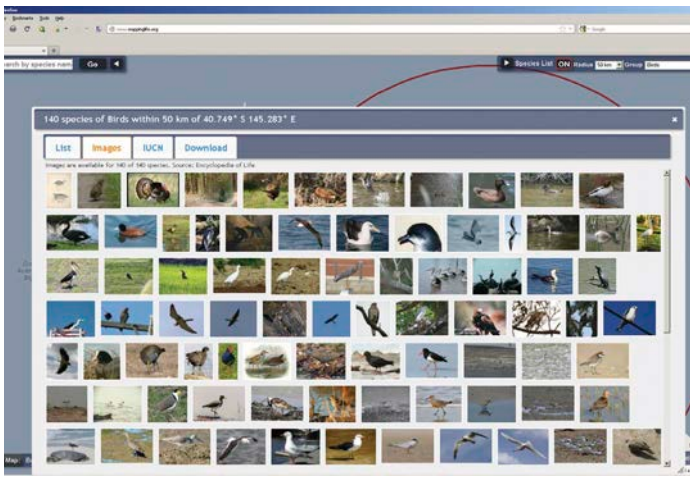
Map of Life

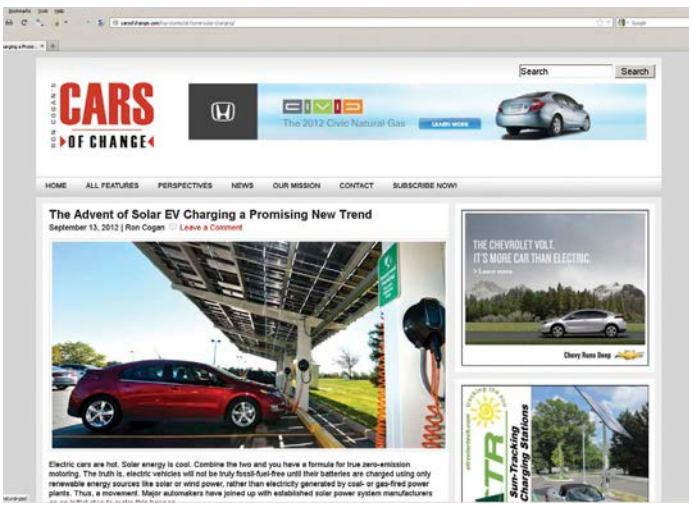
Earth is host to an enormous number of species of birds, fish, reptiles, amphibians and mammals, but do you know which animals live where? What critters are you likely to find if you explore the local parklands or even your own garden?

Map of Life is exactly what it says: an interactive map that tells you the animal life found in your area.

There's not a lot to using the map—just select the zone radius and the type of animal you're looking for, then zoom in and click where you live on the map (it uses Google maps and so works in the same way). The website presents you with a list of the creatures that live in your area, or you can opt to view tiled thumbnail images instead. Click any critter's name or image and you will be taken to the wikipedia entry or another information page for that animal.

www.mappinglife.org





Cars of change

Like it or not, cars are a part of modern day life; until we radically reorganise our cities to be more walking and bike friendly, the majority of people will own a car. So it makes sense to make those cars as eco-friendly as possible.

We've looked at a few sites dedicated to the latest in eco-cars, the electric vehicle, but Cars of Change takes a slightly different tack—it examines not only EVs, but other technologies such as biofuel vehicles, hybrids and ultra-efficient internal combustion engine vehicles.

It includes a collection of articles on current and emerging vehicle technologies, and how those technologies affect our modern lifestyles. You can browse through the complete list of features, or check out the Perspective category, a collection of reviews and opinion pieces. Plus there's a News category as well.

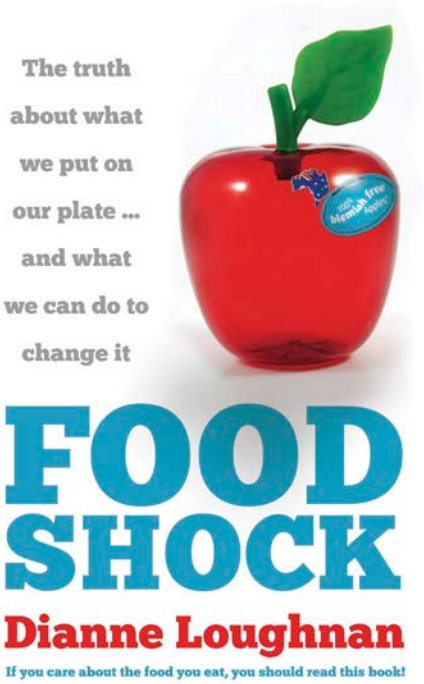
There's the usual advertising (someone has to pay for the website) and you can also subscribe to the printed magazine *Green Car Journal,* whose editors run the website.

www.carsofchange.com

The dirt on Australian farming

Food Shock

by Dianne Loughnan
Exisle Publishing
$29.99
ISBN: 978-1-921966-09-5



Food Shock is less about food itself and more about farming and agricultural systems. Diane Loughnan leads you through the world of farms and farmers in Australia, a world that Loughnan, as a farmer herself, knows a lot about. The reader learns about the intensive farming of chickens and pigs, the use of hormones in beef and about the changes that have happened in farms across Australia over the last few decades. These changes include the opening of the Australian market to world trade (and the subsequent dropping of tariffs), the massive increase in farming productivity but with reduced earnings, the struggle to survive for the small to medium farmers and even how the historical view of farmers (and Australia's reliance on them for GDP) has changed. Farmers are now "just another sector of the economy" as opposed to their previous role according to Loughnan, as "the economic and cultural backbone of Australia".

The reader learns of the impact of the mining boom on farms—especially the coal-seam gas industry. It is shocking to discover that farmers only own the top 15 centimetres of soil on their farm—the dirt under this can be sold by the government to mining companies for exploration, and if successful in the exploration stage, mining appears to take precedence over farming and food production.

Food Shock also covers the impact of foreign ownership of Australia's farms and food manufacturing, which leads onto the issues of food sovereignty. It is only towards the end of the book that the author deals with what consumers can do to help secure Australia's food security.

It is good to have a book with the Australian perspective, and Australian facts and figures. But the book doesn't have a great narrative. It is sometimes hard to see where the author is leading us. Maybe it's the facts and figures in the book that made it interesting, but not inspiring. There was scant detail on 'what we can do to change it' as promised in the book's sub-title. And the facts and figures about possible solutions—such as farmers markets, organic farming and community-supported agriculture that were mentioned briefly in the final chapter—were missing, which made it seem that the world of intensive farming of animals and foreign-owned farms was the only likely future for Australia—a tad depressing.

What *Food Shock* attempts, but doesn't quite achieve, is to make the reader jump up and want to take action against what could be a rather scary option for Australians—a future with the majority of our food being produced in other countries and imported into Australia.

Review by Kate Allsopp

ATA member profile
An inventive spirit

Sasha Shtargot talks to Christian Groves about his backyard projects, including one that's helping hot water systems stay cosy.

ATA members, *ReNew* readers in particular, like to tinker. But perhaps few tinker as successfully as Christian Groves, the inventor of the Valvecosy.

In 2004, having installed solar panels and a solar hot water system on the roof of his family home in Newport in Melbourne's west, Christian decided more was needed to improve energy efficiency.

"To maximise the benefit from our PV system I had a hard look at how we were using electricity and what parts of our house were losing heat," he says. "I noticed that the pressure release valve on the hot water service was quite hot so I figured insulating it would save some energy."

He fitted nitrile rubber over the valve and, although it worked, someone pointed out it was a hazard because the valve's release mechanisms were covered. Insulating the valve wouldn't be as easy as it first appeared.

His interest and creativity piqued, Christian began working on a safe and reliable product with business partner Mark Hollis. They tried and scrapped a number of different designs over several years before finally settling on a prototype.

An industrial designer was brought in to bring the prototype to reality. Voilá the Valvecosy, a polypropylene and polystyrene plastic cover that fits neatly over most hot water service valves and is easily taken apart for recycling at the end of its life.

"The process was a long one with a pretty steep learning curve," Christian says. "It wasn't a particularly easy road, but I've learnt lots of new skills related to developing and prototyping ideas. Picking up sales and marketing skills is a challenge we are dealing with now."

Photo: Pam Davison

→ Christian in his workshop, demonstrating how to fit the Valvecosy on a hot water tank.

The Valvecosy finally appeared on the market in March this year and has been selling well, through the ATA's webshop among other places. It is made wholly in Australia, in a factory in the Melbourne suburb of Dandenong. According to Christian's testing, insulating the valve can save about 55 kWh of energy a year.

A telecommunications engineer by profession, he joined the ATA in 2003 when looking around for advice on solar PV and hot water: he stumbled upon *ReNew* and promptly signed up, encouraged by a members' discount for rooftop solar.

The Valvecosy is not the only tangible example of Christian's passion for sustainability or his love of tinkering—he makes furniture in a shed at the back of his home and sharpens tools for friends and people in the community. His latest backyard project is building double-glazed windows.

"According to Christian's testing, insulating the valve can save about 55 kWh of energy a year."

Christian believes the energy that goes into making something needs to be honoured—whether of wood, metal or glass, a product must be built to last. And the knowledge gained from the creative process can be kept local to benefit friends and neighbours.

"The skills acquired to make furniture can be used on projects around the home and to repair items rather than throwing them away," he says.

"One of the gateway skills to working with wood is the ability to sharpen tools: sharp tools are safer and a pleasure to use. I sharpen knives at the local food swap, so there's a community aspect to helping out and sharing skills." ✱

Here's what the ATA branches have been up to over the last couple of months—useful, interesting and inspiring!

Adelaide: 'Towards electricity without fossil fuels' was the subject of the 19 November meeting. The branch also held a stall at Mitcham's Voices of the Village: Sustainable Communities fair on 21 October, and its October meeting covered energy-efficient glazing.

Tasmania North: About 50 people attended the branch's talk by Peter Rae AO on 'Renewable energy—the future for Tasmania and the world', 15 October at the University of Tasmania in Launceston.

Perth: Group members attended a lecture by international sustainable population writer Richard Heinberg on 27 September at the University of WA.

Sydney Central: The opportunities and challenges of small-scale wind turbines was the topic when the branch met on 16 October. The group's November meeting, the last of the year, included presenters on hybrid solar PV-thermal technology.

Sydney West: Earth-building expert Ray Trappel spoke about homes he has constructed at the branch's meeting on 3 November at Hawkesbury Earth Care Centre.

Brisbane: The branch held a stall at the Brisbane Organic Growers Festival on 7 October. It had a successful Sustainable House Day in September, with media coverage in the *Courier Mail*, local newspapers and ABC radio.

Melbourne: A presentation was made on smart grids at the branch's meeting on 17 October, with an election for office-bearers on the night. A hugely successful project night was held on 19 September.

Melbourne EV: James Brown of ChargePoint spoke about electric vehicle charging infrastructure at the group's meeting on 24 October. It took part, with the Geelong EV branch, in the Wyndham Electric Vehicle Expo on 9 September, displaying 14 electric vehicles from members and businesses.

Geelong EV: The branch continued to meet monthly to update recent activity and projects. With Melbourne EV, it participated in the Wyndham Electric Vehicle Expo.

Cairns: Cairns branch held stalls at several local sustainability festivals in recent months and helped at Sustainable House Day. See the ATA website for more details.

Sunraysia: Had a successful Sustainable House Day on 9 September, organising the opening of several houses.

Coffs Harbour: Check the ATA website for more details about Coffs Harbour branch activities.

Canberra: Has been meeting with the Australian Solar Council at the Ian Ross room at ANU on the last Wednesday of the month. For more details see the ATA website.

Blue Mountains: The branch is looking for an enthusiastic convenor to help it get back on its feet. If you are a local and interested, contact ATA's Branch Officer, Doug Rolfe, on (03) 9631 5407.

Warkworth, NZ: The branch is organising an ATA display for the Sustainable City Showcase in Auckland from 22–24 November.

To find out more, or to join a branch, see www.ata.org.au/branches.

The Pears Report
How blocking change can backfire

Communities and smart consumers drive change as policy makers and industry lag behind. Alan Pears explains.

THE gas industry is now seeing how, when powerful interests block action, it can hurt a 'transition option'. As climate science provides increasingly dire warnings, more people now say we can't afford to just reduce emissions through use of gas and other weak strategies such as marginally more energy efficient buildings. We have delayed action for too long. Now we need to jump to zero emission and beyond zero emission solutions. As electricity consumption continues to decline, Origin Energy has realised this has big implications for their gas-fired power generation strategy. It is also a game changer for electricity networks. So the opposition to policies such as the Renewable Energy Target is not surprising.

This is not a new phenomenon. I recall talking to a representative of a building industry association who was complaining about the varying state-level building energy requirements and the rapid rate of change. I pointed out to him that his association was to blame for the mess. They were so effective at blocking change at a national level that the community was left with no option but to drive change at the local level where they had sufficient influence.

Going back a hundred years, the gas industry tried to block the introduction of the much more efficient mantle gas light from Germany: at that time gas lights were just like kerosene lamps, and relied on the luminosity of the flame to produce light. A local hardware shop began importing the mantles, and the gas industry lost its battle. However, this had a silver lining for the gas industry. It was losing market share to the electric light for street lighting. But the new mantle light reduced gas light running costs and provided a brighter light. The roll-out of electric street lighting was delayed by decades, and the gas industry was saved. We live in a complicated world! And many powerful industries just don't seem to learn from history. They need to ride the wave, not try to block or ignore it.

Smart consumers that could interact with dumb grids

I and others have been advocating for smart demand-side systems that integrate storage, renewables and smart, efficient equipment. These could manage a consumer's interaction with existing 'dumb' grids and save a lot of money. Yet, in Australia, there has been little interest from the energy industry or researchers. Enormous amounts of money are being thrown at 'smart' grids by the federal government, for example the $100 million Smart Grids Smart City project. Little is spent on 'smart' consumers, however. I must be naive, because I haven't been able to work this out.

But recent discussions about drivers of over-investment in networks have made sense of this. Network owners get paid based on investment in their networks, not investment on the customer side of the meter. So they focus on expensive 'smart' grids. Energy policy people are largely captive to the world view of the electricity supply industry, so they allocate money where they're told it's needed. Variable demand is apparently a 'problem' that has to be dealt with by supply-side measures. So it's left to international businesses, like Samsung, and renewable energy firms selling distributed energy solutions to develop consumer-side solutions.

Yet again, energy policy makers will be surprised when these demand-side solutions take off, as consumers yet again act to protect themselves from the disempowering, costly strategies of the existing supply industry and policy makers focused on maintaining a welfare system for the industry.

Let's hope that the inquiry into electricity pricing can expose this bizarre situation and change it.

The global contradiction

Eminent scientists such as James Hansen have pointed out that, to limit climate change, we cannot afford to burn more than a small proportion of the fossil fuels that businesses already 'own'. Yet the search for more continues—with public subsidies.

Governments need to phase out incentives to search for more fossil fuel resources, and shift those funds to driving energy efficiency, renewables and innovation. Of course, it is difficult to do this when those industries are so powerful. But we are tipping money down the drain and making our future challenges even more difficult.

The expansion of Australia's coal industry is another example. Our industry is investing record amounts in expansion. Yet the International Energy Agency forecasts that, for a global 450 ppm CO_2 path—with around a 2 °C temperature rise—global coal demand would decline by a third from today's level. Further, *New Scientist* (11/10/12) points out that US coal producers, who face declining local demand, are gearing up to export coal. Is our coal industry digging a hole for itself, as well as the climate?

Photo: Tesco PLC

↑ A virtual Tesco store in a subway in Korea where shoppers scan and buy groceries that are then delivered to their homes.

"Energy policy makers will be surprised when these demand-side solutions take off, as consumers yet again act to protect themselves from the disempowering, costly strategies of the existing supply industry."

Electricity inquiry

PM Julia Gillard has finally taken the action that governments since the mid 1990s have failed to take. She has exposed the energy 'club' to public scrutiny by establishing a senate inquiry with wide-ranging terms of reference. Unfortunately the timeframe of the inquiry is short, because CoAG must move quickly to influence the next round of price setting for network and transmission funding. But at least it's happening.

Hopefully the inquiry will take the opportunity to review the fundamentals of energy markets, such as the objective of the National Electricity Market, and put in place ongoing mechanisms to refocus the electricity industry—and its policy makers. My submission is on the inquiry website.

The *Hansard* records of the inquiry's hearings are very illuminating. The energy sector's position is "we're working on this, so leave us alone and we'll sort it out". Everyone else, from business to social justice advocates, says major changes are needed. Of particular concern is the admission by energy policy makers (e.g. Department of Resources, Energy and Tourism, DRET), industry participants (e.g. National Generators Forum) and industry lobbyists (e.g. Energy Supply Association of Australia) that no one really understands the drivers of falling demand.

I know of no other industry with an annual turnover of tens of billions of dollars that knows so little about how its customers behave and think. How can the Australian Energy Market Operator (AEMO) sensibly forecast electricity demand? How can DRET publish its imminent Energy White Paper? How much could this lack of data cost the economy through poor investment decisions?

Virtualisation continues

In September, Myer commented that it would be closing down some stores due to the increase in online shopping. In South Korea, global supermarket chain Tesco has been trialling virtual supermarkets on underground railway stations. Think of the energy saving potential and the implications for the real estate and building industries. And the time saved by consumers! Virtualisation is certainly a big player in the journey towards a sustainable world.

The challenges of setting targets

Most policy makers love the idea of creating market mechanisms with caps or targets, to allow the market to pursue 'least cost' solutions. However, if the target is too easy, this elegant policy approach becomes a boom and bust nightmare. Almost every trading scheme seems to suffer this problem. The original MRET target was met several years before its deadline. Australia's carbon trading scheme requires the regulator to set the cap five years ahead, so it can't respond to unexpectedly low or high prices. The world is awash with cheap Certified Emission Reduction credits. Even the original NO_x trading scheme in the USA suffered from much lower than expected prices.

You would think policy makers would have realised that any cap or target scheme needs a mechanism to automatically revise the target if prices fall outside a specified band for more than a set period. This would certainly help to avoid the politics and uncertainties caused by reviews of targets, like the present RET review. Then participants could be more confident of future prices and more stable market conditions. Why is this so hard? ✸

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 feeding solar power into a laptop computer? How about what to do when appliances are failing in an off-grid system? Ask *ReNew* your question via renew@ata.org.au.

Solar laptop power

Q—

I'm wanting to power just a laptop computer and modem using solar off-grid. Is there a simple system that does this? If it's 12 V I'm cool with that.—Ian Sercombe

A—

The simplest way is to feed a solar panel straight into the laptop. Most laptops have a 19 volt power supply, and 12 V solar panels have output voltages around there so they are a fairly good match. It can be a good idea to use a pre-regulator to limit the voltage to the laptop's specified maximum input voltage.

As for powering the modem, it depends on what type of modem it is (ADSL, 3G or dialup). Wireless modems are the easiest as they are usually powered by the PC's USB port. ADSL and dialup modems usually need a 9-12 volt supply, either AC or DC, depending on the modem.

If you want to make sure the laptop gets all the power it needs, then you might want to go with a small battery based system. You would need the aforementioned 12 volt panel, a regulator to suit and a battery. I would recommend a lithium-based battery for lightness, longevity and efficiency. Something like the battery at www.bit.ly/TApbCY would probably do it.

You would also need a step-up converter to provide the 19 or whatever volts for the laptop from the 12 V battery. These are available from places like Jaycar and numerous other suppliers.—Lance Turner

Grid voltage too high

Q—

After two and a half years of trouble-free operation the inverter of our 3.5kW grid-interactive solar installation now shuts down on days of good solar insolation. The inverter has been checked by the supplier, and it is doing exactly what it is programmed to do—shut down when the grid voltage is too high.

We are supplied by a relatively long 19 kV SWER (single wire earth return) feeder with individual step-down transformers at each consumer premises. Our property is near the terminating end of this feeder and several neighbours also have grid-connected solar systems.

Investigation by SA Power Networks (the new name for the old ETSA) led to this explanation: to allow for voltage drop when demand is high, the supply line voltage is kept high. With low demand (and correspondingly minimal voltage drop) and a net export of solar power, the line voltage rises as each inverter increases its output voltage to maintain a feed-in differential.

Now, on an average sunny day, we rarely see below 256 volts (read directly from the supply mains meter display) and when the inverter shuts down the line voltage is over 260. The highest observed so far is 262 volts. There appears to be little recognition of the distributor's obligation to maintain the supply voltage to Australian Standard AS60038, from a minimum of 216 volts to a maximum of 253 volts.

When the inverter is inoperative we are unable to access the power we generate. We are therefore forced to buy extra power from our retailer and are prevented from exporting our excess—a double whammy! There is also the potential for damage to appliances when the supply voltage is too high.

Are we an isolated case, or is this an emerging problem?—John Birrell

A—

Unfortunately, it all boils down to physics. Too much flow in either direction will result in either too high or too low a voltage, there's really no way around it, especially for long SWER lines, which are notorious for voltage variation. There is a limit (in percentage of maximum capacity) of how much generation capacity can be attached to each section of the grid. Generally this limit is considered to be around 20%, although that is slowly increasing, at least on the better sections of the grid.

But it's just the nature of the beast—too much generation on a single line can push the voltage up. It's not easy for a distributor to keep the voltage in range when the factors influencing the voltage vary so rapidly, as they can with renewable generation. They need active voltage control gear on each section of the grid and that simply doesn't exist in many areas, which often have manual tappings on transformers, if any at all.

My personal opinion is that for areas on long SWERs, home owners should be encouraged to install independent systems with grid connect so that they can store the energy and sell into the grid at more appropriate times. These sorts of systems are more expensive due to the need for a battery bank, but they also give you backup for times of mains grid failure, and they ensure that the grid voltages are more stable.—Lance Turner

230 V, 240 V, whatever...

Q—

I'm an avid *ReNew* reader, member and past contributor. We had a recent experience that we thought wouldn't be uncommon amongst your readers and thought it would make an interesting story.

We've been living off-grid for the past five years. During this time we've had issues with electrical appliances breaking down, and each time as soon as the technician discovers we're off-grid they blame the system. It's a real fight to get them to consider other options.

The most recent example was today which prompted this letter. We purchased a new electronic fridge, and had a problem with it as soon as it was plugged in. I won't bore you with the details, except to say that before even looking at or hearing the problem the technician had decided the problem was caused by our power, his rationale being that electronic fridges needed a constant 240 V

supply. When he tested our system is was only providing 230 V. Of course, in the end he finally admitted there was a problem with the fridge and a replacement is being sent.

What would have been really helpful was a fact sheet, written by a qualified person, to give to the tech explaining why the power system is not the problem.—Judy Celmins

A —

You really have to wonder how up-to-date some technicians are, given that Australia officially shifted to 230 volts over a decade ago. This is why current inverters have 230 volt outputs, not 240. The Australian Standard AS 60038 states the nominal mains voltage as 230 V +10%, - 6%, giving a range of 216.2 to 253 V. The ESAA *Customer Guide to Electricity Supply* gives more details on page 27 and indeed is a useful document to read for anyone interested in electricity supply in Australia. It can be found at www.bit.ly/WYBb66. Other similarly useful documents are ENA's *Customer guide to Electricity Supply* at www.bit.ly/XInUhr and the *Electricity Networks Operation Standards 2011* at www.bit.ly/Trfoor.

Even so, most appliances have a wide input voltage range, often from 200 volts up to 265 or so, depending on the brand, model and the markets the model is sold into. Indeed, most modern electronic devices use 'universal voltage' power supplies that handle 85 to 265 volts, although the fridge motor will be designed for a narrower voltage range. But, the motor doesn't seem to be the problem, the electronic controls do, so the technician blaming the power supply on a voltage basis shows considerable lack of knowledge.

Having said that, if you are having a lot of electronic device failures then you might want to have the output waveform of the inverter checked in case it is producing a non-sinusoidal waveform or is producing a lot of electrical noise on the waveform. Any technician with an oscilloscope can check the waveform for any oddities. There might also be another appliance that is producing electrical noise that is damaging other appliances.—Lance Turner

Generator set for reuse

Q —

I have an SPI 4 hp MacDonald diesel engine with a 20 inch flywheel and 5 inch pulley. It drives a Dunlite BDW 40 volt, 37 amp generator at 1500 rpm with an 11 inch pulley and two V belts.

This has been used for years in the past as our 32 volt lighting plant, charging a bank of batteries. It is a beautiful engine and I wonder how I could make use of it now we are on the 240 volt grid. We have 19 PV panels on the roof, feeding the grid through a 4.5 kW inverter.

Could this motor be used somehow with a 240 volt generator, connected with the V belts, or the original 32 volt generator with an inverter, to be used for lights and fridge during blackouts?

I have been told this cannot be done on account of the V belts. Is this a fact?—TG Goedhart

A —

I can understand you wanting to continue to use this beautiful machine.

The easiest way is to use it to charge some batteries, then use the energy via an inverter to run some 240 volt equipment in the house. The cheapest way to do this is with off-the-shelf components; 3 x 12 volt batteries (300 amp-hour should be okay), a 36 volt charge controller (a Plasmatronics PL 40 should do) and an inverter set up to run on 36 volts (Latronics should be able to supply you one).

My only concern is that the output voltage on the generator might be too low to fully charge the batteries. Consult a generator specialist who knows something about the unit and they should be able to advise you if this will be suitable.

You will have to keep the 240 V circuit separate from the rest of the house's mains wiring so there is no chance of the generator feeding into the grid or vice versa. This can be as simple as some separate power points. When you want to run off the generator system you can simply swap power points. A local electrician could wire them in for you. You could connect the inverter to some of the house's existing wiring and use an AC transfer switch to switch between the two sources; these are available in manual and automatic models. You just need to make sure that you only use the inverter to power circuits that won't overload it.

You could find a local solar specialist who works on stand-alone power supplies and get them to help you with the setup. You need to have appropriate fuses, battery housing and other elements to keep it safe. The Clean Energy Council can advise you of a local specialist, ph: (03) 9929 4100 or go to www.solaraccreditation.com.au.

You could try converting the generator set by changing the alternator to 240 volt. This may be cheaper to do but could be more complicated as you would also have to change the power regulation circuitry. I would discuss this with a generator specialist.

There is a lot of DIY information online these days. If you don't have a computer at home you could ask for help from a friend or use the local library.—Michael Harris

Write to us

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.

Send questions to: *ReNew*, Level 1, 39 Little Collins St, Melbourne VIC 3000, or renew@ata.org.au

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Recycle it!
Building a workbench

All avid DIYers need a good workbench, but they can be expensive to buy. Julian Edgar describes how he built a heavy duty workbench from scrap steel and timber.

IF you do any work with your hands, having a solid, strong workbench will make your life vastly easier. You can mount a vice on your bench; you can hammer on it; you can lay out materials out on it. If you currently chase stuff around on the floor or work on a rickety table, you don't know just how easy it can all be!

A cheap and very solid bench can be constructed from recycled materials—and that's just what I did. Note that to build a similar bench to mine you'll need access to a welder (or be prepared to drill lots of holes and use bolts) and you'll also find it easier to build if you have a friction cut-off saw.

But before I get into how to build it, what design features should your bench have?

↑ A fantastic heavy duty workbench can be built for under $100 if you use recycled materials.

Workbench design

HEIGHT

Picking the correct bench height is vital. That's especially the case if you'll be mounting a vice on it. The top of the vice should be near to the height of your bent elbow when you're standing upright. That's because when you place an item in the vice and file or cut it, you'll have greatest control if the item is at that height. So when setting bench height, start off with the largest vice you'll be using and work downwards from there.

WEIGHT

A bench should be as heavy as possible. A well-built bench will be weighty as a matter of course (more on construction in a moment) but having the bench really heavy is something to aim for in itself. Why? A major reason is that when using a vice, you want it to behave as if it's part of planet Earth! Pushing and pulling on the bench shouldn't move it at all.

STRENGTH

All benches should be built super strong. There are three reasons for this.

Firstly—and most simply—you might want to put something pretty heavy on it. That could be a car part, a pot plant or a heavy power tool such as a bench-mounted sander. Any well-built bench should tolerate having 300 kg or so plonked on top.

Secondly, you don't want the benchtop to deflect when you're hammering something on it. Whether you mount a small anvil on the bench, you're hammering an item in the vice or you simply want to centre-punch something sitting on the bench surface—in all cases, the less the bench deflects, the better.

Finally, a strong and well-built bench will be exceptionally durable. A good bench will literally last you the rest of your days.

My approach

The workbench described in this story is extremely strong and yet costs very little. I chose to build one that is long and narrow (2400 x 570 x 900 mm high), but the shape can be whatever suits the available space and the purpose. The design uses a steel frame and timber top.

A good steel-framed bench uses an amazing quantity of steel: the bench constructed in this story used something like 16 linear metres! Pay even ten dollars a metre for the material and

← These old pallet racking beams were cut and welded together to build the bench frame. Pallet racking beams in odd sizes and lengths are available very cheaply—these cost around $50.

the frame alone has cost you $160.

The trick is to find steel that no one wants, and one source is pallet racking. The beams used in pallet racking are available second-hand very cheaply. That's especially the case if they comprise odd collections of different cross-sectional sizes and lengths.

The pallet racking beams used here were left over after I bought a heap of second-hand beams for racking in my home workshop. The lot of 50 second-hand beams cost $200, and I had used 36 of these in the shed racking. Of the 14 remaining beams, 11 were chopped up to build the bench shown here. That means the steel for the bench cost just $44. The size of pallet beam predominantly used in the bench had a cross-section 120 x 52 mm.

This being the fourth workbench I have made over 25 years (with, incidentally, all still in operation), I think the best top for a workbench is thick timber with a thin layer of masonite (compressed high-density fibreboard) placed on top. This gives the bench:

- a very strong surface
- a 'dead' surface that will absorb the blows of something being hammered on it without springing back
- a strong mounting surface for vices, bench power tools, etc
- an easily maintained and resilient surface.

The cheapest way of finding thick timber is to look at a salvage yard—or better still, a building demolition site. Roof rafters or flooring supports from older houses are thick, strong—and often hardwood.

In my case, I had a bunch of timber left over from a shed demolition, and some 40 mm thick hardwood I'd previously bought from a timber mill. I'd guess that sourcing the timber afresh would have cost me about $40.

Building

The first step is to construct the steel frame, working upside-down—that is, build the frame that underpins the benchtop before the legs and the lower shelf.

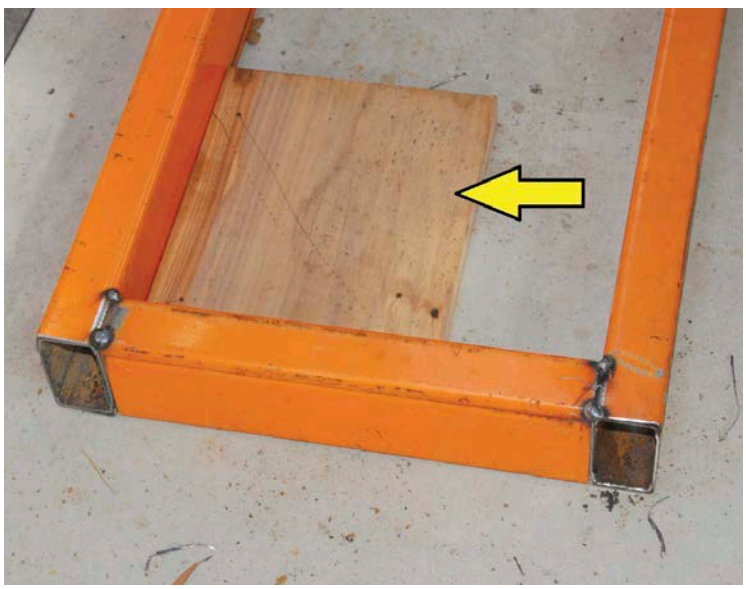
I used a friction cut-off saw to cut the pallet racking beams to size. This could also have been done with a hacksaw (a nightmare) or using a cutting disc in an angle grinder (still very time consuming).

Arrange the beams that will form the benchtop support in a rectangle on the floor and tack them into place with the welder. Check for squareness of the beams and then fully weld them together.

Next, add the legs and weld the rails into place to provide a strong shelf support and stiffen the structure. The shelf should be placed as low as possible to allow the storage of heavy items. This is effective in stabilising the bench without it needing to be bolted to a concrete floor. I used many cross-pieces between the rails to give the shelf a lot of support.

After the frame is completed, give it a coat of paint. To do a proper job you should use a metal primer and an anti-rust final coating. However, the bill for these paints can blow the cost of the project out of the water!

An alternative, which is still fine if the bench is not going to be out in the weather, is to use a general-purpose, self-priming exterior paint. If you're not worried about colour, cans of discarded paint of this sort can be picked up at very low cost from the shops associated



↑ The rectangular frame that underpins the benchtop was built first. Here it has been tack-welded and the shape is being checked for 'square' using the arrowed piece of board.

↑ The welded and painted frame. Note the number of cross-pieces used to give the lower shelf lots of support. You want to be able to place heavy items here to stabilise the bench.

with some rubbish tips. Note that if the pallet racking beams are powder-coated (rather than painted), the surface should be heavily scuffed with sandpaper to allow the paint to key into the surface. My paint came from a discarded tin at a country rubbish tip and so cost me nothing.

Options for the benchtop

The next step is to mount the timber top. A few different approaches can be taken. Simplest is to use building adhesive to glue the pieces of timber to the metal frame. This can work very well, but if the bench is going to cop a lot of hammering or pulling, it's better to drill countersunk holes and use bolts or self-tapping screws to firmly attach the timber to the frame. Place adhesive between the planks so the top becomes a homogenous mass.

If the planks form an uneven top surface, you can run an electric plane or sander over them. If you don't have either of those, you can use a hand plane or, as a last resort, a hand saw used at an angle of about 5 degrees, thus 'rasping' the surface rather than cutting it.

With the timber flat, place a layer of 5 mm masonite over the top. Unless you're really lucky in finding something being discarded, this usually needs to be bought new. Masonite works very well—it is replaceable, quite hard (unlike plywood, it can be hammered without easily denting) and gives a smooth top surface. The edges of the benchtop can also be trimmed with masonite or simply painted the same colour as the frame. Attach the masonite with small brads punched beneath the surface, or use flush head screws—either approach makes it easy to replace the masonite when the top layer wears out.

You can then oil the benchtop. I just use any new unwanted engine oil I have around the place (don't try used oil—it may well have nasties in it). The oil should be applied with a brush, left for 15 minutes to sink in, then any surplus wiped off with a cloth. The resulting surface is dry, doesn't show oil stains (!), and can be easily touched up should it be scratched.

The lower shelf surface can then be placed into position. Any composite board can be used; because it is well supported, even relatively thin material won't unduly droop. The board can be glued and/or screwed into place. I used the coated particle board from flat-pack bookshelves that had not survived a house move.

The bench shown here is weighty and strong. With periodic replacement of the masonite top layer, it will last a lifetime. And best of all, it is made largely from recycled materials! ✷

Pallet beams

Pallet racking beams come in two types. Strong beams, of the type used for most of the bench construction shown here, comprise two nested and overlapping sections (see right). The two parts of the beam are held together only by the welded end brackets. This has two important implications:

- When the end brackets are cut off so that the beams can be used in a new project, nothing holds the two parts of the beam together and so they easily come apart.
- If the beams have been stored outside, water can easily penetrate the long seams between the two pieces, allowing rust to form inside the beams.

If the two-part beam is being used in a part of the bench where its end is fully welded, the two parts comprising the beam will again be held together.

However, if one end of the two-part beam is not being connected to anything (for example, it's a bench leg), then a short length of welding bead should be run along the seam to hold the nested sections together, as shown in the middle picture on the right.

Lighter beams use a different type of construction, as seen at right. No special precautions need to be taken in their use.

What a corker!
Even the smallest items can be recycled

One organisation is recycling items that most people wouldn't think could be reused. By Jodie Meehan.

ONE of the many benefits of working in the ATA office is that it is located next to an extremely hip Melbourne wine and tapas bar called Bar Lourhina. A measure of its 'coolness' is the fact most of the wines on its extensive and exotic wine list are in bottles still sealed with corks, not the ubiquitous screw tops we get when buying our inexpensive plonk from the local bottle-o or supermarket. These corks are the reason Peter McConnell regularly visits our office. He collects the corks that Bar Lourhina off-load onto us, the first step to them being recycled.

Peter works part-time with Green Collect, a not-for-profit social enterprise with an environmental focus. They offer a range of innovative environmental and social services, providing opportunities for people who face barriers to employment due to social and economic disadvantage, while at the same time assisting businesses to achieve positive environmental outcomes by promoting recycling and waste minimisation.

After experiencing a health crisis several years ago, Peter was linked in with the Green Collect team and has now been participating in the collection service for 10 years. Apart from Green Collect, Peter is a writer. In 2008 he had his first novel, *A History of the Great War*, published. He has also contributed to various journals and newspapers including the *Bulletin*, *Age* and *Australian*.

But back to the corks. After Peter has deposited them at the Green Collect office, the corks get shipped off to Embleton's in Coburg, Melbourne, to be remade into items including flooring, soundproof wall tiles, auto gaskets, cricket ball innards and, quite aptly, drink coasters! Cork is great for its impact absorption and noise suppression capabilities. Since Green Collect began the cork collection service as a pilot program in 2002, about 2.7 million corks (7.6 tonnes) have been collected and sent to be recycled!

Photo: Green Collect

↑ Peter collects corks and takes them back to the Green Collect depot for recycling.

Green Collect has now expanded its operation to include re-homing unwanted stationery, office equipment and computers, along with stores promoting sustainable products. The collection service also now incorporates e-waste, printer cartridges, batteries, CDs and DVDs.

The priority when sorting items is reuse, remake (upcycle) and then recycle. When upcycling, they save unwanted materials from landfill, giving them another life and then selling these items through their retail outlets and online through Etsy. As an example, A5 journals are made from discarded folders and unused letterhead.

In 2011, 65 tonnes of materials were collected, of which 62 tonnes were diverted from landfill, while employment was created for 33 people. Green collect is a great example of upcycling of both stuff and opportunities. Remember that when the champagne corks are flying this Christmas!

www.greencollect.org.au
www.etsy.com/shop/GreenCollectUpcycled

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