ReNew

Technology for a sustainable future

Inside Issue 120
Energy efficiency on a budget; Seven Star home; Where to for solar incentives; DIY PC upgrades

Heat Pump Buyers Guide

It's warm inside

Efficient electric heating

Tips to save energy—and money

Nearly zero energy homes

Issue 120 July–September 2012
AUD $7.95 NZ $8.95
www.renew.org.au
ISSN 1327-1938

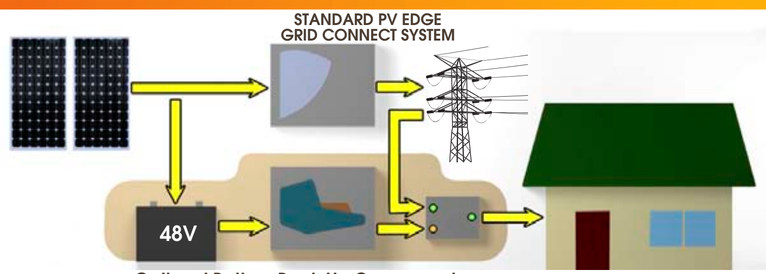
Energy efficiency: from passive solar homes to small changes with a big impact

WIN a washing machine from V-ZUG!

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

NEW MULTIFUNCTION ENERGY METER

With 30 years combined experience in grid connected and battery based inverters, Latronics have a grid connected battery back up solution to keep you up and running. If you own a PV Edge 1200 inverter you're already half way there.



Optional Battery Back Up Components

Bottled Sunshine

Your grid connected solar panels can also work for you during a power failure. Only Latronics PV Edge grid inverters will work with batteries, our transfer switch and our stand alone inverters to form a solar charged battery back up system that provides electricity during power failures. Existing owners of PV Edge 1200 grid connect solar systems can be upgraded to establish their own back up power system. When the grid is online, our battery back up design will export power to the electrical grid as normal.

Modular Design

Our battery back up design is made from modular components: The PV Egde 1200 48V DC grid inverter, our 40A Automatic 2-way Transfer Switch plus any of our 48V stand alone LS inverter models (600W - 7000W). If you only need a grid connect inverter to start with, you would install the PV Edge inverters. Later, you can have our upgrade kit installed, add batteries and establish your own back up power supply to run lights and appliances. If you're after energy security, our all-aussie solution is the most cost effective.

Safety

By using lower DC voltages on the solar array, high voltage arcing hazards on the roof can be eliminated, giving peace of mind to the home owner, emergency services and electrical service personnel.

2ND GENERATION PV EDGE 1200 GRID CONNECT INVERTER

AUSTRALIAN MADE

CALL 1300 550 204
www.latronics.com.au

LATRONICS® A NEW WORLD POWER

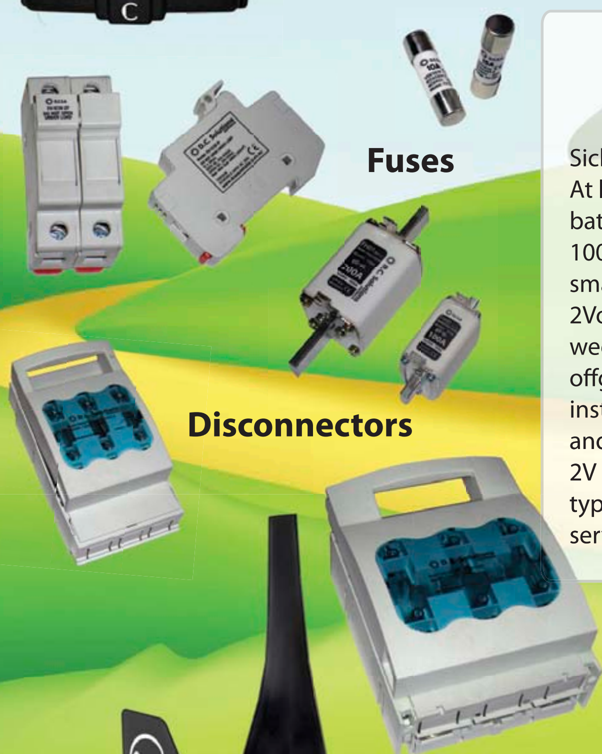
WHOLESALE ENQUIRIES WELCOME

The Classic MPPT charge controller from Midnite.

MidNite SOLAR, inc

The Classic is the world's most versatile and feature packed MPPT available giving you the best value for money available today.
Substantially manufactured in the USA. All quality control and programming is kept in-house.

Backed up locally with a five year warranty by an Australian company with in-house service expertise. And because a Classic should exist forever, the internal software is always free and infinitely upgradeable via the standard USB port too, making sure you always have the latest features as they become available at no extra cost.



Fuses

Disconnectors

PowEx®
The Power Experts

Sick of batteries that leave you up the creek? At last high quality deep-cycle AGM and GEL batteries at reasonable prices. Small 12Volt 100-120Ah models are ideal for Caravans, and small scale solar applications and the larger 2Volt (600Ah and up) are ideal for weekenders, houseboats up to offgrid homes and commercial installations requiring high capacity and long life energy storage. All of the 2V GEL range feature a proven OPZV-type tubular plate design for a 10+ year service life at prices that make most wet cells extinct.

Generate more power at low wind speeds

Chinook Turbines
Small Wind Specialist

Chinook 200 - Only $1249 for a high reliability micro-turbine that is a drop-in replacement for a lot of common machines. Made in the USA and totally serviceable. TIG welded alloy body (not plastic!). Only two moving parts, sealed bearings, proprietary 3-phase axial generator utilising Neodymium Iron Boron technology. Quiet operation and low TSR rotor give excellent performance at truly low (and realistic) wind speeds. Suitable for land based and freshwater marine applications. Available in 12V and 24V models. Price includes plug-and-play DL300 load dump controller.

D.C. Solutions® AUSTRALIA

D.C. Solutions Australia Pty. Ltd.
166 Christmas Street, Fairfield, VIC, 3078, Australia.
Tel: (03) 9482 2203 Fax: (03) 9482 7711
Website: www.dcsaustralia.com.au Email: info@dcsaustralia.com.au

Off-Grid Solar Packages

Take the hassle out of designing your off-grid system with our expert designed systems

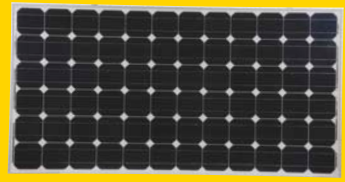
Remote Getaway
3kWh/Day System

3 days of battery autonomy
1500W inverter power
35A of battery charging
1050W solar array

From $10,790

MP-9005

1x 45A SunStar Solar Controller



6x 24V 175W Powertech Solar Panel

1x 24V 1500W Invertek SuperCombi

2x 12V 600Ah Powerstack Battery Bank

Each system also includes battery temperature sensor, necessary CombiNet data leads, solar panel joiners and connectors, solar cabling and solar connector crimping tool. Battery DC cabling and fuse protection are not included, but recommendations are available from our power experts. Solar mounting hardware is also not included, we recommend the Ecotech Solar Mounting System.

Remote Eco-Living
5kWh/Day System

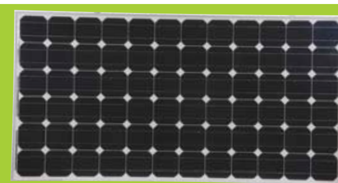
4 days of battery autonomy
3000W inverter power
70A of battery charging
1575W solar array

From $17,790

MP-9007

Each system also includes

1x 60A SunStar Solar Controller



9x 24V 175W Powertech Solar Panel

1x 24V 3000W Invertek SuperCombi

2x 12V 1350Ah Powerstack Battery Bank

Each system also includes battery temperature sensor, necessary CombiNet data leads, solar panel joiners and connectors, solar cabling and solar connector crimping tool. Battery DC cabling and fuse protection are not included, but recommendations are available from our power experts. Solar mounting hardware is also not included, we recommend the Ecotech Solar Mounting System.

Remote Luxury
10kWh/Day System

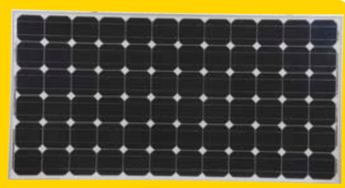
4 days of battery autonomy
6000W inverter power
140A of battery charging
3150W solar array

From $32,590

MP-9009

Each system also includes

2x 60A SunStar Solar Controller



18x 24V 175W Powertech Solar Panel

2x 24V 3000W Invertek SuperCombi

4x 12V 1350Ah Powerstack Battery Bank

Each system also includes battery temperature sensor, necessary CombiNet data leads, solar panel joiners and connectors, solar cabling and solar connector crimping tool. Battery DC cabling and fuse protection are not included, but recommendations are available from our power experts. Solar mounting hardware is also not included, we recommend the Ecotech Solar Mounting System.

Learn more

Download information brochure, comparison tables, techpapers, guides and much more at
www.jaycar.com.au/powertech

Customised Systems

Contact our CEC Accredited experts to help design your perfect customised system
Email. powertech@jaycar.com.au

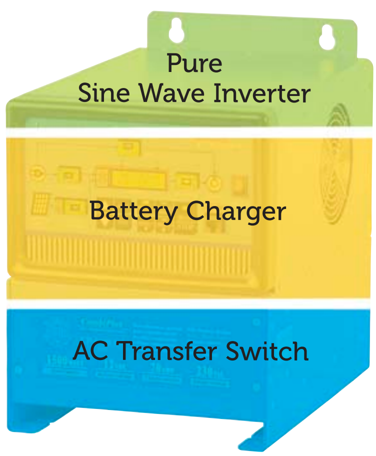
Want more info? Have a burning question to ask? www.jaycar.com.au/powertech

Off-Grid Power For Your Property

Combi Series Inverter-Chargers for Off Grid Power

At Jaycar Electronics, we've been selling inverters for over 20 years and we've never found anything as robust, reliable and as well featured as the Rich Electric combi series interactive inverter-chargers.

- A pure sine wave inverter, battery charger and auto transfer switch all in one!
- Huge power output, rated at 70°C with NO DE-RATING, giving over 40% more power than other equivalent brands!*
- Stack multiple units to increase power or to supply 2/3-phase power
- Auto start a generator** on heavy loads, low battery, etc
- Can combine inverter power and generator power to boost total output power
- Designed in Australia for harsh Aussie conditions
- Clean Energy Council approved (off-grid inverters)



3-in-1 Functionality

* Compared to other equivalent units rated at 25°C in typical operating conditions

** Requires generator with compatible remote electric start

Get the Complete Solution:

- Deep cycle battery banks
- CEC approved Solar panels
- Code compliant solar mounting hardware
- Much, much more!

www.jaycar.com.au/powertech

Email: powertech@jaycar.com.au

CEC Accredited experts

Jaycar Electronics

Better, More Technical

www.jaycar.com.au

Free call orders 1800 022 888

Over 65 stores and 150 stockists nation wide
See our website for your local store or stockist
Prices valid till 31/08/2012

Contents

Issue 120, July – September 2012

Read more articles at renew.org.au
Follow us on Twitter: twitter.com/ReNewMagazine
Like us on Facebook: facebook.com/ReNewMag

Features

18
Opinion: Is wood good?
David Coote responds to the question of wood heater emissions.

28
Policy: Is the solar multiplier still needed?
It's time for the federal government to reduce the upfront incentive for solar PV systems. But is this a good or bad thing? Damien Moyse investigates.

54
Introducing the LEAF program
Up to 50 West Gippsland businesses could be flying the sustainability flag by year's end, writes Maggie Riddington.

56
Sustainability ratings to transform infrastructure
A new ratings tool is set to provide a clear assessment of the sustainability of Australian infrastructure projects.

67
Are electric vehicles really so great?
Does it really make a difference to your emissions if you buy an EV but run it on fossil-fuel-generated electricity? Bryce Gaton investigates.

70
The meter box equation
There's more going on in your meter box than meets the eye. Richard Keech examines the energy measurements associated with domestic PV systems.

72
DIY: Don't junk it, upgrade it
Lance Turner explains how to make that old PC run like new.

78
DIY: Turning fridges into worm farms
A fresh look at materials reuse to create worm farms from municipal tip waste. By Tim Frodsham.

82
DIY: Home electroflocculation
Terry Tranter describes how to electroflocculate your water until it's clean.

↑ Passive solar design in the Sunshine Coast hinterland. Page 46.

↑ Quick tips for saving energy: the ATA's new guide. Page 30.

↑ Do electric vehicles really reduce emissions? Page 67.

Cover image by Lindsay Edwards Photography. Tim Adams designed the roof of his house to maximise the effectiveness of solar PV. Page 34

Special feature: energy efficiency

26
Putting a price on carbon: some facts about the carbon tax
The carbon price could make households and businesses better off if they take a few important steps. By Alan Pears.

30
Reduce your energy use and save money
The ATA is publishing a free guide to energy efficiency on a budget. Get a preview here.

34
The house with no bills
Careful design has minimised the building and running costs of this rural Victorian house. By Tim Adams.

36
Family room upgrade
An energy-efficient renovation of this family's living room is paying off, reports Danielle King.

40
Reducing emissions with a boatie's lifestyle
Living on a boat instead of a 40-square house can greatly reduce your environmental footprint. By Geoff Chia.

44
PassivHaus school in Upper Austria
Energy use has been slashed by ninety per cent at this school, thanks to energy efficiency. By David Coote.

46
The power of integrated design
Even a difficult block didn't stop Mike Stasse from building this net zero energy home.

50
Eco lodge opts for micro-hydro
With plenty of water and not enough sun, Forest Walks Lodge installed a micro-hydro system. Rosemary Norwood describes the process and the benefits.

Efficient electric heating is now a reality with heat pumps. Page 60.

Buyers guide

60
Heat pump buyers guide
Not all electric heating systems are the same. Lance Turner examines why heat pumps come out on top.

Regulars

06 About ATA

08 Editorial

10 Up front

14 WIN! *ReNew* subscriber prize

16 Letters

20 Products

84 Pears report

86 Browser

87 Book review

88 Q&A

90 Shop with the ATA

91 COMP! DIY video competition

92 Classifieds

94 Salvage It!

About
ReNew and the Alternative Technology Association

ReNew magazine

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

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

Sanctuary magazine

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

ATA branches

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

Webinars

With the support of bank**mecu**, the ATA has recently run a series of free online webinars to share practical knowledge about sustainable living. The webinar recordings are available for playback on demand via the ATA website: www.ata.org.au

Alternative Technology Association

The Alternative Technology Association (ATA) 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 the government, industry and community sectors.
www.ata.org.au/projects-and-advocacy

International Projects

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

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

For more information and to make a donation to give the gift of light in East Timor, go to www.ata.org.au/ipg

Publisher: ATA
Editors: Jacinta Cleary, Robyn Deed
Technical editor: Lance Turner
Advertising manager: Katy Daily
Proofreader: Stephen Whately
Editorial and production assistance: Anna Cumming, Donna Luckman, Laura McLeod, Hannah Reekie, Sarah Robertson
Design templates: SouthSouthWest
www.southsouthwest.com.au

Contacts and contributions

Send letters and contributions to:

ReNew
Level 1, 39 Little Collins St
Melbourne VIC 3000

Ph. (03) 9639 1500; F. (03) 9639 5814
renew@ata.org.au
www.renew.org.au

Contributions are welcome; guidelines available at www.renew.org.au or on request. Next editorial copy deadline: 20 July 2012.

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.

Next advertising deadlines:
Booking: 20 July 2012
Advertising copy: 3 August 2012

Printed by Ego Printing using best practice ISO 14001 Environmental Management System and FSC certified stock. Distributed in Australia and New Zealand by Gordon and Gotch and overseas by Pansing IMM.

$7.95 (Aus) $8.15 (NZ) Recommended Retail Price

Registered for posting by Aust Post: No VBG 4172

ISSN 1327-1938

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


Shine baby shine!
»Forget about oil. Solar electricity is the energy of the 21st century.*«
Shine baby shine!
www.tuv.com
TÜVRheinland®
ID: 0000022848
Power controlled
Larry Hagman, also known as the oil tycoon from the TV series "Dallas", always had an intuition for profitable businesses. Now he focuses on clean energy made from the sun and sand, and on solar electricity systems from SolarWorld. High performance, German technology. Find out more about our smart solar solutions at www.solarworld.sg
Contact us for your local SolarWorld installer
service@solarworld.sg
SOLARWORLD
We turn sunlight into power.
* On his farm in Ojai, California, Larry Hagman established the largest residential solar power system of the Unites States.

Editorial

Small changes, big impact

I FEEL a fraud putting my picture up for this issue of *ReNew*. Having come in at the end, my job has been simply to get this production out the door, while Jacinta gets on with her own production, a baby, due the day I write this. The others in the process also deserve their photos up—Lance, our technical editor, who seriously knows everything about the technologies we feature and Anna, our projects manager, who, in between facilitating webinars, finessed every page. This issue also had a slew of other helpers, including our wordsmith, Stephen, who proofread the whole thing, and our interns, Hannah and Laura, who contributed their writing and editing skills to several articles.

Energy efficiency

The focus this issue is on energy efficiency. With the carbon tax due to hit the streets on 1 July, it's a good chance to take a closer look at the small things than can make a big difference to our energy consumption—and so further reduce carbon emissions.

In true *ReNew* style, we look at this from every angle—from nearly zero energy designs, to small-scale retrofits, to behavioural and technology choices that can save you money, as well as saving on energy. We even look at eco-living on a catamaran in the Brisbane River. Our buyers guide is on energy-efficient electric heating—this might once have been considered a contradiction in terms, but is now a reality with super-efficient heat pumps, or reverse-cycle air conditioners as they're more commonly known.

We also look in detail at a whole range of things that fit loosely into our theme. Damien Moyse, our energy policy expert, asks whether the solar multiplier is still needed—and what about feed-in tariffs? Our regular columns are all here: Julian Edgar salvages a VCR and printer parts to use in a highly efficient bike dynamo, and Alan Pears is so good that we put him in twice. We've got a PassivHaus school, a micro-hydro system, a DIY worm farm, a process for cleaning bore water (providing a new word for our style guide: electroflocculation)—and more. I hope you enjoy reading this diverse, inspiring and practical set of articles, and I look forward to hearing your thoughts—and to being less of a fraud next issue!

Robyn Deed
ReNew Editor

HELLO and welcome, readers, to issue 120 of *ReNew: Technology for a sustainable future*. *ReNew* has been brought to you for over 30 years by the Alternative Technology Association (ATA), an independent, not-for-profit organisation which exists to connect, inspire and assist people to make sustainable choices in their homes and communities.

With *ReNew 120* we welcome Robyn Deed, who has been appointed as managing editor, working with technical editor Lance Turner, while Jacinta Cleary is on maternity leave. I've been very impressed with Robyn, and her strong publishing and editing background will be a great asset to *ReNew* and to the ATA's publications team—who also produce ATA's *Sanctuary: modern green homes*.

One of Jacinta and the team's most recent initiatives has been the refresh of the look and feel of *ReNew* which was unveiled in the last issue. The response from readers and stakeholders has been overwhelmingly positive, and we hope you continue to enjoy *ReNew*'s fresh new look.

A major focus for us at the ATA and a focus in *ReNew 120* is, of course, the emergence of the carbon price on 1 July. ATA has strongly supported the need for a price on pollution over many years, and we have welcomed the move to put in place a carbon price.

ReNew readers know that energy efficiency and sustainable energy solutions such as PV will reduce the impact of the price on their energy bills. At the end of the day, sustainability begins in the home, as *ReNew* and our readers have consistently demonstrated. Energy efficiency is a theme in this issue, with a focus on our new guide to reducing energy use, another gorgeous 7 Star home, and more.

Happy reading.
Ian Porter
CEO, ATA

The Hustler ZEON™ is the first electric zero-turn introduced to the green industry.

- Up to 80 minutes of mowing time – enough to mow over 1 acre!
- Clean and neat, no fluids, no filters, no plugs, no belts and no fumes.
- No engine noise. Much quieter than petrol-powered equipment.
- Earth friendly, zero emissions.
- Nearly zero maintenance.
- Clean quiet, and simple.
- Perfect for mowing hospital grounds.
- Help lower your carbon footprint with the efficient ZEON™.
- Green Friendly.

HUSTLER®

1300 363 027

www.poweruplawncare.com.au

Up front

The Volt finally coming to Oz

The Chevrolet Volt is quite an impressive electric vehicle. While having a rated range of a modest 80km on electric power only, it is the only EV currently available with built-in range extension via a high efficiency petrol engine, which effectively eliminates the biggest perceived problem for potential electric car buyers—range anxiety, or 'running out of juice'.

It's been available in the USA for some time, but Australia has yet to see the Volt on our roads. That is set to change later this year when the first Volts arrive for sale to the general public.

Sales of the Volt in the USA have been rather lacklustre, seemingly due to the high purchase price—a definite problem in a country known for its low car prices. The same problem may well be prevalent here, with the price expected to be in excess of $60,000.

But it's early days yet for the EV industry, and the public are yet to understand the advantages of EVs in general, and range-extended EVs like the Volt in particular. Education is the key to moving cars away from petroleum-only energy sources. If the average comment on the many car forums is anything to go by, EV manufacturers have got their work cut out for them, as it seems the public understand very little about EVs or range-extended vehicles.
www.holden.com.au

Clean Energy Week

Clean Energy Week is Australia's largest event for the renewable energy and energy efficiency industries. It incorporates Australia's largest solar event, ATRAA, a trade exhibition, schools program and events for the general public.

Clean Energy Week, which will be held in Sydney this year from 25 to 27 July 2012 (so it's really only three days), is hosted by the Clean Energy Council, Australia's peak industry body. The focus this year is "achieving 20 per cent by 2020". The week will feature the latest on policy initiatives and technology developments, and will provide industry members with plenty of networking opportunities. Attendance fees are $1700 plus GST for CEC members or $1900 for non-members.
www.cleanenergyweek.com.au

It's getting hotter

New research in the *Journal of Climate* shows that the past 60 years in Australia have been the warmest in the past 1000. Lead researcher Dr Joelle Gergis of the University of Melbourne says: "Our study revealed that recent warming in a 1000 year context is highly unusual and cannot be explained by natural factors alone, suggesting a strong influence of human-caused climate change in the Australasian region."

The study's conclusion comes after examining 27 different natural climate records, such as tree rings, coral and ice cores, and processing them 3000 different ways "to ensure that the results were robust."

In approximately the past century, temperatures in Australia have increased 0.75°C, with each decade since 1950 becoming warmer than the previous one.

Carbonxchange project

'Slash and burn' agricultural techniques have led to widespread deforestation and soil erosion in East Timor.

A new agricultural sustainability initiative called Carbonxchange aims to rectify the damage by supporting farmers in remote communities and assisting them to become effectively self-sufficient in the cultivation of their land.

The Carbonxchange program also aims to help build resilient and productive communities in places that may not otherwise have the resources to improve. Carbonxchange does this through awareness schemes which encourage Australians and Australian businesses to offset their carbon emissions by donating to the funds that provide key materials to these remote communities.

Carbonxchange projects focus on the benefits of agroforestry—the practice of integrating crops and trees and/or livestock in the same space. This practice improves soil quality and can increase groundwater stores. It provides a strong base to build successful subsistence farming that will provide for a community into the future.

The primary project is the Bagina Community Tree Trust, which funds a schools-based propagation nursery supplying plants to farmers. Farmers then plant the trees (mahogany, teak and sandalwood varieties) amongst crops and where livestock sometimes graze. The farmers, many of whom are women and children, are given an annual fee for the upkeep of their trees. Trees are mapped and monitored to audit their influence on their local landscape.

The germination, upkeep and auditing of the trees is supported by the Carbonxchange Tree Trust Fund which is funded by the Carbon Emissions Scheme. The Emissions Scheme collects support and donations from the school and business sectors and from the government as part of its bid to inspire people to reduce their carbon footprint.
www.carbonxchange.net.au

EV charging stations popping up

With more electric vehicles entering the Australian market there is a need for public charging points. ChargePoint has created a publicly available network of over 30 EV charging points that can handle any EV currently or soon to be on the Australian market.

At the moment, charging is free, although this may change in the future. Some stations require that you book in advance. Charging points can be accessed either using a ChargePass RFID card or by calling the number on each ChargePoint station.
www.chargepoint.com.au

Congratulations to another winner

ReNew subscriber Jeffrey Miller was the lucky winner of the ATA/SCHOTT Solar competition. Jeffrey kindly donated his prize to his parents Jan and John (that's Jan pictured here) to say thank you for all the support they have given him over the years.

The original prize was a 1.5kW system but SCHOTT Solar upgraded the system to 3kW, as the location demanded a bigger system suitable for the warm Queensland climate and potential shading issues. SCHOTT supplied a system that incorporated amorphous thin-film ASI 100Wp PV modules to capitalise on the generous roof space available. They have a better temperature coefficient and are more shade-tolerant than crystalline panels, which makes them highly suitable to hotter climates like Queensland. For more information, go to www.schottsolar.com.

More chances to win!

For all of those who entered and didn't win, don't worry, ATA has two new competitions! For a chance to win ATA's new major prize, a washing machine from V-Zug, see page 14. If you fancy yourself a bit of a Steven Spielberg, or just want to share your attempts at living a more sustainable lifestyle, check out our video competition on page 91.

And solar ones too

If you want to charge your EV with clean energy then you might want to head to the new solar-powered EV charging point at CERES environment park in Lee St, East Brunswick, Victoria.

The level 2 station (which can supply up to 7.2kW to a suitably capable EV) is fitted with a 2.7kW grid-interactive photovoltaic array on the station's roof, which offsets some of the electricity used by charging EVs. The array was donated by Q.CELLS Australia and the inverter by Delta Energy Systems. The filling system is a standard ChargePoint unit. EV drivers will be able to locate and navigate themselves to the station with an iPhone or Android app.

The project has been realised through a Green Precincts Grant from the Federal Department of Sustainability and is a collaboration between the Victorian Department of Transport, Delta Energy Systems and Q.CELLS Australia.

Other renewably powered ChargePoint stations include a level 1 station powered with a solar shade in Queensland and a solar PV and ceramic fuel cell powered level 1 unit in Adelaide.
www.ceres.org.au/greentech/solarcharging

Up front

Gujarat Solar Park switched on

On the 19th of April 2012, the world's largest solar energy producing park was switched on. With phase one having a capacity of 214MW of photovoltaic panels, the Gujarat Solar Park, in the northern state of India, became Asia's largest solar PV power plant, beating China's 200MW Golmud Solar Park. When phases two and three of the park are completed, total generating capacity will be 500MW.

The project was made possible with investment from 21 different companies, including several key investors from the USA. Together they have helped to contribute to India's long-term goal of increasing overall energy use that comes from renewable energy sources from 6% to 15% by 2020.

Although the Gujarat Solar Park will have a final cost of 105 billion Indian rupees ($US2.3 billion), a further $400 million is being reserved for the increasing of this region's solar power production capacity, which includes funding for residential support in terms of household solar power production.

In total, it covers approximately 1200 hectares of land which borders the Rann of Kutch (salt marshes found in eastern India). The land on which the solar farm is built is sparse, desert land which would be scarcely of use for anything else (such as farming, comfortably living or raising livestock). The Gujarat land is exposed to abundant strong sunlight, making it ideal for India's leading solar energy park.

While the activation of the Gujarat Solar Park means big things for global solar energy production, there is talk of an even bigger plant soon to be under way in Tunisia. Known as the TuNur scheme, it will involve a 2000MW (2GW) concentrated solar power (CSP) plant to be operational by 2016.

Photo: Ajit Solanki

↑ Part of the Gujarat Solar Park, India.

However, amid all this exciting talk of solar energy projects and production from our neighbouring and not-so neighbouring countries, Australia's solar energy schemes seem to be significantly dormant. Australia is absent from the list of leading solar energy producers and seems to be falling behind with innovative solar energy projects.

Yet, much of our landscape in central and western states reflects the kind of land that the Gujarat scheme has been built on. It is strange that in a country traditionally famous for its sunshine, our deserts—where the Australian sun is harshest—aren't being used for solar energy parks.

The extent of India's solar energy dedication is inspiring, and bodes well for the future of renewable energy plant construction. The Gujarat park makes Australia's solar energy efforts seem unevolved to say the least. www.gujaratsolarpark.com

28MW in just seven weeks

While the Indians are doing it on a large scale, the Germans are doing it fast.

The 28MW solar park in Amsdorf, central Germany, was built on 55 hectares of former opencast mines and slag heaps, and took less than seven weeks to finish from the time construction commenced, with energy first being generated on 20 April 2012.

The €50 million solar park, owned by GERO Solarpark GmbH, was planned and developed by joint partners Getec Green Energy AG and the Romonta Group, with Q.CELLS as the system integrator.

The park is the latest in a series of multi-megawatt solar parks installed by Q.CELLS, which has now installed over 548 megawatts of photovoltaics in numerous solar parks. www.q-cells.com

And Australia's largest

Sadly, even this relatively modest plant dwarfs anything existing in Australia, the largest being the currently under construction 80-hectare Greenough River Solar Farm near Geraldton in Western Australia. When completed, this $50 million farm will have a capacity of 10MW, making it by far the largest PV installation in Australia. It will consist of more than 150,000 thin film PV modules from First Solar.
www.greenoughsolarfarm.com.au

Letters

Wind farms not for everyone

I am writing to express my disappointment at Alicia Webb's article regarding wind farms in *ReNew 118*. She has presented a very single-sided argument with no thought for those who actually have to live with the proposed turbines, those whom the government's legislation is there to protect. The Mount Alexander Sustainability Group (MASG) is indeed petitioning to install a wind farm near Castlemaine: very close to my family's sheep farm in Sutton Grange, to be precise.

While MASG claim wide-ranging support for the farm, this support is from the residents in Castlemaine and Bendigo, 20 to 30km from the actual site. The community of Sutton Grange is almost unanimously against the development, which they were not consulted about (despite assertions from MASG to the contrary). They were relieved when the government prohibited the development of wind farms between the Calder and the Hume Highways: they felt that the government was working to protect them and their families.

Webb, having attended the Senate inquiry into wind farms, knows better than most how genuine and well-founded communities' concerns are regarding wind farms, when they are the ones who have to live below them.

It is very easy for MASG and others like them to say "we must have wind farms". But when a vocal few can force their ideals and demand unwanted development on other people's land, where it will not impact themselves at all, then that is a sad day indeed.

Ania Hampton

Interval meter malfunction

In 2008 we installed a 4.32kW solar system feeding through an AMPY EM1200 interval meter. It displays cumulative readings for power used from and contributed to the grid, updated in 15-minute cycles. The retailer prepares bills on the basis of those cumulative readings.

As we had had some billing issues with our retailer, AGL, I have recorded the readings each night since 21/09/2009. There have been two anomalous readings over that time.

On 30/09/2011 the consumption figure was 9491kWh. The next night it had jumped to 9701kWh. Our daily grid use at the time averaged 9kWh. It seems likely that the reading on 1/10/2011 should have been 9501, not 9701.

On 18/02/2012 the figure for solar power contributed to the grid was 5495kWh. The next day it had dropped to 5102kWh. Our daily solar contribution to the grid averaged 8kWh at that time. It is probable that the reading on 19/02/2012 should have been 5502, not 5102.

The two anomalous readings have occurred at the end of a 100kWh cycle each time.

The meter has been tested by the utility company, Jemena, on each occasion (at no cost to me) and they reported that it was working correctly.

AGL has adjusted the account for the first period. I have raised the second anomaly with them and am waiting to see what they do. A loss of 400kWh at our 68c pFiT amounts to $272.

In a vigorous discussion, AGL suggested that it could be attributable to our wiring, or an appliance in our home, such as a hot water service booster cutting in. We have a gas-backed solar hot water service.

I have contacted the installer of our solar system and the manufacturer of the meter but so far have not identified what is causing the malfunctions.

In the meantime readers may feel that it would be prudent to record the readings from their meters periodically as a check on their suppliers.

Malcolm Walter

Rule changes

In regard to Patrick Blackwell's letter in *ReNew 119*, where he wanted to connect both wind turbine and solar panels to one inverter to feed into a battery/grid system, I did this, but with 3.6kW of panels and a 2kW turbine.

It was an excellent setup and after running three months legally, the rules were changed such that only one generator, either panels or turbine but not both, could be used.

Patrick needs to do his homework to avoid a costly fine or disconnection—unless the law has changed again, which I'd be keen to know about. I lost $13,500 setting up my turbine and now want to sell it and move on after being gutted.

I tackled the laws without a class action—it was hopeless. So, instead I installed a standalone system to supplement the house to cut 70% off our power bill. The 3.6kW system is our cash cow.

Arthur Zaicos

Underground school

The earth-covered library story in *ReNew 119* has the potential to mislead readers who may intend to build a similar structure for accommodation purposes.

The impression is that an earth-covered roof is required for a bushfire resistant building. However, modern corrugated-iron roofing, with high temperature-rated mineral fibre insulation, is just as capable of stopping embers or radiant heat from igniting the building below. Houses lost to wildfire fail due to ignition at the weakest points, which are windows, doors and eaves.

Earth covering was my choice for the purpose of aesthetics, although eliminating one or more walls of the building by building into a slope does also reduce the building's potential exposure.

This school library, although looking like a perfect passive solar building, faces south. The article points out the reasons for this were for its additional fire safety and the elimination of glare. Given that the nearest forested area has had its undergrowth removed and the school does not open on total fire ban days, I would have thought, 'problem solved'. Given that not a single beam of winter sunlight will ever

Road versus rail

While I normally agree with Alan Pears's column and admire his ability to distil readable information from government dross, I feel it important to present an alternate perspective to his comments concerning the interaction of road and rail in Melbourne.

Alan's idea that updated automation of boom gates at level crossings could save time for both cars and trains is accurate and important—the improvements on Bell Street some years ago afforded by better gate sequencing were immediate and clear.

His suggestion, however, that crossings encourage rail use by increasing traffic congestion is deeply flawed and exactly the kind of backwards idea that mustn't be spoken aloud near politicians! For a start, any study of human nature will show that punitive measures are ineffective at forcing change. Whether it be the cost of cigarettes, congestion on the roads or capital punishment, human beings will only change behaviour if there is an incentive.

Congestion on roads caused by level crossings does not encourage people to use the trains; it encourages them to leave for work earlier, use back roads or alternate routes. And the fact remains that an extra 15 minutes spent in the privacy and comfort of one's own car is still preferable to being on a train!

Which raises the next point: Australian public transport is overpriced, unreliable and inconvenient. Simply making the proportion of the population that commutes by road angry and frustrated is not going to fix any of these problems! The only way to get car users off the road is to make PT a more attractive option than taking the car; something that will not happen in this decade.

Thus, from an environmental perspective, since it is not practical in the short term to force people out of their cars by failing to reduce congestion, surely it is better to reduce the amount of time spent by cars simply sitting still, idling. With some concerted action to improve the coordination of the traffic-light network and reduce waiting time at level crossings, Melbourne's road fleet would consume less fossil fuel.

Finally, Alan's suggestion that there could be a property levy based on proximity to PT alienates anyone who works where there is no PT access (essentially anywhere that isn't the CBD) or who relies on a vehicle as a tool-of-trade. Perhaps Alan would volunteer to help me take my tools and equipment to a site on PT instead of using the ute?

Unfortunately, while we are hamstrung by the popularity contest that is Australian democracy, there will be no action to resolve this fairly simple issue. Rest assured however, that reducing the efficiency of the road network before providing a useable real-world alternative will only reduce quality of life, not commuter congestion.

Chris Hooley

See Alan Pears's response to this letter in his column on page 84.

enter this building, it therefore needs to be totally artificially heated, leaving the only energy efficient aspects of the building to be the LED lighting and the double glazing. With such a large window area, heat loss would still be a significant factor. Any south facing window is a net heat loss surface, which should be minimised in good energy-efficient design. As far as 'reducing glare' goes, if this building did face north no sunlight would enter in summer, and I can distinctly remember as a child at school seeking out the sunniest part of the room in the cooler months when the sun moved low across the horizon. An educational opportunity lost.

The other issue I have is with its cost. Readers should be aware that this library cost $850,000 for a school with 100 students. Who would consider the option of an earth-covered home at this price? Earth-covered architecture can be very energy efficient, aesthetically pleasing, long lived, and need not be so indulgently expensive.

I know this because I achieved similar for one tenth of the price.

John Hermans

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.

Send letters to: ReNew, Level 1, 39 Little Collins St, Melbourne VIC 3000, Australia or by email: renew@ata.org.au

Heating the eco village
—is wood good?

David Coote responds to the question of wood heater emissions.

THE question about wood heater emissions in an eco village and Lance Turner's reply on page 91 of *ReNew 119* caught my attention. There are a number of interesting issues raised in this exchange which are worth exploring further.

Lance is correct in saying that badly operated simple wood heaters can lead to less than desirable environmental outcomes, and that it's important to use sustainably sourced wood. So let's have a look at how an eco village establishing its renewable energy supply might use wood as a key contributor.

But first let's step back a bit to examine how we might minimise the need for energy in our eco village. No matter how clean the energy source, the less we need of it the less it will cost us to install and operate. Building to the 8 Star or PassivHaus standard will reduce our heating and cooling requirements to a fraction of what would otherwise be required. We should need very little heating in our climate. And if we only use best-of-breed energy efficient appliances in our eco village this will also drastically reduce our need for electricity.

So how can we meet any remaining heat demand? Well-designed simple wood heaters can run cleanly if used correctly. Rather than just condemn them outright, perhaps the solution is education. There are numerous websites on how best to operate them.

People looking to live in an eco village are likely to have a strong community spirit and an interest in minimising their environmental footprint. An intentional community will have guidelines in a number of areas which might be administered by social norming or other techniques. The eco village could list allowable efficient wood heaters and provide a one-pager on how to operate a wood heater effectively.

As Lance says, pellet heaters can achieve better performance than simple wood heaters. The eco village could use pellet and chip heating systems. The case studies listed on UK renewables consultancy Dulas's website (see link at the end of this column) present a number of systems. But this would require a supply of pellets or chips.

Modern European log burners are engineered to achieve efficiencies comparable to pellet systems. They are available in sizes suitable for homes but also for larger heat demands for communities and large buildings. An eco village would be a suitable candidate for an efficient log boiler supplying heat through a small district heating system to each house. The log boiler could store heat in a hot water buffer tank, which could also be topped up from solar thermal collectors. Each building in the village could then have its heating and hot water needs met by an efficient renewable source.

But where could the eco village source fuel wood? Lance raises the issue of taking what ecologists and foresters call coarse woody debris from the forest, as this is a valuable source of habitat. European states allow a fraction of this material to be gathered for energy use while leaving the rest for habitat.

If the eco village didn't want to use any of this material, there are many other opportunities. Potential sources include commercial firewood suppliers, timber-industry processing waste, orchard management, agroforestry and plantation harvest residues, roadside wildfire fuel reduction, firebreaks, local council tree management, senescent fence-line farm trees, and construction and demolition waste.

Perhaps our eco village would like to have its own wood supply. Small woodlots can be designed to supply wood for energy use. But they can be used for a lot more than that. With appropriate design a woodlot can meet multiple objectives including fine timber, habitat, biodiversity, shade, aesthetics, salinity management and erosion control. There are a number of community reforestation projects in England, Scotland, Ireland and even Iceland that are aimed at developing local timber and energy supplies as well as meeting these other important objectives. Using a portion of the trees for commercial purposes through careful harvesting practices provides economic support for the reforestation. We could do the same here.

↑ High efficiency wood boilers such as this Fröling S4 Turbo are a much cleaner option than conventional wood heaters.

David Coote has been involved with renewable energy one way or another for many years. He thinks building a low-carbon economy is a lot more likely if we get on with it.

For the Dulas case studies, see bit.ly/KbNVwO

Products

01

A personal heliostat

Sunflowers naturally track the sun, and now there's a man-made sunflower that not only tracks the sun but reflects it into your home.

There are many reasons you might want to do this—lighting a dark and dingy south-facing room, bringing light to indoor plants or creating a sunspot for your pet.

The Sunflower Home Heliostat from Wikoda Inc in the USA is a fully self-contained stand-alone automatic heliostat for domestic uses. It features six reflective panels that give it the sunflower look, mounted around the central solar-powered sun tracking controller dome.

It is relatively simple to assemble and set up, and once running it will track the sun and maintain the reflection at the same spot on the house, whether that be a window, skylight or even a solar water heater.

The Sunflower has a reflective area of around $0.5m^2$ and can be installed on any pole with a 1¼" NPT female thread. An optional mounting kit is available which includes a PVC pole and mount, but for Australian buyers we recommend you source your pole and mount locally as it will be a lot cheaper!

RRP: US$399. Available directly from the website or check their link to their eBay listings. Shipping is around US$100 to Australia. For more information, contact Wikoda Inc, 52 Bradford Street, Concord, MA 01742, USA, ph: (978) 610 6492, sales@homeheliostat.com, www.homeheliostat.com

02

A tiny PC with real power

We have looked at a lot of miniature, low-power PCs (commonly called nettops) but invariably they all have less processing power and lower specs than larger desktops or even high-end notebooks.

CompuLab, the maker of the tiny fit-PC computers, has recently announced its latest model and it's a great deal more powerful than previous units.

The IntensePC uses the Intel Core i7 processor and includes up to 16GB of DDR3-1333 RAM to provide the performance you would expect from a full-sized desktop machine. Despite this, power consumption at idle is just eight watts.

Other features include the Intel HM65 Express chipset, provision for an internal 2.5" SATA3 6 Gb/s hard disk or SSD, two SATA 2 eSATA ports, mSATA socket, HDMI 1.4 up to 1920x1200 with 3D support, DisplayPort up to 2560x1600, 7.1 channel S/PDIF in/out audio, two Gigabit LAN ports, 802.11b/g/n wifi with 2 antennas, Bluetooth 3.0, two USB3 ports, two USB2 ports and an RS232 serial port. All of this is crammed into a case measuring just 190 x 160 x 40mm.

The unit is powered from any DC source from 8 to 16 volts, making it ideal for mobile and solar applications.

RRP: Starting at US$399. For more information, go to www.intensepc.com

03

Leave the fuel at home

There are lots of camp stoves on the market but most require you to take some form of fuel with you too, such as an LPG cylinder or methylated spirits. Of course, you can burn wood, but wood smoke is a pollutant and can be damaging to the lungs.

The BioLite CampStove is a wood-burning stove that uses a fan to increase airflow and so virtually eliminate smoke. It will happily run from twigs and sticks collected on site. Unlike other designs, the Biolite produces the electricity for its fan itself, by converting some of the heat directly using an inbuilt thermoelectric generator.

One of the great things about this design is that it produces excess electricity—enough to charge mobile devices such as phones, GPS units and similar. You can charge your phone while you cook a meal and, in case of an emergency, you'll have a charged phone!

The BioLite CampStove is not just for camping: it also makes a great backup at home during power failures and natural disasters. It can cook a meal, provide warmth and some light, and keep your gadgets charged.

The larger version, the HomeStove, while not yet available, is aimed at replacing polluting open fires in developing countries.

RRP: US$129. For more information and to reserve a unit, go to www.biolitestove.com

04
Beat the smart meter blues

Like it or not, most homes in Australia will probably eventually end up with a smart meter installed. Unfortunately, most householders won't get much useful information from their smart meter.

The people at Watts Clever have solved that problem to some degree with their EW4030 wireless smartmeter monitor. The EW4030 makes use of the output LED on the front of each smart meter (and some other mains meters). This is usually a red or green LED that flashes once for each watt-hour of energy used. The EW4030 has a simple light detector that you stick over this LED to measure the flashes, and hence the energy consumption.

Information from the smart meter is then transmitted to an in-house display as with most other home energy monitors. The transmitter runs on a pair of AA batteries which will run for up to one year.

Other features include support for up to five channels and up to three tariff settings per day, an alarm for high-usage warning, up to 30 metres transmission distance and data updating every 45 seconds.

RRP: $119.95. For more information or to buy, contact Steplight, PO Box 331, St Leonards, NSW 2065, ph: 1300 139 996 operations@steplight.com.au, www.steplight.com.au. Also see www.wattsclever.com

05
Recycled planking for many uses

Many wetlands, beaches and other environmentally sensitive areas have boardwalks for easy accessibility. Unfortunately, many councils still make these out of toxic materials such as treated timber, which not only leach heavy metals into the surrounding soil but eventually rot and need replacing.

Enduroplank from Replas is a fibre-reinforced recycled plastic designed to replace treated timber in boardwalks, bridges, jetties, footpaths and similar applications. It is extremely durable, has a non-slip surface and will not rot, split or crack. It also never needs painting, as the colour is embedded in the material.

When combined with Replas's other fibre-reinforced materials, such as their Composite Fibre (imaginative name there), entire structures such as bridges and boardwalks can be constructed that will be maintenance free and will last decades.

These materials are also suitable for domestic applications such as decking, greenhouse flooring and walkways.

For more information, contact Replas, 27 Titan Drive, Carrum Downs VIC 3201, ph: 1800 737 527, www.replas.com.au

06
Non-toxic children's accessories

There are lots of accessories and toys for babies and young children but most are not made with the environment in mind and many contain toxic materials and additives such as BPA and phthalates which have yet to be banned in Australia.

IttyBittyGreenie has a large range of bottles, utensils, food storage, toys, clothing and other accessories that have been designed specifically to reduce their environmental impact.

Their utensils and bottles are all BPA-, phthalate- and PVC-free while their toys are made from plantation rubberwood painted with non-toxic water-based paints, or from recycled polyethylene or polypropylene. Packaging is either from recycled materials or fully recyclable, depending on the supplier.

There are some unique products, such as the star-shaped Eco Stars crayons made from recycled crayons collected from schools, restaurants and other organisations.

Every product in the IttyBittyGreenie range seems to have been selected to be as eco friendly and safe as possible—exactly as it should be when buying toys and accessories for your children.

For more information and to see the range, contact IttyBittyGreenie at info@ittybittygreenie.com or go to www.ittybittygreenie.com

Products

07

Preventing gutter overflows

Even the best-designed guttering system can be overwhelmed by sudden heavy downpours. While extra downpipes can be added to prevent overflows, they can be difficult and sometimes expensive to add to existing guttering, especially if you have to call in tradies. What's more, the swirling effect of water as it enters the downpipes means that the downpipes contain mostly air, even when the gutters are overflowing.

The Supa Gutter Pumper is a simple device that can be fitted into most flat-bottom gutters. It uses a siphon effect to suck excess water out of gutters, preventing the majority of overflows. Flow rates can be in excess of 60 litres per minute, according to the manufacturer.

Fitting the device is simple—you just cut a 32mm diameter hole in the bottom of the gutter and screw the two-piece device together through the hole. Then you add a 20mm downpipe and route it to the stormwater system or your water tank. The installation only requires basic tools and knowledge and can be done by almost anyone just by following the instructions, greatly reducing installation time and costs.

RRP: $12 plus $6 postage. For more information and to purchase, ph: (03) 9704 5339, supa@gutterpumper.com.au or go to www.gutterpumper.com.au

08

Crank up that light...

Some years ago, the ATA sold the Nightstar range of shake flashlights. While they are quite good flashlights, rapid shaking back and forth is not the ideal motion for human-generated electricity.

In recognition of this, many hand-crank torches have sprung up, but they all have one drawback—they all use rechargeable batteries, which have a limited service life. This is especially the case with lithium cells, as they can fail completely if left for long periods without charging.

To eliminate this problem, Applied Innovative Technologies have replaced batteries with ultracapacitors, which have almost unlimited lifespans, in their Lightstorm CL1 (pictured) and SL1 flashlights.

Runtimes are quite reasonable for hand-powered flashlights—two minutes of cranking gives you up to 20 minutes of runtime. The CL1 has three LEDs—a 0.5 watt LED for bright spotlighting and two smaller 5mm LEDs for wider illumination. The SL1 has two brightness settings—a 0.5 watt white LED, or three 5mm LEDs, as well as three flashing red LEDs.

Both devices also come with an output socket and a micro-USB lead for charging portable devices, and various adaptors are available. They both have a five-year warranty.

RRP: US$24.95 for either model, with volume discounts available. Contact Applied Innovation Technologies, PO Box 754, Fort Lupton CO 80621, USA, www.appliedinnotech.com

Photo: Larry Bollig

09

...or stick it in the sun

We come across some interesting and unusual ideas quite often here at *ReNew*, and the Nokero solar light bulbs would have to fall into that category.

Available in three models, they all feature embedded solar panels that charge an internal replaceable NiMH AA battery. When it gets dark, the bulbs turn on and provide light until the battery goes flat. Runtime ranges from around two hours to more than six, depending on the model, brightness setting and daily insolation.

The original model, the N100, has five LEDs and four separate solar panels. It looks a lot like a Mercury space capsule! It has only one brightness setting.

The N200 (pictured) has a different design, with a single solar panel and four LEDs. It is rated at 13.5 lumens on high and five lumens on low. While this won't light a room, it does make for subtle safety and garden lighting, or an ideal backup light for camping or hiking.

The N220 is similar to the N200 but has two batteries and a single higher-power LED to produce more light than the other two models.

RRP: US$15 for the N100, $20 for the N200 and $29 for the N220. Volume discounts are available. For more information and to buy, go to www.nokero.com

10

Know your water use

Keeping track of your water use can help you reduce water bills, but when you are responsible for your own supply then knowing exactly how long your tank will last becomes very important.

The Aquamonitor uses wireless sensors to provide data to a portable display, much as wireless energy meters provide data about energy use. The unit can have a mains meter sensor (compatible with common water meters) or a water-tank level meter, or both. These let you monitor your water use and keep track of how long your tank will last before the next rain.

The tank data displayed includes water level, water consumption rate, water inflow rate and remaining capacity. The water level is shown both in litres and as a percentage while water consumption is displayed as the average litres consumed from the tank daily and weekly, as well as per person.

Inflows are shown in litres for the current day and the past week. Remaining capacity is calculated from the current water level and your water consumption history, and is shown as days of water remaining.

There are also two alarms—a low level alarm, which activates when the tank water level falls below a set value, and a prolonged use alarm, which activates if consumption occurs for more than a preset time.

For more information, contact AquaMonitor, www.aquamonitor.com.au

11

Start a garden anywhere

Most people would love to grow at least some of their vegies at home. After all, the benefits are numerous—you can grow organic, you have the food on tap when needed and you save money, of course. But many people have neither the time nor the space for a vegie garden.

Elevated Gardens has a range of fully automated self-contained growing systems that can be used almost anywhere. They consist of a growing tank, the growing medium (cocopeat) and an automatic watering system that can be either solar- or mains-powered.

There's a range of models, from the tiny Grow Zone for small spaces such as balconies through to the Sustain Plus which comprises three or more Sustain 2D tanks (pictured) and a greenhouse cover. There's even a vertical solution for making green walls, the Sustain 3D. The tanks come in a range of Colorbond colours, and some are available in a granite-effect finish.

A range of consumables, such as the growing medium, nutrients and a nutrient meter are also available, although these may be easily obtained at local nurseries.

The systems are available to be delivered Australia-wide. For more information, contact Elevated Gardens, ph: 0459 990 036, orders@elevatedgardens.com.au, www.elevatedgardens.com.au

12

Folded furniture

Furniture can be made with many materials, but one of the more interesting ones is cardboard.

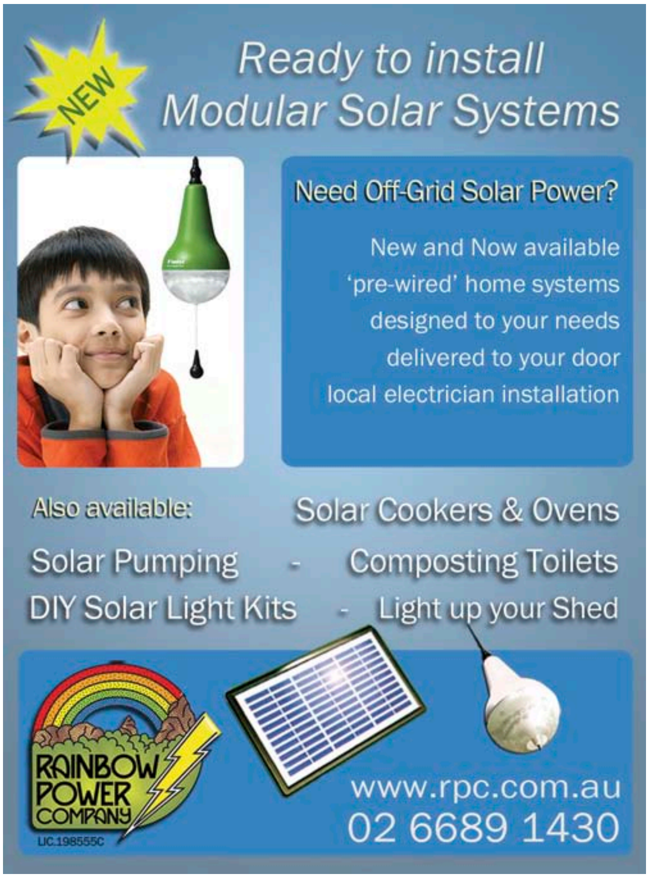
Karton supplies a range of engineered cardboard furniture that is supplied in flat-pack form. You simply fold it and slot it together—no glue, screws or anything else required.

The range includes tables, stools, bedroom furniture including a bed, office furniture and even a TV unit. All are made from a 100% recyclable mix of virgin and recycled paper with non-toxic vegetable starch glues.

Most items in the range are available in raw kraft or white-paper finish. They are fully paintable, and water-based polyurethane finishes are recommended to add extra strength. Our only wishes are that the range include some less boxy items and that prices could be a bit lower, although several packages are available that reduce prices slightly.

If you are in the USA, then you might also want to check out SmartDeco. They make a small range of cardboard furniture including a bedside table, dresser and desk. Prices are very low as they are locally made in the USA.

For more information, contact Karton, 3/126-134 Fairbank Rd, Clayton South VIC 3142, ph: 1300 527 866, www.kartongroup.com.au, info@kartongroup.com.au. See www.smartdeco.com for the SmartDeco range.


NEW
Ready to install
Modular Solar Systems
Need Off-Grid Solar Power?
New and Now available
'pre-wired' home systems
designed to your needs
delivered to your door
local electrician installation
Also available:
Solar Cookers & Ovens
Solar Pumping - Composting Toilets
DIY Solar Light Kits - Light up your Shed
RAINBOW POWER COMPANY
LIC.198555C
www.rpc.com.au
02 6689 1430


WATER FROM AIR
as nature intended
EcoloBlue 30
the echo of nature
PURE, DELICIOUS, ENDLESS DRINKING WATER MADE FROM THE AIR AROUND YOU.
Over 30 litres a day
12-stage filter process
Energy efficient and economical
No water source needed
No plastic bottles wasted
Advanced ECO Solutions Pty Ltd
65 Hume Street
Crows Nest NSW 2065
Ph. 02 8437 6264 Fax 02 8437 6265
web: www.advancedeco.com.au
email: info@advancedeco.com.au


QUALITY INVERTERS & BATTERY CHARGERS
www.excelsiorpower.com.au
BP SOLAR PANELS, LOW PRICES!!!
WHOLESALE PRICES & 20 YEARS EXPERIENCE
CREDIT CARDS ACCEPTED (03) 9775 1590
SAVE TIME,ORDER DIRECT FROM OUR WEBSITE
FREE CATALOGUE AVAILABLE NOW
PHONE FOR YOUR FREE COPY
OR VISIT OUR WEB SITE
REDUCED PRICES!!!
NEW: INVERTER / CHARGERS & SOLAR!!
SUPER ICISS 2000 & 4000 INVERTER CHARGERS
PURE SINEWAVE INVERTER
35 TO 140 AMP INTELLIGENT BATTERY CHARGER , GENERATOR SUPPORT.
BUILT IN SOLAR REGULATOR
AUTOMATIC GENERATOR START OUTPUT!
12 VOLT, 24 VOLT AND 48 VOLT MODELS
2 YEAR WARRANTY
LOWEST PRICES & HIGH QUALITY
FREEZER/FRIDGE 12,24 or 240 Volt
FREE CARRY BAG
DIGITAL TEMP DISP
30 litre $599
60 litre $799
80 litre $999
NEW
NEW MODELS!
GRID FEED INVERTERS GRID FEED SOLAR SYSTEMS
DEEP CYCLE & GEL BATTERIES REGULATORS
TV ANTENNAS SOLAR PANELS 120 V CONVERTERS
LED LIGHTS WATER HEATERS DC CONVERTERS
WIND GENERATORS BITS & PIECES MORE
INVERTERS
EX 12300 SHOWN
AVAILABLE IN 12 OR 24 VOLT
HIGH QUALITY OUTPUT
FULL DIGITAL DISPLAY ON EXT
NEW MODELS
FREE remote with EXT2300 and above!
MODEL | SURGE WATTS | NORMAL WATTS | SPECIAL PRICE
INV200 600 200 $39.95
INV400 1,000 400 $59.00
EXT1100 3,000 1,100 $179.00
EXT1500 4,000 1,500 $279.00
EXT2300 6,000 2,300 $399.00
EXT3500 8,000 3,500 $599.00
BATTERY CHARGERS
INTELLIGENT 3 STAGE CHARGER
WON'T OVERCHARGE BATTERIES
WORK WELL WITH GENERATORS
AMP & VOLT METERS ON LARGER MODELS
SMALLER UNITS FROM $79
MODEL VOLTS AMPS PRICE
BAT12/12F 12 12 $249.00
BAT14/24F 24 14 $399.00
BAT25/12F 12 25 $399.00
BAT25/24F 24 25 $649.00
BAT50/12F 12 50 $649.00
BAT50/24F 24 50 $1,299.00
BAT100/12F 12 100 $1,299.00
SINE WAVE INVERTERS
2 YEAR WARRANTY
FROM 200 WATTS & UP TO 7000 WATTS
PSU1000 SHOWN
AVAILABLE IN 12 , 24 AND 48 VOLT
PURE SINE WAVE
FULL GRAPHICAL DISPLAY
AUTOMATIC TRANSFER on UPSU
INVERTER/CHARGERS ALSO
FROM A LOW $249.00
Phone :(03) 9775 1590 Fax :(03) 9775 1891
Email:excelsior@optusnet.com.au
Postal Address: P.O.Box 2133 Carrum Downs Vic. 3201
Factory Address: 8/9 Elite Way Carrum Downs Vic. 3201
SPECIAL REDUCED PRICE
AGM DEEP CYCLE BATTERY
200 AMP $499
100 AMP $279
Short time only!
EXCELSIOR POWER
www.excelsiorpower.com.au

Putting a price on carbon
Some facts about the carbon tax

Will paying a price for carbon dioxide emissions make our lives miserable and destroy the economy? No. In fact, the carbon price could make households and businesses better off if they take a few important steps. By Alan Pears.

A CARBON price is an important response to the climate change challenge. At present, those who dump greenhouse gases (particularly carbon dioxide) into the atmosphere don't pay for the damage they do, or to help repair that damage. A carbon price creates a price disincentive to keep doing this, while making emission reduction more financially attractive.

The aim is to change behaviour, not hurt people or businesses.

Businesses (apart from a few hundred really big ones) won't have to fill out any forms, estimate their emissions or deal with more bureaucracy when the carbon price begins operation from mid 2012.

It's quite different from seeking voluntary certification to be declared 'carbon neutral' for marketing purposes—which does involve thorough documentation to satisfy the ACCC that the claims are valid.

In fact, neither businesses nor households have to do anything in response to the new carbon pricing scheme: it's not like income tax or GST.

Greenhouse-intensive industries are being given transitional assistance to reduce competitive impacts, and to give them time to make changes, so they don't have to pass high carbon costs on to us in the future.

For example, brick makers can phase out their old, inefficient kilns and shift to modern, efficient ones—halving their energy and carbon costs and saving more than enough money to avoid passing carbon costs on to customers.

Similarly, the cement industry is already improving energy efficiency, shifting to lower greenhouse-impact fuels and blending cement with low emission 'extenders' such as blast furnace slag and fly ash from power station waste.

↑ The steam is visible, but the damaging pollution, the CO_2, isn't.

Again, the combination of lower energy costs and lower emissions will mean carbon costs can be absorbed rather than being passed on to customers. And this innovation will mean you can choose alternative, lower polluting products and keep your costs down too.

All households and almost all businesses, if they make no changes, will experience a very small increase in the costs of goods and services purchased (on average about $10 per week for households, according to the government).

This is the effect of large emitters (including energy suppliers) passing through some of their carbon costs. Fossil fuel sourced electricity and gas will comprise almost half of this.

The government has committed to compensate most households fully or partially for these cost increases.

But, regardless of compensation, businesses and households can convert costs into benefits fairly easily over time.

First, consider energy. The carbon cost impact depends on the amount of carbon dioxide released by each unit of energy

> "A carbon price creates a price disincentive to keep polluting, while making emission reduction more financially attractive. The aim is to change behaviour, not hurt people or businesses."

consumed. Renewable energy sources like hydroelectricity and solar won't pay the carbon price, because they don't emit greenhouse gases.

The rest of us will see electricity prices rise from today's 20–25 cents by 2.5 to 3.5 cents per unit due to carbon costs. This is about a third as much as electricity prices will rise anyway, due to increasing electricity supply investment.

Typical households can offset the carbon cost on energy by reducing electricity usage by 10 to 15%. That's easier done than many realise.

Switching off the old fridge in the garage could save 10%. Replacing most-used lights with energy-efficient ones can save 5 to 10%. Buying more efficient appliances can also help. And there are lots of other ways to save.

Each tonne of greenhouse gas a household saves by cutting home energy use saves around $230—as much as paying to emit around 10 tonnes of greenhouse gas. So savings on energy bills can more than offset the carbon cost built into electricity prices.

EPA Victoria's new Australian Greenhouse Calculator can help households and small businesses to estimate their carbon footprint, then work out ways to cut emissions—and save money.

Households and business can also reduce the carbon cost impact on goods and services by choosing products supplied by low emission businesses, food that's less heavily processed, and so on.

Suppliers of goods and services that are energy efficient and use renewable energy will pay lower carbon costs, and their prices will be cheaper than their higher emission competitors. So businesses that cut energy waste, choose low emission suppliers, and sell products and services that help their customers save energy will avoid carbon costs and grow market share.

Because the carbon tax isn't like a GST or an income tax—because it's a tax on pollution—reducing the amount of pollution your lifestyle creates will mean you'll pay less. You may even profit. ✱

Alan Pears is a senior lecturer in Global Studies, Social Science & Planning, RMIT University.

Article reprinted with permission from The Conversation, theconversation.edu.au

UPDATE: The Australian Energy Market Commission has since revised estimates of the impact of the carbon price on electricity prices, suggesting a lower rise of 1.4 to 2 cents per kWh. This takes into account the assistance some power stations are receiving and the possibility that market competition will mean they don't pass on all costs to consumers.

Useful resources for reducing your carbon footprint

ATA INFORMATION AND PUBLICATIONS

ATA sustainable living info: www.ata.org.au/sustainability

ATA sustainability rebates page: www.ata.org.au/rebates

Water Not Down The Drain rainwater and greywater guide: www.ata.org.au/publications/water-not-down-the-drain

Renters Guide to Sustainable Living: www.ata.org.au/sustainability/renters-guide-to-sustainability

Guide to Reducing Your Energy Use and Saving Money: www.ata.org.au

Tankulator online tool for calculating the best rainwater tanks for your home: tankulator.ata.org.au

ATA WEBINARS

Retrofitting for energy efficiency: www.ata.org.au/news/retrofitting-webinar

Choosing a solar PV system: www.ata.org.au/news/solar-pv-webinar

OTHER USEFUL WEBSITES

Australian Greenhouse Calculator: www.epa.vic.gov.au/agc/home.html

Your Home Technical Manual: www.yourhome.gov.au/technical/index.html

Federal Government's sustainability website: www.livinggreener.gov.au

Victorian Government's Resource Smart: www.resourcesmart.vic.gov.au

NSW Government's Sustainable Households: www.environment.nsw.gov.au/households/index.htm

The solar multiplier and FiTs
Is the multiplier still needed?

It's that time of year again—mid year, and time for the federal government to reduce the upfront incentive for solar photovoltaic (PV) systems. But is this a good or a bad thing? Damien Moyse investigates.

BY NOW, those with or considering buying a solar PV system will have heard of small-scale technology certificates (STCs)—or renewable energy certificates (RECs), as they were originally called. These certificates are awarded to purchasers of solar PV systems and can be traded in the renewable energy market. Usually, purchasers of a system sign them over to the installer and are then given a discount on the upfront system cost.

The number of STCs provided for a system is based on an estimate of how much electricity the system will generate over a set period—for solar, this is 15 years. The generation estimate varies according to the size and location of the system—a system in sunny Adelaide, for example, will receive more STCs than the same-sized system in Melbourne.

For the past couple of years, the number of STCs awarded has been increased through the use of a multiplier, thereby providing an even higher discount on the upfront system price. In the 2010–11 financial year, the multiplier was five: for the first 1.5 kilowatts of a system, the number of STCs was multiplied by five, with any watts above this generating STCs at the usual rate.

Coupled with high state-based feed-in tariffs at the time, the five-times solar multiplier led to strong uptake of solar around Australia. In response, in July 2011, the federal government commenced reduction of the multiplier.

On July 1, 2011, the multiplier was reduced from five to three. Ongoing, the Minister is required to reduce the multiplier by at least one on July 1 each year, although they can opt to reduce it by more. Thus, on July 1 this year, the multiplier will go down at least to two, but potentially could even go back to one—in effect, with the multiplier phased out completely.

↑ Even with the reducing multiplier, larger domestic solar arrays are becoming more common due to the decrease in PV prices in recent years.

So, what will be the impact of a reduction in the multiplier to two or one?

At current market prices (approximately $28 for each STC), the value of the discount for a 1.5 kilowatt system in Sydney, Adelaide, Canberra, Perth and Brisbane with the current three-times multiplier is around $2600. In Melbourne and Tasmania, it is closer to $2200, whereas in the more northern parts of Australia it can be up to $3000.

If the government reduces the multiplier from three to two, this would reduce the discount by about $700 to $1000 for a 1.5 kilowatt system, depending upon the location. If the multiplier went from three to one, the reduction would be roughly double this.

Effect on prices

But does this mean we'll see an extra $1000 or $2000 added to the retail cost of a system?

As with all incentives and rebates, the solar multiplier can tend to artificially inflate prices a little, even as the cost of the technology decreases. Past experience tells us that often the industry has a little room to move on prices, so it is likely that the full impact of the incentive reduction won't be directly passed on to purchasers. That being said, some of the incentive reduction will definitely be passed on and prices will be higher than they would have been with the current multiplier.

However, this also needs to be put in the context of continuing cost reductions for solar technology. Since mid-2008, the installed cost in Australia of solar PV has dropped by about 75%—from $12 per watt to somewhere around $3 per watt in mid-2012, before incentives. At the same time, electricity prices have begun to rise sharply.

This has made the economics of solar PV more and more attractive to consumers: initially as a way to earn a return through the value of the exported electricity, and now through the avoidance of increasing grid prices.

It is generally accepted that solar PV has reached 'grid parity'—the point at which the 'levellised' cost (similar to average cost) of electricity from a solar system over its lifetime (roughly 25 to 30 years) equals or is better than the levellised cost of electricity from the grid over that same period.

Thus, new solar consumers don't need the strong level of incentives that have existed in the past. As solar PV prices continue to fall, the upfront costs become more affordable without extra incentives, particularly as consumers also get to avoid increasing grid prices.

So, phasing out of the multiplier isn't a bad thing—rather, it's a sign of a healthy solar PV industry.

Future solar policy

This leads us to the next big question in the solar debate: Now that we have reached grid parity, what should be the long-term policy approach for solar?

The ATA tackled this policy question in recent advocacy efforts to both the NSW and Victorian state governments, in response to their feed-in tariff reviews.

The ATA advocates that feed-in tariffs that recognise the *value* to the energy market of the electricity generated by distributed solar is the most appropriate future policy approach for small- and medium-scale solar.

Electricity from distributed solar has inherent economic value within the electricity market. This value can exist whether the solar electricity is consumed within a household or premises, or fed directly into the grid. The value also exists regardless of how cheap solar technology becomes over the longer term.

Currently, economic evaluation of distributed generation in Australia is done poorly, with an almost sole focus on its value with respect to carbon abatement—at the expense of a proper analysis that recognises its full market value.

A number of conservative energy-market economists now recognise the significant value within the energy market of electricity generated by distributed solar. This value is based on a number of components, including:

- the wholesale price of the energy generated; that is, the value that the net exports would earn if they were traded on the wholesale market
- avoided losses; e.g. reduced energy losses over transmission lines from central supply sources, and lowered costs incurred by retailers in contracting for wholesale energy
- environmental benefits through reduced emissions
- reduction in the wholesale price to all customers during peak periods, as the need for expensive peak-load generation is reduced (known as the 'merit order effect')
- ancillary savings: e.g. avoided market fees.

Despite this recognised value, there remain significant failures in our electricity market with respect to the cost-effective use of distributed generation. These failures centre around inefficient market investment to satisfy peak demand.

Some industry analysts suggest that 25% of all money spent by consumers on electricity goes towards building and operating the energy market system during peak demand periods, which amount to less than 40 hours per year.

As a consequence, the market over-invests in the more expensive supply side generators, such as gas peaking plants, that attract very high wholesale market prices.

Distributed generation benefits

Distributed generation such as solar has a significant role to play in reducing peak prices in the wholesale electricity market and reducing average energy demand across the network. Indeed, the evidence is that this has already started to occur, with average energy demand reducing by over 5% in 2008–09 and by a further 1.2% in 2009–10.

Distributed solar, coupled with other efficiency measures in the market, places downwards pressure on energy prices in the wholesale energy market. This has a direct benefit for all consumers by way of lower wholesale electricity prices, particularly during peak periods. Known as the 'merit order effect', this tangible benefit is something that has been well recognised in overseas markets such as New Zealand, the USA and Germany, and even at home here in WA.

"Since mid-2008, the installed cost in Australia of solar PV has dropped by about 75%—from $12 per watt to around $3 per watt in mid-2012, before incentives."

The wholesale energy market works on the basis of 'bids' made by large power plants, such as coal- and gas-fired generation. Generators bid into the market at the price at which they are willing to sell electricity for a given time period. During times of peak demand, many of these generators will bid into the market at many hundreds and even thousands of dollars per megawatt hour.

The merit order effect occurs when a reduction in electricity demand prevents the need for the next most expensive large generator from being accepted into the wholesale market. Solar PV is a form of demand reduction on the wholesale market, and at peak times, the more solar and other distributed generation and energy efficiency we have in the market, the more savings to all consumers from either preventing those more expensive generators from generating, or from a resultant lowering of their bid price.

Overall, ATA contends that the primary objective of a well-designed feed-in tariff should be to correct market failure and to ensure that the benefits of distributed generation are realised, particularly where the market alone can't realise those benefits.

Depending on how the calculations are done for each of the components of value (as listed above), ATA believes that an ongoing feed-in tariff for distributed solar somewhere between 12c and 25c per kWh would be in keeping with the principles outlined above.

A feed-in tariff set at this level would no longer be considered a subsidy or an incentive. Rather, it would reflect the value of the solar electricity generated. Significantly, this value would be returned not only to individual owners of solar systems, but also to all consumers, through lower wholesale prices in the electricity market.

Damien Moyse is Energy Projects & Policy Manager at the Alternative Technology Association.

Back to basics
Reducing your energy use and saving money

Along with the Victorian Council of Social Service and with the support of the Melbourne Lord Mayor's Charitable Foundation, the ATA is publishing a guide to energy efficiency on a budget. Laura McLeod gives us a preview.

WITH energy prices set to rise considerably over the next few years, now is the time to seriously consider inexpensive technology items and behaviour changes that could make a significant difference to your energy bills. No matter whether you're a home owner or a home renter, and whatever your income level, you can make changes to your home to make it more comfortable, save energy and money, and reduce your environmental impact.

Here is a preview of some of the guide's top energy efficiency tips.

Lighting

Switch off lights when the room is not in use and change to energy-efficient light bulbs to make a big difference to your electricity bills.

Replace incandescent light bulbs: Replace your old-style light bulbs with compact fluorescent lamps (CFLs) or light emitting diode (LED) bulbs. Both CFLs and LEDs are much cheaper to run—they can reduce running costs by up to 75% and 90%, respectively, paying for their higher purchase price in a few months. They also last much longer than incandescent bulbs. LED bulbs are becoming more readily available; despite their higher shelf price, they are generally more efficient than CFLs and can last for up to 50,000 hours—that's over 22 years at six hours' use per day!

Don't use halogen downlights: If your house is full of energy-hungry halogen downlights, replace them with good-quality LED bulbs or complete LED fittings. Halogen downlights are a very inefficient type of lighting, with 90% or more of the energy used by the globe lost as heat.

↑ CFL and LED bulbs are more efficient than old-style incandescents, and styles compatible with your existing light sockets are readily available.

Heating and cooling

Heating and cooling are among the most energy-hungry aspects of running a home, but it doesn't take much effort to reduce their impact.

Use heating and air conditioning wisely: Reducing the temperature on the thermostat of your heater or increasing it on your air conditioner by just 1°C can reduce the energy used by 10%. In winter, set the heater thermostat to a maximum of 18–20°C; in summer set your air conditioner to a minimum of 26°C.

Hang curtains: Heavy, lined curtains or blankets over your windows keep the heat in during winter and out on hot summer days. For best results make sure they are close fitting, hang down to the floor, and have an overlap of at least 100 millimetres on each side of the window.

Direct the heat: If your house has central heating, consider buying vent directors. These can be placed over vents to help direct the air into the centre of the room instead of straight up to the ceiling—and they're not expensive.

> "Reducing the temperature on the thermostat of your heater by just 1°C can reduce the energy used by 10%."

Seal up gaps and block draughts: Stop draughts by closing gaps around doors and windows. Self-adhesive door and window

"You probably spend a lot of time in your living room, so it's the best place to start making your home more comfortable and energy efficient."

seals are cheap, easy to install and removable if you live in a rental property. Alternatively you could use a 'door snake'.

Install insulation: Insulation is generally the single most effective investment that can be made to improve a home's energy efficiency. Insulation can be installed in ceilings, walls and floors, although the latter two may be difficult to do in an existing house.

Living room

You probably spend a lot of time in your living room, so it's the best place to start making your home more comfortable and energy efficient.

Turn appliances off at the power point when not in use: Many appliances such as DVD players, TVs, stereos and computers use electricity called 'standby power' when they are not being used. Standby power can account for as much as 10% of household energy bills.

Choose an LCD monitor: LCD computer monitors, especially LED-backlit units, use less than half of the electricity of the old cathode ray tube monitors. Turning the brightness down can also cut energy use. All monitors now come with an energy rating, so you can see how much energy a specific monitor is likely to use over the course of a year.

Kitchen

While the kitchen is home to one of your home's biggest energy guzzlers (your fridge), simple tips can keep energy use down.

Don't place hot items in the fridge: Wait until a dish has cooled down before placing it in the fridge. Put cold items straight back into the fridge after use rather than letting them warm to room temperature.

Get the temperature right: The recommended operating temperature for a fridge is 3°C to 5°C. For freezers, the recommended range is -15 to -18°C.

Keep the fridge well ventilated: Provide at least 50 millimetres of space at the top, back and sides to improve ventilation and let your fridge work at its best.

Making toast: Making your toast in a toaster instead of under the grill reduces the energy used by up to 75%.

Cooking with gas: Use an appropriately sized pot and turn the gas down to keep flames under the pot rather than up the sides. Gently simmer pots with the lid on rather than boiling vigorously. Use a microwave oven where practical, as they are more energy efficient than stovetop cooking.

Bathroom

Think that bathrooms are only about water use? Think again—using water wisely can also save a lot of energy and money.

Have shorter showers: Reducing your shower time will save both water and energy—particularly if you have an electric hot water system. Heating water using an electric storage water heater is very inefficient, costing up to three times more than a high efficiency gas system to heat the same amount of water, and up to five times more than a gas-boosted solar water heater. So try to keep your showers to four minutes or less.

Install water-efficient shower heads: One of the best ways to save both water and energy is to install an efficient shower head. Inefficient shower heads can use more than 15 litres per minute; a WELS 4-star rated shower head uses

↑ Curtains help reduce heat loss through your windows and glazed doors.

Look for the energy and water efficiency rating stars when buying new appliances.

just seven litres per minute. And remember that these volumes of water require heating—so the more efficient the shower head, the less energy will be required to heat your shower water.

Water-saving shower heads can easily be fitted to existing shower arms. Rebates are available and prices start from $20. Local councils often run exchange programs, so check before purchasing a shower head.

Laundry

Making changes in the laundry can be as simple as hanging up your clothes or as complex as researching and purchasing the latest energy-efficient appliance.

Hang it up: Avoid using electric clothes dryers. Use the natural power of the sun to dry your washing by placing your clothes outside on a clothes line or on a rack. During wet weather use a clothes rack inside your house.

Buy energy- and water-efficient appliances: If you need a new washing machine or other appliance, check the energy and water star ratings. Look for the highest star rating and buy the right size for your needs. Make sure the washer can do a true cold cycle because some machines heat the water even during cold washes.

Reduce the temperature of hot water: Check that the thermostat on your hot water system is set at 60°C. If it's set higher, you will be wasting energy, but any lower could pose a health risk as harmful bacteria may thrive. Instantaneous hot water systems should be set to no more than 50°C.

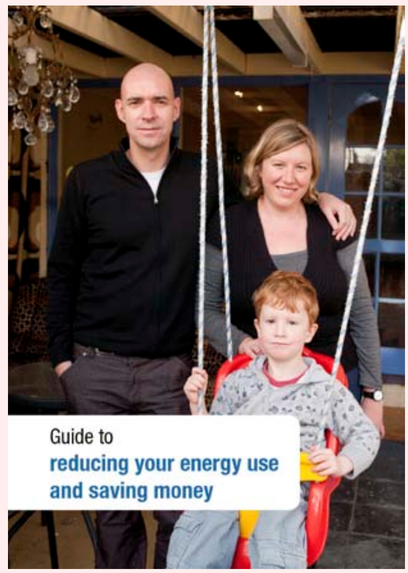
Getting around

Transport is a major contributor to energy use, but there are many choices you can make to reduce your impact while still getting from A to B.

Choose where you live carefully: If you're looking for a new home, whether to rent or own, think about its location. Is it within walking or cycling distance of public transport, schools, work, shops and your recreation choices? On average, Australian households spend around $9000 each year on transport, $3500 of that being for fuel. Reducing the amount of time travelling will be better for the environment, your health and your hip pocket.

Ride a bike or use public transport: Riding a bike is not only an eco-friendly way to travel, it's also cheap and is good exercise. If you are unable to ride, catch a bus, train or tram—leave the car at home whenever possible.

Start out with some of these small and easy-to-implement changes and let your sustainability grow from there. Energy efficiency makes economic sense! ✱



Get the guide

The complete *Guide to Reducing Your Energy Use and Saving Money* is available now and is completely free. Get it as a PDF download or in printed form from the ATA: www.ata.org.au

The guide was developed by the ATA and the Victorian Council of Social Service (VCOSS, www.vcoss.org.au), with support from the Melbourne Lord Mayor's Charitable Foundation (www.lmcf.org.au).

VCOSS Victorian Council of Social Service

LORD MAYOR'S CHARITABLE FOUNDATION

Aquatronic®
Solar Pool Purifier

Lower Electricity Bills By More Than $500 per annum

HARNESSING THE POWER OF THE SUN

TO PURIFY POOL WATER... NATURALLY.

Launch Special
RRP ~~$495~~
$395
on presentation of this ad!

Distributor Opportunities AVAILABLE

POTENTIAL OVERALL ANNUAL COST SAVINGS FOR A TYPICAL BACKYARD POOL WITH AQUATRONIC

WITHOUT AQUATRONIC

Average daily pump operation	6.5 hours
Total annual pump operation (6.5 x 365 days)	2373 hours
Energy cost @ $0.32 / hour	$759.00

WITH AQUATRONIC

Average daily pump operation	2.0 hours
Total annual pump operation (2.0 x 365 days)	730 hours
Energy Cost @ $0.32 / hr	$234.00

**Aquatronic is a solar powered pool water purifier.
It uses the power of the sun to control algae and bacteria in pool water, naturally.
If you are ready to slash your energy bill, reduce your carbon footprint,
and enjoy naturally clean pool water ... Find out more about Aquatronic today!**

Phone: 1300 779 720

info@auscleanenergy.com.au
www.aquatronic.com.au

The house with no bills
A 7 Star owner-designed home

Careful design and a range of sustainable energy, water and waste management systems minimise the running costs of this rural Victorian house. By Tim Adams.

ANXIETY caused by the prospect of rising bills might be alleviated if more people used building design solutions to arrive at carbon-neutral housing solutions.

After three years of occupation, my house in Gherang, Victoria, has now delivered on its goal to be 'a house with no bills' and to have a zero carbon footprint. The house achieved an energy rating of around 7 Stars, a bit lower due to the fact that the double glazing is only on the south windows.

Our priority was to eliminate air conditioning in summer, so we placed a concrete slab on the ground, without under-slab insulation. The coupling of the slab to the ground means we can use the stored 'coolth' of the thermal mass of both bodies to assist in passive summer comfort. This, combined with careful attention to summer shading, cross ventilation, ceiling sweep fans and night purge cooling, assisted by an evaporative water feature, meant that mechanical air conditioning did not need to be factored into our capital budget or our ongoing costs.

We decided on electric appliances, balancing their electricity demand with a grid-connected photovoltaic (PV) system. Cooking appliances include a full suite of everyday gadgets: a kettle, toaster, microwave, espresso coffee maker, 800mm oven and four-plate induction cooktop. Other major electrical appliances include a 500-litre two-door fridge, full-size dishwasher, front-loading clothes washer and an assortment of entertainment electronics. We don't have a clothes dryer or separate freezer. A cool cupboard with natural convection airflow helps to reduce mechanical refrigeration needs. The lights are mostly compact fluorescent uplights and pendants, with a few LEDs as well.

↑ Around 3kW of photovoltaics sits next to the solar water heater, which supplies hot water for domestic use as well as the in-slab hydronic heating system. It's backed up by an efficient wood-fired boiler. During summer, one of the water heating collectors is covered to prevent overheating, as seen here.

"The first three-month electricity bill with the smart meter in place delivered a $205 credit, even though the average daily sunshine last summer was 1.5 hours below average."

The water pumping power required is higher than standard suburban loads due to our domestic water pressure pump, black-water treatment system, solar hot water circulation, hydronic slab-heating circulation and wood-fired backup boiler circulation.

Solar power system payback

Prior to installing our solar power system, the power use through a full year of seasonal variation came out at an average daily use of 9.25kWh. Accordingly, we decided to install twelve 180W panels with a 3kW inverter. With average sunlight this system is able to deliver enough to match demand. Prior to the cut off of the Victorian 60c premium feed-in tariff, another six panels were added to optimise the inverter capacity. The system now generates significantly more than the current demand and should easily cope with consumption, even for a larger family than ours.

The first three-month electricity bill with the smart meter in place delivered a $205 credit, including all consumption and service charges. This has been achieved even though the average daily sunshine last summer was 1.5 hours below average. Tariffs in Victoria at the time were 21c/kWh for supply and 66c/kWh for feed-in, although the feed-in tariff for new solar systems dropped last year to 23c/kWh.

We've calculated a return on investment of around 18% on the $9300 cost of the solar PV system, with a saving of $950 on power

↑ The roofline of the house was designed specifically to provide the optimum angle for the north-facing solar panels.

bills in the last 12 months, plus an anticipated annual credit of approximately $800.

Free water

With 120,000 litres of rainwater storage in three tanks, collecting water from around 400 square metres of roof over three buildings, we store more than enough water for domestic consumption and garden watering. We even play under the sprinkler in summer.

Our domestic hot water and water for the slab hydronic heating system are heated by 60 solar evacuated tubes. The system is backed up by an Italian wood-fired boiler with a high-efficiency heat exchanger system, which runs at 70% to 75% efficiency. A reforestation program on the property will provide a totally self-sufficient fuel supply on site and sequester more carbon in the trees than will ever be released by the fire in the boiler.

The worm-based Biolytix black-water treatment system has an annual service fee of around $300. The treated output can be used for sub-surface irrigation. Annual checking has so far reported water output as being of very high quality. The initial outlay for supply and installation of the system was approximately $10,000.

We have achieved the 'house with no bills', where water is free, passive thermal building conditioning is embedded in the design, wood fuel is grown on site and credits from the electricity feed-in tariff (contracted for 15 years) will easily offset the maintenance fee for the black-water treatment system.

Not all projects and all sites will offer the combination of opportunities available in this case, but many of these options will be possible. To ignore them denies the potential for good, cheap, sustainable solutions. ✷

Tim Adams is the owner and designer of this 7 Star home. He is principal of F2 Design and president of Building Designers Association Victoria.

Turning waste into useful products

Our small commercial worm farm operation uses our household waste, along with horse manure from the neighbourhood, to produce worm leachate and worm castings. This solar-powered installation takes waste that, historically, has been a nuisance and turns it into useful organic products.

The worms have three 15-minute 'showers' each day to produce the concentrated leachate. The water filters through the worm beds and is collected below and then recycled. The marine bilge pumps used for the pumping for this process are powered by a simple standalone 12-volt solar power system.

The resulting products can be used in large- and small-scale agriculture and horticulture, as a conditioner that provides beneficial microbial activity to stimulate healthy soil, and assists in nutrient uptake and moisture retention. In addition, Bushaven Plumbing Service (a local installer and maintenance provider for Biolytix systems) now purchase their worms to dose systems from our worm production.

Family room upgrade
An efficient renovation

This family room renovation reflects the common constraints many families face when considering eco-living renovations. By Danielle King.

THESE days, renovations of family homes often take place bit by bit over several years. Renovations are done one step, or one room, at a time, to reduce disruption to family living and to avoid breaking the bank. A family in Melbourne's south-east renovated their family room in just this way. With a few cost-efficient, environmentally friendly changes, they ended up with a family room that's much more liveable, while also significantly reducing their power and gas usage—a win all round.

As with most homes, the family room is the most used room in this house. But before the renovation it was one of the least comfortable spaces. It was often unbearably hot in summer and draught-ridden in winter. With the ducted gas heating on for much of the winter, the family also had high gas bills to contend with. To add to the livability problems, the room had limited access to the lush garden that it overlooked.

↑ Well-sealed, double-glazed windows and doors provide thermal efficiency as well as making this a beautiful room to live in, with lots of natural light and a lovely view to the garden.

The problems

The primary problems with the family room were that the windows were old and draughty and the ceiling insulation was patchy and inefficient. The family also wanted to upgrade their outdoor living area.

The family room faces south-west, so passive heating and cooling opportunities were minimal without a much more major renovation.

The room was insulated, but the insulation wasn't working as effectively as it could. The external walls and one internal shared wall had been insulated and there was old blow-in insulation in the ceiling. Due to the downlights in the ceiling, there were also lots of gaps in the insulation, as the insulation had to be at least 200mm from each light fitting.

The windows and doors were single glazed and wooden framed and did not seal well against the frames. There were also no window coverings as the owner wanted to be able to see the garden and get as much natural light as possible into the room.

The room was heated via a floor ducted heating system using a 40-year-old gas-fired heating unit. To keep the room at a comfortable temperature, the heating was on most of the winter and gas bills were high: $7.07 per day, or $1060.50 over the five months of winter. The gas usage for heating was 404MJ per day. The owners wanted to reduce these costs, as well as minimise their energy usage.

Summer was also an issue. During the summer months, the room was almost unbearable due to excessive heat. The window area was about 1.5m wide and the sun streamed in during summer. The home did not have air conditioning or ceiling fans, and heat radiated into the room from the dark paving that was outside .

The solution

A key change was the replacement of the large family room windows with efficient double-glazed windows so that more heat could be retained in winter or kept out in summer. Gaps around the windows and doors were also sealed to stop air leakage.

↑ The roofed outdoor area provides protection for the family room from the elements and the sun. Drop-down blinds on the western side provide additional shading during summer.

Window heights were raised at the same time to let in more natural light. This reduced the use of ceiling and lamp lights, and so reduced energy usage and costs even more. External block-out blinds were installed on the two east-facing windows to keep sun off the glass on hot summer mornings.

A large sliding door was also added to let in more natural light and provide better access to the garden outside the family room.

The insulation was upgraded in the ceiling to R3.5 levels. To do this, light mitts were installed over the downlights in the ceiling space. This removed the 'chimneys' in the ceiling and so reduced the loss of heat in winter while giving better protection from heat gain in summer.

Rather than a complete replacement of the halogen downlights, they were downgraded from 50W to 35W halogens. The change in light levels is relatively unnoticeable. Although halogen lights are less energy efficient than LED or compact fluorescent light bulbs, changing a 50W globe to a 35W globe does make a difference in energy consumption and, therefore, the overall power usage of the room.

Immediately outside the family room, an outdoor living area was created. A 9 x 7m area was paved and a roof structure erected to provide shade and protection from the elements. The colour of the paving stones was selected in order to effectively help reflect heat in summer.

Drop-down shade blinds were also installed on the west-facing side of the external roof. These can be dropped down during summer to provide additional shade to both the family room and the external living area, making it both a more comfortable and more efficient space in which to live.

↑ External blinds on the east-facing windows keep the sun off the glass on hot summer mornings.

There were other small alterations to the family room and space around it, including draught proofing and the installation of standby power cut-off switches. Draught proofing was also applied to the older doors and windows throughout other areas of the house, helping to reduce draughts and heating requirements.

An energy-efficient reverse-cycle air conditioner was installed in the family room for extreme weather conditions, although this has been used only rarely since the renovations took place—just three times in two years. Remote-control standby power cut-off switches were installed on entertainment equipment and are actively used by the family.

These relatively simple renovations were not only cost effective, but have had a significant effect on comfort as well—always the desired result for such a well-used room in the family home.

In summer the room stays cool and comfortable as the external shades prevent direct sunlight from hitting the windows.

"Because of this simple renovation, heating costs have reduced by more than 55%."

In winter the use of gas central heating is now kept to a minimum. Even without the aid of the heating system, the family room stays at least 6°C warmer than the rest of the house, with the only difference being the double glazing and insulation.

There has also been a significant reduction in power and gas costs after the renovation. Gas usage for winter heating went down from 404MJ per day to 183MJ per day. The cost is down to $3.20 per day, or $480 over the five months—a significant change from the original $7.07 per day, or $1060.50 over five months.

The family estimates that the energy-efficiency upgrades—double glazing rather than single glazing, upgraded insulation and draught proofing—added about $5800 to the total cost. Given the whole renovation cost was in the region of $95,000—mostly for the build of the outdoor entertainment area—this was a minor increase of approximately 5%.

Because of this simple renovation, heating costs have reduced by more than 55%, a remarkable improvement.

Appropriate use of simple sustainable building resources such as good insulation, double glazing, effective shading and draught proofing have clearly made a significant difference to a family's cost of living, as well as to the cost to the environment. ✱

Table 1: Summary of cost reductions.

	In 2006	In 2010	Difference
Gas bill per day	404MJ $7.07	183MJ $3.20	221MJ $3.87
Gas bill each winter	60,600MJ $1060.50	27,450MJ $480.00	33,150MJ $580.5
Greenhouse gas emissions	162.05kg per day 24,307.5kg per winter	73.35kg per day 11,002.50kg per winter	88.7kg per day 13,305kg per winter
Electricity charges	11.5kWh per day	9kWh per day	2.5kWh per day
Winter cost over 5 years	$ 5302.50	$ 2,400.00	Saving of $2,902.50

Figures for gas usage are from actual readings off the gas bills for the period May to September 2006 and 2010. Due to bill estimations, usage was averaged out over the 5 months to provide an average daily usage figure. Costs based on current pricing of 0.0175 cents per MJ.

Sustainability advisor Danielle King is the director of Green Moves Australia. www.greenmoves.com.au


Asia's Largest PV Inverter Manufacturer
available in Australia
SUNG
Photon DAS SOLARSTROM-MAGAZIN
sehr gut
www.photon.de
Photon DAS SOLARSTROM-MAGAZIN
sehr gut
www.photon.de
Photon DAS SOLARSTROM-MAGAZIN
sehr gut
www.photon.info
Photon DAS SOLARSTROM-MAGAZIN
sehr gut
www.photon.info

Green on the water
Reducing emissions with a boatie's lifestyle

Living on a boat instead of the great Aussie dream of a 40-square house can greatly reduce your environmental footprint. Geoffrey Chia explains how he plans to do that in the future with his newly acquired catamaran.

IT IS feasible to drastically reduce personal fossil fuel consumption, carbon emissions, fresh water consumption and waste production without significantly compromising quality of life. Many yachties are already living proof of this fact. I plan to demonstrate and live this myself, on my newly acquired Mahe 36 catamaran, using the latest devices available to show that modern appliances and electronic technologies can be part of a sustainable life. The technology is sufficiently mature and I have sufficient equity to embark on this project now.

I am unable to address issues of embodied energy, which can only be addressed by the manufacturers of items and materials. I will only be purchasing products which are commercially available. Nevertheless, as the embodied energy of standard houses and appliances is much greater than that of the items and materials used in this project, the net benefits, taking into account both embodied energy and long-term daily consumption and waste, will be far superior in this project, compared with our standard lifestyle.

I will not be able to completely eliminate fossil fuel use, but intend to show we can drastically reduce our carbon footprint by a tremendous amount, hopefully by at least 80% to 90%, fairly easily.

This project will be a proof-of-concept, low-footprint residential project in the first instance. I will continue to work, with my car parked near the river for workday commuting. Coastal and ocean passages are options for the future when I have reduced the substantial loan that funds this project.

↑ Can living on a boat instead of a land-based home reduce your environmental footprint?

Modern appliances

The most important aspect here will be the utilisation of energy-efficient and energy-saving electrical devices. Air conditioners, fridges, freezers and plasma TVs are the major consumers of electricity in Australian households, while heaters can be a major electricity guzzler in colder climates.

Incandescent lights are also terribly wasteful, converting less than 10% of electricity to light, the rest being wasted as heat. Hence all lighting will be LED lights, which are now more efficient than even compact fluorescent lights. LED lights contain no mercury and have a projected lifespan of 30,000 to 100,000 hours.

There will be no sacrifice of electronic connectivity when living on the boat. Television, audio entertainment and computing will be based on laptop computers with LED-backlit screens which consume perhaps half the electricity of desktop computers. My internet connection will use high-speed mobile broadband. My mobile phone will give me connectivity. Nowadays, many new home owners are not bothering to establish landline phones, with the mobile phone being more than sufficient.

Marine fridges and freezers are designed to be ultra efficient, with very low energy consumption compared to land-based fridges. Unfortunately they also carry a higher initial cost, but there should be energy and hence cost savings in the long term.

There will be no need for energy-hungry air conditioning or heating on board, given the mild Brisbane climate and the well-insulated foam core boat. Instead of laying tonnes of concrete as required for a land dwelling, the surrounding water provides the thermal mass to maintain stable temperatures. On hot days, one can open all ports and windows and use cabin fans.

The power of insolation

The next consideration is the primary source of electricity. This will hopefully be more than 80% to 90% from solar photovoltaic (PV) panels. Queensland has among the highest levels of solar insolation in the world and we should take more advantage of this: the average insolation in Bavaria, Germany, is 3kWh/m²/day, whereas in Brisbane it is 5kWh/m²/day—and yet there are far more PV panels per person in Bavaria than in Brisbane.

Crystalline panels need to be kept cool to maintain efficiency, so flush mounting on the coach roof is undesirable, as there is no free circulation of air underneath. Furthermore, they are more likely to be shaded by the sails, boom and mast if located on the coach roof. Instead, I have 400W of monocrystalline PV panels mounted horizontally just behind and on the same level as the hardtop Bimini. The panels here also serve as eaves to shade the cockpit against oblique rays of the morning or evening sun.

With solar PV, prices are falling and efficiencies are improving all the time. In the past, partial shading of panels caused major reductions in energy output, but this is less of a problem with newer model monocrystalline panels, due to the incorporation of bypass diodes. Hence, I am also considering a future option to flush mount amorphous PV panels on the remaining coach roof space. I am also considering adding a wind generator.

Which washing machine?

There are no 12-volt washing machines available: they all require 240-volt input. My initial understanding was that a small front-loading machine, generally more energy and water efficient than a top loader, would be the way to go. However, my research (mainly on caravan websites) soon showed that my best option was a top-loading combined washer/spin dryer made by Lemair. The combined washer and spin dryer is more convenient and takes up less space than the mini twin-tub models found in camping stores. The Lemair can apparently take a double bedsheet and two pillow cases in a single load.

The other model commonly used by caravanners is the front-loading Dometic model which weighs 54kg, uses more power

↑ Hot water is provided by two Heliatos solar collectors and circulated by a pump run by the 10-watt solar panel.

than my PV system can deliver and, according to the instructions, needs to be vented to the exterior—which is a deal breaker for a boat, where it's desirable to keep the number of holes in the hull and deck to a minimum.

The Lemair weighs just 18kg and apparently draws only 280W maximum for both the wash and spin cycles; thus, it can be run off my PV system using an inverter. Daytime solar energy will be more than enough to keep up with the energy drain.

Nowadays, many washing machines do not have a separate hot water intake, the water being heated by an electric element, which further increases their carbon footprint. Instead, I will be able to fill mine with solar-heated water.

The full wash and double-rinse cycle uses 60 litres of water, which to a yachtie is a tremendous amount. I therefore intend to harvest the rinse water for washing dishes, cleaning the windows and solar panels, and swabbing the deck (in the first instance, I prefer not to use the foul Brisbane River water for anything). After spin drying, clothes will be air dried on a rack—no tumble dryer needed.

A first for solar hot water

This will be, as far as I know, the first small boat in Australia to be fitted with solar hot water panels. Most boats have their hot water heated by cogeneration from a diesel engine or by LPG/CNG, with plug-in electric heating when docked.

Instead, I have purchased two Heliatos M-37 panels for direct solar heating of water, a system which only became available in 2011. They will be flush mounted on the coach roof. The system cleverly uses a small DC pump, run by a 10W PV panel placed adjacent to the hot water panels. Thus, when there is insufficient sunlight to heat the water, there is also insufficient sunlight to run the pump, thus stopping the water from circulating through the panels. The heated water will be stored in a standard hot water cylinder in the boat.

LPG, and the sun, for cooking

Cooking will be done with LPG. There will be no microwave oven, electric toaster or electric kettle. LPG is of course a fossil fuel but produces much less CO_2 emissions per unit energy than coal (about a third) for direct burning.

The CO_2 emissions are markedly less for LPG cooking as compared with electric cooking powered by coal-fired electricity. Coal is burned to generate electricity (most of the energy being lost as heat) which is transmitted over hundreds of kilometres (with line losses) and the electricity is converted to heat again at the destination—immensely wasteful.

I also intend to purchase a portable solar cooker to use on sunny days which can be placed on the foredeck, to let me enjoy the simple pleasure of sun-baked bread.

↑ The yacht has a composting toilet to eliminate plumbing and storage tanks and their associated hassles.

Fresh water solutions

The Mahe 36 evolution is one of very few boats which has built-in guttering on the coach roof for rainwater collection, a thoughtful design feature. However, the coach roof area is tiny compared to the roof of even the smallest house, boat tankage is small compared to even the smallest household tank and, notwithstanding La Nina, which will eventually come to an end, most days of the year in Brisbane are dry. Hence, I will be carrying jerry cans of fresh water from land to use on board, at least initially (with a long-term plan outlined below). To minimise this physical effort, it simply makes sense to be water efficient.

Ever since the Queensland drought years, I have got into the habit of using less than three litres of water for every complete wash. The method is easy using a small pitcher: first wet and soap up the hair, followed by a partial rinsing douse over the head and body. Then, using a wet soapy cloth, thoroughly scrub the entire body. Finish with a couple of rinses, and you will be even cleaner than after a standard shower. This method is eight times more efficient than even a frugal three-minute shower, assuming an economical shower-head flow of eight litres per minute.

In the long term, when lithium-ion phosphate battery technology becomes more mature and affordable, perhaps in four or five years, I intend to change my lead-acid batteries to lithium batteries, which will more than double my electricity storage capacity and battery lifespan. This will enable me to run a reverse-osmosis water maker completely powered by renewable electricity. A water maker will undoubtedly clog up if fed with dirty raw Brisbane River water, so I will need to pre-filter the water; hopefully, just a simple sand filter will be sufficient. I look forward to no more lugging of heavy jerry cans onto the boat!

Sewage without the hassle

Even efficient Australian domestic toilets use four to six litres for full flush and three litres for half flush. Instead, I have installed a Nature's Head composting toilet which uses no water, one of the most exciting innovations in the project. Very few boats in Australia have composting toilets and I hope this project can publicise the tremendous benefits of such a simple system. I believe this should become the norm, at least on boats.

Water for flushing is, of course, not an issue with marine toilets which use seawater. However, the conventional systems require plumbing (which often leaks odours) and holding tanks (which encourage the formation of pathogenic bacteria), create foul smells, require regular pumpouts (with pumpout stations few and far between) and are overall inconvenient and offensive to manage.

In contrast, the composting toilet has zero water use, hence zero plumbing and thus zero chance of nasty liquid leaks. Also, properly used, there should be no smell. Plus it creates a final useful product which can safely be spread on gardens—I'll be checking with environmental authorities for disposal recommendations.

Smell can arise with liquid sewage due to the mixture of urine and faeces (a mixture with high nitrogen-to-carbon ratio), the enclosed storage of the liquid sewage and the resultant anaerobic decomposition.

The composting toilet overcomes these issues. The separation of urine and faeces markedly reduces the nitrogen and moisture content of the solid waste. The carbon content of this waste is increased by the addition of peat moss, plus top ups of wood shavings or sawdust, with everything churned together with a mixing handle. This encourages aerobic organisms to decompose the solid waste to harmless compost, facilitated by continuous ventilation. Air is drawn from the exterior into the solids bin then expelled outside by low-energy 12-volt fans which run continuously off the batteries. Hence, there should only be an 'earthy' smell, at most.

It may take some time before the solid waste is rendered inert and safe for garden use, so I will have two alternating solids bins. When the solids bin attached to the toilet fills up, I will remove it, cover it with the vented lid and put it aside to compost for another month or two, before finally disposing of the inert waste on land.

Urine is sterile and should have minimal smell when not combined with faeces. Any smell can be eliminated by sprinkles of sugar. When the bottle fills, it will be emptied at a land-based toilet. I have purchased an extra bottle, to be alternated.

Dinghy outboard

I will be sourcing a Torqueedo 1003 electric outboard for the dinghy, claimed to have equivalent thrust to a 3hp outboard. The major drawbacks are potential difficulty making headway against a strong current, limited range and high initial cost. The major advantages are not having to carry petrol on board, being maintenance free and having the ability to run on renewable electricity.

Off-the-shelf inspiration

Off-the-shelf technology is now available which can enable us to drastically reduce our personal energy consumption, fossil-fuel emissions, fresh water use and sewage waste without compromising our quality of life. I hope this project will allow me to demonstrate this, and so provide help and inspiration for future boat and even land-based dwelling fitouts or retrofits.

I wish to thank Richard, Nod and Patrick from Multihull Solutions (Mooloolaba), Aki of Heliatos and Larry of Nature's Head for their help and advice. ✱

We will catch up with Geoffrey and see how his project is coming along in a later issue of *ReNew*.

↑ The dinghy will be powered by a Torqueedo electric outboard. They have lithium batteries built-in and can be charged from solar while in use.

Nearly zero energy
PassivHaus school in Upper Austria

Energy use has been slashed by ninety per cent at this agricultural school, thanks to some of the best building energy efficiency standards in the world. By David Coote.

EARLY this year I attended a sustainable energy conference in Wels, Upper Austria, which included a focus on nearly zero energy buildings. One of the conference site visits was to a school recently built to the PassivHaus standard. An example of a nearly zero energy building, this school shows how rigorous building energy efficiency standards, low-carbon local building materials and multiple renewable energy sources can deliver a stunning environmental outcome.

The European Union reports that buildings are responsible for 40% of EU energy consumption and 36% of greenhouse gas emissions. Zero net energy buildings aim to make energy at the building from renewables such as wind, solar or biomass equal to the amount consumed. Nearly zero energy buildings recognise that going all the way to zero net energy, while an admirable goal, can be a lot more expensive than going most of the way.

Photo: Walter Ebenhofer, Steyr

↑ This school, built to PassivHaus principles, has reduced energy requirements by almost 90% over the old building.

The PassivHaus standard

Obviously the less energy that is used the less needs to be generated. Natural lighting and energy-efficient artificial lighting and appliances decrease energy consumption, but a major consumer of energy is heating and cooling.

Heating systems in inefficient Australian homes could be described as offering incidental warming as energy passes quickly from heaters to outdoors. Recent government initiatives aim to enforce 6 Star efficiency for new houses, and there are a small but increasing number of houses in Australia built to the 8 and 9 Star standard. The PassivHaus standard takes this further.

The PassivHaus standard builds on earlier energy-efficient housing initiatives by setting standards for air leakage, maximum annual heating and cooling energy used per square metre and maximum energy use for all purposes. To meet the heating and cooling standards typically requires very high-standard insulation, a well-sealed building envelope, high-efficiency windows, thermal mass, appropriate siting and the design of windows and eaves with respect to insolation and prevailing winds.

Based on work done during the 1970s in North America and northern Europe, the PassivHaus approach began to take form in the late 1980s, leading to the foundation of the PassivHaus Institute in 1996. The institute has a range of roles around certification and administration of standards, and also produces software and reports to help designers. There are now around 30,000 buildings around the world built to the PassivHaus standard, including the school the conference visited, the Agrarbildungszentrum (Agricultural Education Centre), located at Altmünster in the Salzkammergut region of Austria.

The school is in an attractive location with views of Traunsee Lake and the Traunsteinmassiv mountains. The new building—opened in October 2011—replaces earlier 1950s buildings. There are over 200 students, with more than 100 boarding at the school. The students study vocational agricultural disciplines and hospitality using onsite equipment, including kitchens, a still for making fruit schnapps, a fruit-press and facilities for training in meat and dairy products. Classes for adults are also available.

The school's design

Designed by Austrian architects Fink & Thurnher, the school has three floors, for a total of over 10,000m² of floor space, arranged in a traditional middle-European square around a central court. The school covers over 4000m² including the 550m² courtyard, with 1400m³ of wood used in the building. The wood was supplied from within a 150 kilometre radius to avoid long transportation distances and keep money within the local economy. Other sustainable materials include 4600m^3 of sheep wool and cellulose insulation.

As well as wood being used for the exterior walls, most of the interior and exterior surfaces are also wood. The white pine used for the interiors looks great and because it is untreated there are no volatile organic compounds (VOCs) outgassing from paints or other chemicals, just a faint scent of pine. Wood walls are combined with steel and concrete columns. Heat is distributed by radiators and underfloor heating, with the heat recovery ventilation efficiency in the range of 70% to 85%.

Concrete and sustainability?

The use of so much sustainably produced wood represents a drastic reduction in the building's embodied energy and consequent carbon emissions. However, the building still uses a substantial amount of concrete, which raises some interesting issues. Concrete can form an excellent thermal mass, but the energy-intensive manufacturing process results in very high embodied energy. Limited recycling is possible but most concrete from demolished structures isn't reused as concrete.

The Australian concrete industry states it has reduced the amount of manufacturing energy per tonne in the last 20 years and has also increased the amount of waste from other industries used as fuel in the manufacturing process. PassivHaus buildings such as this school are usually designed for a long lifetime. The embodied energy in these buildings is amortised over many years and, of course, they use very little energy beyond what they make if equipped with onsite renewable energy supplies. As with so much in sustainability, there's a range of trade-offs which result in an improved overall outcome.

Ninety per cent energy reduction

The school reports that it consumes about 14.6kWh/m^2/year compared to 130kWh/m^2/year in the old building—a reduction of nearly 90%. A number of renewable energy systems at the school reduce the need for external energy supplies. A 400kW (thermal) wood boiler used for space heating burns wood supplied by local farmers. There are 90m^2 of solar thermal collectors and 72m^2 (around 10kW) of photovoltaic (PV) panels. American reports note that PVs tend to be a large contributor to the extra expense of near zero energy buildings. The recent drop in PV panel prices makes large rooftop PV installations cheaper, which reduces the cost of satisfying the electricity demand of buildings with sufficient roof space.

There are interesting claims of other benefits from PassivHaus buildings. The teachers think the pleasant internal atmosphere due to the extensive use of wood has led to improved behaviour from the students. There have been suggestions that allergy sufferers benefit too, with the air in PassivHaus buildings refreshed so often.

Photo: Walter Ebenhofer, Steyr

↑ Natural light helps reduce energy consumption.

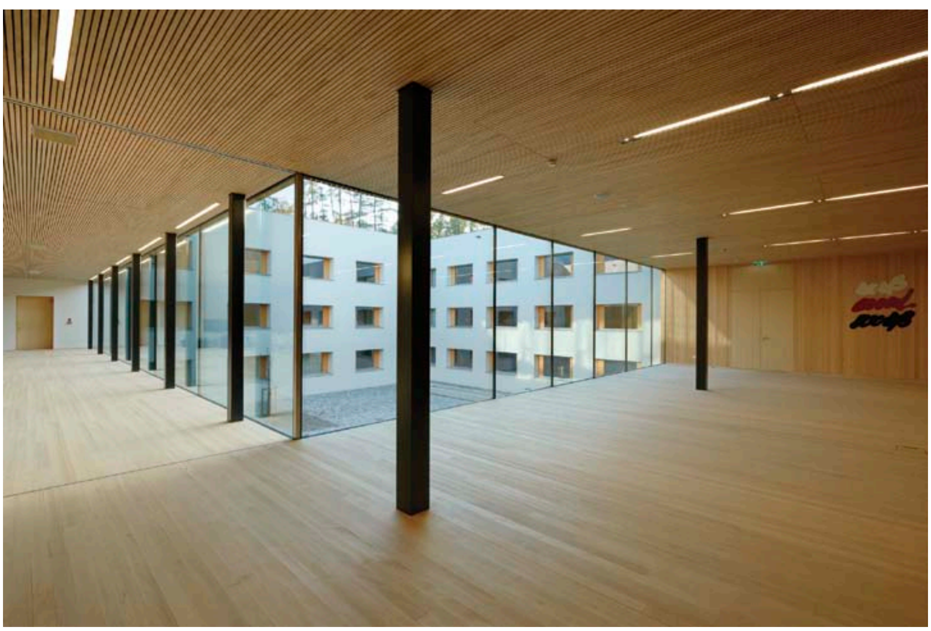


Photo: Walter Ebenhofer, Steyr

↑ The extensive use of sustainably sourced timber greatly reduces embodied energy and makes for a relaxing learning environment.

Aiming at these standards in Australia would differ from what is required in colder climates. A substantial amount of work has been done in Australia on building energy-efficient houses. Local building energy efficiency experts are confident we can reduce building energy requirements to a fraction of what is currently consumed with relatively short payback periods. While like-for-like figures for building energy use in Australia are the subject of some debate (due to how the statistics are organised), it appears likely that at least 23% of the energy used in Australia is consumed in buildings. Based on European examples such as this school, rolling out very high energy efficiency standards and incorporating onsite renewable energy production can drastically reduce greenhouse gas emissions, improve energy resilience and increase green jobs. ✱

For an impressive example of a PassivHaus home, see issue 19 of *Sanctuary* magazine.

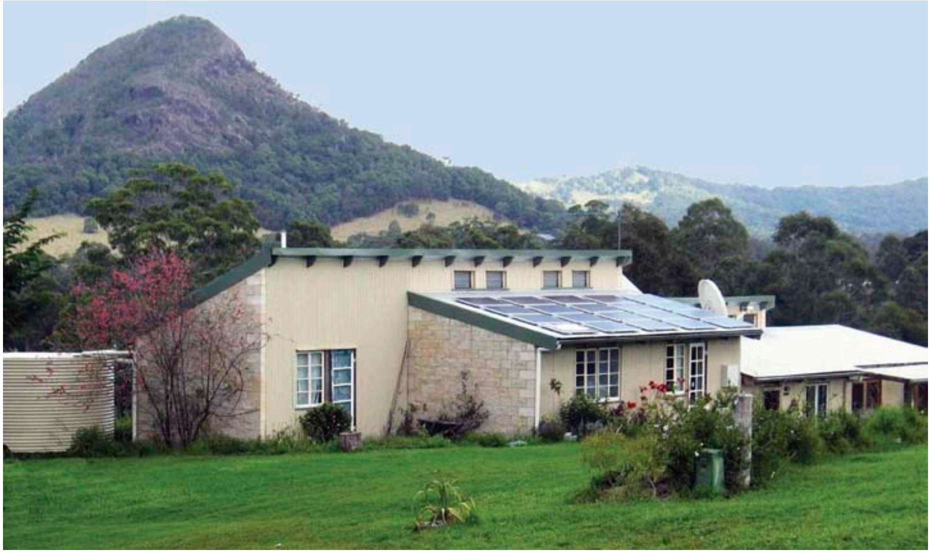
David Coote and his partner have installed roof and floor insulation, energy-efficient lighting and appliances and have begun weatherising their 1930s double-brick home. With a biomass heater, 1.44kW PV array and solar hot water, they are well on the way to near zero energy status for around $15,000, spread over several years.

The power of integrated design
Building an energy-efficient home

Even a difficult block didn't stop Mike Stasse from building this energy-efficient home that is a net zero energy user. He takes us on a tour.

DURING the 1990s, I had an epiphany and decided to abandon my photographic career to learn about sustainability. It was the best thing I ever did. I enrolled at the then Ithaca Institute of TAFE, and what I learned not only blew me away, it totally changed my life.

After much procrastinating, we eventually purchased the land we now live on at Cooran, in the Sunshine Coast hinterland in Queensland. The plan was to build a house that incorporated everything I had learned at TAFE—no compromises. This is our story of how it all happened.



↑ Mike's house makes use of the Queensland sunshine to help heat the home and generate more electricity than the house needs.

House siting

Our block falls from east to west, which makes life difficult when you want to build a long, narrow passive solar house facing north. The reason for the east-west axis is that it gives you more control over how the sun interacts with the building, such that in summer (when temperatures can go higher than 40°C) the sun almost never shines inside the house and in winter (during which we saw -6°C four years ago) it does so all day long. Achieving this is the reason there are so many windows on the north face of the building.

The house is 25m long and only 3.6m wide along 10 of those metres. One of those narrow sections is our living room, with glass on both the north and south sides. To the left (south side) we have a deck covered by a shade sail, with fabulous views of two of the volcanic plugs which surround the area. The other narrow section is our master bedroom, which also has fabulous cross ventilation, a must on hot summer nights.

The rest of the house is 7.2m deep. It started as a 20m x 7.2m rectangle, but because of the lay of the land, I decided at the design stage to split the house in half lengthways under the clerestory windows and offset the two halves by five metres, creating the narrower sections. To this day I consider it to be one of my very best ideas!

To simplify the foundations and slabs the house is also split width-ways, halfway along the length, and drops by 1200mm. At the split, a filled concrete block wall holds back the earth under the upper floor and gives us even more thermal mass.

Glazing

The beauty of having a narrow house is that it is not necessary to have any windows facing east or west to light the rooms. It's a little-understood fact that summer heat is not just a problem in the afternoon when the sun shines from the west, but that every bit as much heat is gained from the east. The sun's strength is exactly the same from either direction.

Nearly all the windows are recycled timber casement windows which swing out to catch breezes from the north-east on the north side and the south-east at the back. This is where our regular cooling sea breezes come from. The clerestory windows are louvres.

In summer, the sun never enters the house directly thanks to the eaves, and any heat coming in through windows and gaps is soaked up by the concrete keeping the house cool. At night the heat is vented out the clerestory windows.

Insulation and thermal mass

The whole house is well insulated, with R3.5 batts in the roof and polystyrene slabs in the walls to an estimated R value of at least 1.5. The long walls are clad in maintenance-free Colorbond corrugated iron.

To have a truly thermally stable house you must have a lot of thermal mass—that is, heavy material like concrete—inside the building. Thermal mass has the ability to soak up heat and store it a long time, just as black bitumen roads get very hot in the sun and remain so, long after sunset. Therefore I chose to build on a slab and do so across the natural slope—not easy. And all the block walls are core filled.

Last summer when the temperature hit 43°C, it was just 30°C inside and the house cooled down overnight with the clerestory windows open to vent the heat. And, I hasten to add, the house is not yet finished—we are still working on hanging curtains under pelmets to achieve total control.

In winter the sun shines into the house all day long and warms up the thermal mass which acts as a heat source overnight, keeping the temperature at around 20°C until the sun comes up the next morning.

While it did use a lot of energy to make all this concrete, unlike conventional houses this one will repay its debt for as long as it stands, instead of adding to it. I estimate that it will take just 20 years of habitation to do this and we are already over one third of the way into this period.

In 2007, Glenda and I won a Glossies Award for the house's resource-saving features. From a liveability point of view, it's the very best house we've ever lived in.

Refrigeration

Our old fridge, which consumed vast amounts of energy, finally gave up the ghost and had to be replaced.

If you run a freezer, especially a chest freezer, as a refrigerator, you will use considerably less energy than a standard fridge. Why? When you open the top, most of the cold air stays inside and, because they are designed to run far colder, the insulation used in freezers is often three times as thick as that in fridges. All you need to do is use an alternative thermostat to override the freezer's internal device. Amazingly, the whole thing is actually cheaper than a comparable fridge!

I found a suitable thermostat at www.mashmaster.com.au. It's one that home beer brewers use, was cheaper than any other I've yet found and it looked well made. Fifty dollars later one arrived in the mail. Now all I needed was a freezer to go with it.

Years ago I'd spotted an unusual Haier chest freezer in a shop—it had a drawer in the bottom. It's the only design like it, as far as I know. The beauty of this design is that the stuff in the drawer is not as cold as that stored in the freezer's top compartment—perfect for fruit and vegies. Because the top is very shallow, you don't have to bend in half to reach the bottom for the beer. I wanted one!

After three years usage I'm pleased to say that our new 'fridge' is still working well, and best of all it's only ever used 0.25kWh per day—about 20% of the energy consumption of a conventional refrigerator.

Water heating

As far as I'm concerned, there is only one way to heat water, and that's the solar way. Furthermore, if you do it properly, it is possible to achieve 100% solar fraction (that's jargon for never needing to boost)—a little trick I learned at TAFE.

Basically, you have to tilt the collectors such that they are optimised for winter, when the sun is weaker, the days shorter and the water you want to heat is colder. To calculate

↑ Features in the kitchen and living area include an AGA combustion stove, LED lights, an energy-efficient TV and an internal block wall for thermal mass. The inverter is mounted behind the doors in the bookcase.

the best angle of tilt in the winter, take your latitude and add 15 to 20 degrees. This will give you the angle from the horizontal at which the panel should be tilted, which here on the Sunshine Coast is about 40°. Also, remove the tank from the roof and put it inside your house somewhere warm, standing upright. A vertical tank will not mix cold water with hot anywhere near as much as a horizontal roof-mounted one. Nowadays, most solar water heaters are split systems like this, although most people still install the tank outside.

I should also mention the importance of a water-saving shower head. We bought ours 20 years ago when we first started living on tank water, and it is incredibly efficient at under 4L per minute. The less hot water you draw from your tank the less you need to reheat—particularly important in cloudy weather.

Our collectors are on a south-facing roof and as such needed to be tilted up on a frame to face the equator at the winter angle. This setup has been through destructive winds twice now and it hasn't yet blown away!

Efficient living too

To reduce one's consumption to the level we have certainly requires commitment. You often have to spend money upfront to make the gains, but I can assure you we are laughing all the way to the bank as the cost of energy rises.

We've done two other things in the past two years to lower our electricity usage from 4 to 2.5kWh per day. One was to replace the 120W desktop computer that used to live here with not one but two laptops (his and hers!). They are rarely both on at once, but at just 40W each, does it matter? And then, as digital TV becomes the norm, we replaced our ageing 130W CRT TV not with a gigantic plasma screen or similar LED TV, but a same size (58cm) LED-backlit LCD device that barely uses 30W. We don't miss a big screen because we have never owned one.

In winter we cook on an old wood-fired AGA stove that I restored from the dead (see bit.ly/LKw6Zt for the full AGA saga). It also heats our water when it's cloudy, which means we don't need to get stingy with hot water consumption just because it's raining. In summer we cook with gas and consume about three 9kg bottles of LPG a year.

Solar power

As soon as our house had a roof, 20 US64 thin-film panels were installed and hooked up through a SunProfi 1500E inverter to both the grid and an emergency-backup battery bank for blackout protection.

The system automatically and instantaneously switches to battery power whenever the grid fails. To be honest, the battery backup is a real indulgence. We first started out with a tiny 48V, 17Ah battery bank which very quickly turned out to be totally inadequate. It was soon replaced with a secondhand 100Ah set of batteries which cost us the princely sum of $100 and a bottle of rum. They were the better value for money because they lasted maybe 18 months or more, but they eventually curled their toes up and died.

So, a replacement set made in China and bought on eBay arrived, for a grand total of

The power of energy efficiency

Hardly anyone believes we can run a house 'with everything' (except a swimming pool, I draw the line there) on virtually zero energy.

Each electricity bill we receive has two sections: one is the amount of energy we consume, the other is the amount of excess energy we generate via our two solar arrays. A recent bill shows that we used an average of 2.5kWh per day, and we generated an excess of 7.4kWh per day (in some of the worst solar weather I've seen—things have improved now the sun's come back).

That we pay only 21c/kWh for what we use, and collect 52c/kWh for our exported solar energy certainly helps us get our account in credit.

But the point lost on many people is that the main reason we have achieved this is because of the strategies we have undertaken to reduce our consumption from some 20kWh per day 20 years ago, to just 2.5kWh today.

"The beauty of having a narrow house is that it is not necessary to have any windows facing east or west to light the rooms."

↑ The roof features two solar PV arrays, solar water heating system, the flue for the AGA stove and a white vent for the composting toilet.

↑ The lounge is a narrow room with a thermal mass west wall and glass on north and south sides for cross ventilation.

$1300. Gel cells—never again. They barely lasted long enough to run out of warranty, and the problem with this inverter is that it will not work at all without batteries. If the batteries are dying, prodigious amounts of solar energy are wasted trying to keep them charged instead of feeding the grid.

I worked in the grid-tied PV industry for a short time in 2010 and, luckily for me, my boss bought an entire telephone exchange worth of backup batteries for a song. Not gel cells and not small 100Ah jobs, these were the Rolls Royces of lead-acid batteries—500Ah Japanese-made Yuasa cells, which, he claims, have been known to last as long as 34 years.

So I bought a set of 24 for barely more than the previous set of batteries. I've attached a Megapulse anti-sulphation device to the bank in the hope of assisting in their longevity. The batteries are housed in a little cubby I built entirely out of salvaged materials.

With all the incentives to put solar panels on one's roof now, it's hard to resist. We decided to top up our old system with a new 2.2kW array of monocrystalline Chinese-made PV panels, with a 3kW inverter.

Sweet success

To have been able to integrate all the elements in our house so successfully has been sweet indeed. Nowhere else have we been able to live so comfortably, and so cheaply. We could not live any other way now. ✱

Mike Stasse is the author of the blog, Damn the Matrix. Read more at www.damnthematrix.wordpress.com.

Running on water
Eco lodge opts for micro-hydro

It took Forest Walks Lodge two years to design and develop a reliable micro-hydro system, writes Rosemary Norwood.

AT FOREST Walks Lodge we like to keep our guests warm, comfortable and anxiety free whilst on holiday. That means plenty of hot water for showers, suitably heated bedrooms and sufficient electricity to charge multiple devices. This is a challenge, living as we do on the south side of a mountain in the Tasmanian valley of Jackeys Marsh, with no mains power.

Despite building a passive solar house with a 1.2kW solar power system, we still need extra power in winter when the sun might not shine for weeks. Even when it does shine, it only reaches our panels for four to five hours a day in winter, so adding more panels would not gain us a great deal.

It wasn't until our backup generator broke down at the beginning of winter 2010 that we realised we were living in an all-electric house. We use electricity to run the three pumps of the underfloor heating system, the two pumps in the Biolytix waste water system and the gas ignition on the water heater.

It became obvious that we didn't have enough energy to also run the fridge, freezer, computers, toaster, washing machine, and the occasional dishwasher use. But we had plenty of water! It has taken us two years to design and develop a water turbine that is now delivering enough electricity for our needs.

↑ Forest Walks Lodge sources its electricity from a combined solar and micro-hydro system.

A suitable water supply

Quamby Bluff to the north of us has multiple streams and springs. Tallahassee Brook, within our property boundary, was the obvious choice for a water intake. It is approximately 250m from the lodge, but 300m away once we found a suitable water-intake point.

We grappled with whether to put a turbine on the creek and bring cable to the house, or bring the water closer to the house, requiring only a short length of cable. In the end it was cheaper to buy more pipe than cable.

When trying to decide on a system we didn't really understand how electricity generation worked and the difference in transmission infrastructure required for the different voltages of 12, 24 or 240 volts. We already had a 24V solar system with batteries and an inverter, so we needed something that would feed into this. With the new water turbine, we generate power at 75V that is then transformed to 27V by the turbine control system. This is then fed via the solar controller for storage in the 24V battery bank. The inverter then converts it to 240V to run the domestic electricity system.

Micro-hydro system design

We contacted *ReNew* to see if they could recommend a consultant to help us design a system, and used our own contacts, but there are very few people in this field. Quoting is difficult because the design, particularly of the head works at the water intake point, will be different in each situation. We were quoted from $7000 to $20,000. The system eventually cost $10,000.

We engaged a neighbour with his own micro-hydro system to help design the head works. We considered a concrete dam, but decided that, because of the nature of the creek, it would be impossible to seal the dam wall. We made the decision that a timber construction would be less environmentally destructive and less trouble to replace if washed out in a flood.

Six stainless steel pickets in two lines were driven into the creek bed and a wall of cedar floorboards were slotted between them. The pickets were cabled to existing vegetation to hold them in place in case of a flood.

The relationship between head and flow is important. You need to get it right to generate as much electricity as possible.

This forms the dam wall. A plug hole was cut in the wall and a 150mm-diameter pipe inserted. This pipe runs for 30m, with a gentle downward slope, and feeds into two settling drums. These drums also moderate the water flow when the dam drops to keep the head constant. A 75mm-diameter pipe brings water 300m to the turbine house, which contains a Platypus Power turbine.

The relationship between the head, which is the height of the water intake above the turbine, and the flow, which is the amount of water coming through the pipe and into the turbine, is important. You need to get it right to generate as much electricity as possible within the constraints of your system. Because we have a low head of only 16m, we went for greater flow of water with a 75mm pipe. Platypus Power was happy to advise on the best turbine for our needs.

The turbine is a single unit which sits on a stormwater pit set in a concrete slab. The water feeds into the side of the turbine and drains out through the stormwater outlet.

↑ The Platypus Power micro-hydro turbine provides a large proportion of the lodge's electricity.

↑ The turbine produces power at 75 volts which is stepped down to 27 volts for the batteries.

The electricity is generated by an alternator that sits immediately on top of the turbine within the same sealed unit. It is a very elegant design. The water drains away into a natural swamp and feeds back into the same creek system that it came from.

The dam is small and not completely sealed because it's in a rocky mountain creek. We tried to seal it with black plastic held down with rocks, and then later with cling film along the banks. Although it now holds the water better it still leaks through the bottom.

However, we don't regard this as a bad thing as it provides the creek with an environmental flow, even when the creek is low. When the creek is high, the dam spills and ensures there is plenty of water in the creek.

The turbine is in a shed about 50m from the batteries, which are connected to the solar system. We engaged Lorinna Energy Systems to connect the power to the house.

With this system we have doubled our energy input and rarely use our backup generator. We can use our dishwasher more often, which is a boon when we have lots of guests to stay—and we can even use an electric jug. ✷

Other eco features

Forest Walks Lodge is a passive solar house, with many eco features including:

- north-facing double-glazed windows
- European-style tilt-and-turn windows and doors, triple glazed
- thermal mass including a rock wall, Trombe walls and solar hall
- wood-fired hydronic underfloor heating
- R7 insulation in the ceiling and insulated slab
- solar electricity and hot water
- Biolytix waste water system
- natural paints and lime render
- recycled timbers, wool carpets
- hand-woven, naturally dyed floor rugs
- locally made mirrors, vanities and furniture.

↑ The solar hall brings warmth into the lodge during the cold winter months.

Forest Walks Lodge, Tasmania, www.forestwalkslodge.com

Forest Walks Lodge would like to acknowledge the following companies:

- Carawah Environmental Design for design
- Gumpy Modular Homes for construction
- Paarhammer for the windows and doors
- Harmonic Energy for the solar system design and installation
- Prime Plumbing for the hydronic heating system and Biolytix installation.

Businesses making a difference
Introducing the LEAF program

Up to 50 West Gippsland businesses could be flying the sustainability flag by year's end, writes Maggie Riddington.

AUSTRALIA'S ecological footprint—the estimate of land needed to sustain the quantity of products and services we consume and waste we produce—is currently four times what it ought to be.

According to a measure of biologically productive land, the average Australian requires 6.6 global hectares (gha) to satisfy their current lifestyle, while the earth can only provide for one person every 1.8gha. The average Victorian requires even more productive land to sustain their lifestyle, with a footprint of 6.8gha.

Considering that 36% of Victoria's ecological footprint is attributable to goods and services, it is worth working to reduce the impact that these have on the environment.

This is exactly where the Baw Baw Sustainability Network, a rapidly growing, volunteer-powered group in Victoria's Baw Baw shire in West Gippsland, is focusing its energy. The group has recently initiated the LEAF accreditation program to encourage and acknowledge sustainable business practices. When a business is accredited, they are awarded an A4 leaf symbol to display in their window—a highly recognisable sign of their environmental credentials.

Sustainability Project Officer Natasha Brown hopes the program will inspire widespread change within the communities of Baw Baw shire. So far more than 18 businesses have signed up, and Brown hopes to accredit up to 50 by the end of the year.

The LEAF program

There are two categories in the LEAF program—Yellow and Green. Yellow, the simpler of the two levels, calls for businesses to undertake a number of sustainable activities including recycling, educating staff in sustainability and reducing energy use with energy-saving appliances.

↑ Jo Wolswinkel, owner of the Town and Country Gallery in Yarragon, displays the leaf symbol earned as part of the Baw Baw Sustainability Network's accreditation program for local businesses.

The Green category takes sustainability up a notch. At this level, activities include installing solar panels and water tanks, double-glazing windows and undertaking voluntary carbon offsets.

Each initiative is evaluated for its effect and the cost and ease of implementation, and awarded an appropriate number of points. The points are tallied and the total score indicates whether the business has reached accreditation.

Sustainability in practice

The town of Yarragon has been keen to take on the challenge, with local business operators gathering at least once a week to discuss sustainability. LEAF businesses also frequently meet with the Baw Baw Sustainability Network to talk about progress and make plans for change.

Jo and John Wolswinkel from the Town and Country Gallery in Yarragon were among the first to sign on to the LEAF program. The gallery is well loved by locals and tourists alike, making it the perfect avenue for applying environmental change. The first step in transforming the gallery into a sustainable business was to design and implement a business plan with realistic goals.

One of the biggest changes they planned and implemented was an upgrade of the gallery's lighting. Since the start of their involvement in the program, they have replaced 67 out of 85 fifty-watt halogen lights with five-watt LEDs. This has reduced both daily electricity usage and the longer-term costs associated with light bulb replacement. As a result, over a five-year period, the gallery will save close to $10,000 on lighting alone.

In just one year, the gallery has reduced its electricity bill by 62%. The changes have been relatively small: upgrading the lighting, monitoring energy use, reducing heating and cooling, and maintaining and replacing appliances. These simple changes have reduced the gallery's expenses and also their greenhouse emissions.

Community influence

The Wolswinkels are proud to be a part of the LEAF program as it shows the community that they are committed to an environmentally sustainable future.

Having the community on side is a key element of the program, with the accreditation certificate designed to be placed in shop windows or vehicles so that businesses can advertise their achievement.

There are some local precedents when it comes to businesses displaying their sustainability credentials. The Community Resource Centre in Heyfield, East Gippsland, developed its own environmental program which uses flags to indicate a building's sustainability level. The simple symbol of a flag has inspired most of Heyfield's 2000 residents to switch to a more environmentally friendly lifestyle. In Heyfield, when one house raised a flag the rest of the street followed suit.

The LEAF program predicts that displaying an A4-sized leaf in a shop window will influence other businesses nearby to get on board with the program.

Want to follow suit?

The first thing you'll need to do is make a comprehensive business plan. Without one, it's hard to monitor achievements and note areas of improvement. The Wolswinkels created a plan for upgrading their lighting that meant they reached goals at three, six and 12 month intervals.

To transform a business into an environmentally sustainable one it is best to draw from a holistic concept of sustainability. Consider all angles of sustainability within a business such as energy and water usage, waste, food, staff and customers.

Simple changes such as avoiding bottled water, dressing more appropriately for the weather, composting, phasing out plastic bags and sealing gaps around doors and windows are cheap and easy to make. Together such changes combine to create a much more sustainable business.

Both the LEAF and Heyfield Sustainable Town programs came from humble beginnings and have grown because a few people wanted to make change. If you don't have access to a similar project in your community, start one! ✱

For more information on the LEAF program, contact Natasha at s.leaf@dcsi.net.au or call (03) 5634 2284.

Other contacts:
Baw Baw Sustainability Network:
www.bbsn.org.au
Gippsland Green Centrepoint:
www.heyfield.net

Beyond business-as-usual
Sustainability ratings to transform infrastructure

A new ratings tool is set to provide a clear assessment of the sustainability of Australian infrastructure projects. By Linda Vergnani.

REDUCING energy use and cutting greenhouse gas emissions are among the criteria that are assessed by Australia's landmark new Infrastructure Sustainability (IS) rating tool, which was introduced this March.

The IS ratings scheme, which received $750,000 in backing from the federal government, the New South Wales and Queensland governments, and industry, is seen as the infrastructure equivalent of the Green Star rating for buildings.

The tool provides designers, developers, contractors and owners with an incentive to recycle, cut energy costs, use more sustainable materials and reduce the carbon footprint of major construction projects.

It takes a life cycle approach to the design, construction and operation of infrastructure including roads, bridges, tunnels, railways, harbours, airports, water storage and supply, and energy distribution and transmission.

The scheme was developed by the Australian Green Infrastructure Council (AGIC), which represents 90 organisations with over 70,000 employees across the country.

A common benchmark

Rick Walters, Technical Director at AGIC, says the Australian IS scheme is one of very few rating schemes in the world to take into account environmental, social and economic factors. They set a benchmark that can be used by governments, designers, constructors and operators across Australia.

"One of the benefits of the tool is that we start to get a nationally consistent language around infrastructure sustainability," says Walters. "The principle is that all infrastructure can be made much more sustainable than it is now."

He acknowledges that the IS rating tool is available for application to all types of infrastructure regardless of the sustainability of their inherent purpose. For example, the IS tool could be used to rate the sustainability of a railway line built to transport coal from a mine.

"We don't make a call on what is the most sustainable end purpose for infrastructure," says Walters. "It's not our role to do that."

He points out that the railway line to the coal mine could be constructed in a more sustainable way that uses less energy, produces fewer greenhouse gas emissions and has less impact on the environment in terms of route selection and clearing of native vegetation. "There are a whole bunch of decisions that can have a significant impact, regardless of the overall purpose of the structure."

Designers, constructors and owners will aim for a certain IS rating and then get the project independently verified by AGIC

Photos: Gold Coast City Council

↑ One of the pilot projects for the IS rating scheme, the redevelopment of Broadwater Parklands at Southport on Queensland's Gold Coast includes sustainability features such as wetlands for stormwater capture and treatment, and shade structures incorporating solar panels.

"One of the benefits of the tool is that we start to get a nationally consistent language around infrastructure sustainability."

through each stage (design, construction and operation). Walters says the scheme is designed to encourage and reward projects and assets that "go beyond business-as-usual in infrastructure".

As an example of what can be achieved, he cites the installation of the 500-metre-long photovoltaic sound barrier on the interchange between Melbourne's Tullamarine and Calder freeways. The barrier provides 25kW of peak power output. The installation of the innovative barrier pre-dates the development of the AGIC tool, but AGIC will now champion this kind of initiative.

Walters expects that fewer than 20 projects will be assessed and rated in the first year, but that the scheme will snowball once people see what leaders in the industry are doing.

CEEQUAL, the United Kingdom's assessment and award scheme for sustainability in civil engineering, started in 2003 and has now assessed more than AU$30 billion worth of projects.

Importantly, the IS rating tool can be applied to existing assets as well as new projects, providing a mechanism to improve the stock of existing Australian infrastructure.

Photo: Christopher Frederick Jones Photography

↑ One of the Infrastructure Sustainability ratings scheme's pilot projects involved increasing the energy efficiency of new stations on Brisbane's Eastern Busway by installing solar panels and LED lighting.

What's counted?

The IS tool covers six themes and 15 categories, including, for example, energy and carbon, urban and landscape design, and materials and management systems. Projects are awarded credits on the basis of sustainability measures taken in the design, construction and operation stages, which combine to produce an overall score on a 100-point scale.

In terms of energy and carbon, credits are given for measuring and reducing the carbon footprint of projects; for using energy from renewable sources; and for cutting costs by reducing energy use and greenhouse gas emissions.

In the materials category, designers and contractors need to consider the embedded energy in different materials; the amount of energy produced in transporting them; and overall environmental impact. To measure the life cycle impact of different materials, AGIC is launching a new 'ecopoints' materials calculator, which can be downloaded from the AGIC website.

Based on the latest Australian data from the Built Products Innovation Council, the calculator gives the most ecopoints to materials with the worst environmental impact. Thus, one way participants can improve a project's rating is by swapping to materials with lower ecopoints.

Pilot project: Brisbane busway

Scott Losee, an AGIC board director, says the AGIC scheme went through two rounds of pilot testing involving 14 projects. "What we would really like to do now is encourage projects to come forward and offer themselves up for sustainability ratings."

He cites initiatives taken during the construction of a one-kilometre section of the Eastern Busway in Brisbane as examples of changes that could win a project a higher sustainability rating. The development, which began in 2008, was completed by the Eastern Busway Alliance, consisting of Queensland Department of Transport and Main Roads, Leighton Contractors, SKM and AECOM.

Energy saving measures taken by the

alliance partners included installing solar lighting at some construction car parks, producing around 1552kWh of renewable energy a year. Solar panel systems were placed on the roofs of the busway stations and LED lighting was used in the bus stations and on medians, "which had a significant operational cost saving".

About half of the 100 houses in the path of the busway were relocated, while 94% of material from the other houses was recycled. More than 53,000 cubic metres of excavated fill was reused on site, abating 310 tonnes of greenhouse gas emissions.

Originally the plans showed a section of the bus lane going through a tunnel-like structure on Norman Creek, but Losee says "that was redesigned to remove the covered area, saving a lot of lighting and reducing embodied energy. The data we have shows an estimated saving of 85 million kilowatt-hours over a 100-year lifetime. This, together with a couple of other design changes, saved nearly $700,000 a year in electricity costs."

"That's what we're excited about in this area of infrastructure. You probably wouldn't even think about the kind of lighting used in this type of infrastructure—we take it for granted. But when you run the lights for the entire life of the facility, they chew up a fair bit of power."

Volker Richter, Systems and Commercial Manager for Leighton and a key member of the Eastern Busway Alliance management team, says that from the outset the alliance tried to make the development as sustainable as possible. They already knew about the planned IS ratings when they were approached by AGIC to take part in the pilot project. "I suppose we were aiming to get some kind of AGIC rating, regardless of what that was."

He says his firm had been keen to "provide a better sustainable outcome from a construction perspective." Leighton and the other alliance partners assisted AGIC in assessing the tool and gave feedback.

"From Leighton's corporate perspective, sustainability is one of our values, so we are keen to learn more and do more and provide sustainable projects." He says this goes beyond meeting the regulatory requirements to report on greenhouse gas emissions, waste and so on.

Richter says the AGIC ratings will challenge constructors, owners and operators and might drive them to seek alternative solutions and better outcomes. "I think there will be a bit of competition to get the first project with the highest AGIC rating. I strongly believe that."

He says Leighton will definitely be going for IS ratings on its projects. "We'd like to get the Eastern Busway assessed by AGIC. It definitely would be nice to see what we actually did deliver." ✱

For more information:
www.agic.net.au/ISratingscheme1.htm
info@agic.net.au

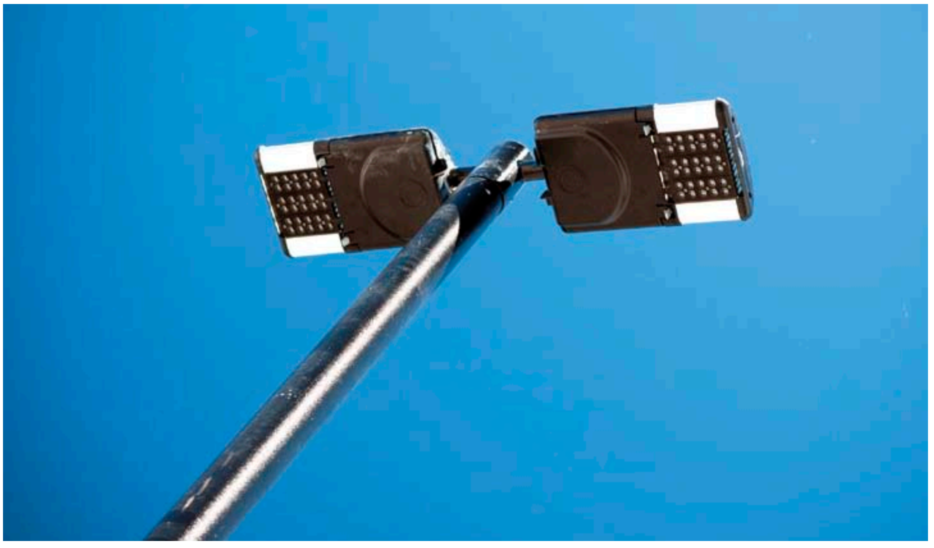


Photo: Eastern Busway Alliance

↑ LEDs light Brisbane's Eastern Busway.

The most efficient electric heating
A heat pump buyers guide

Electric heating is often the only option for many people with no access to natural gas. But not all electric heating systems are the same. Lance Turner examines why heat pumps come out on top.

WHEN most people think of electric heating, the images that come to mind are bar heaters or fan heaters. No matter what type of electric heating you have, they all have the same efficiency in turning electricity into heat—100% (i.e. 1kWh of electricity produces 1kWh of heat). All except one, that is.

Unlike other forms of electric heating, which use resistive elements of one form or another to turn the electricity into heat directly, there's one type of electric heating that is much more than 100% efficient—heat pumps.

Heat pumps are all around us. Your fridge is a heat pump, but it only works in one direction. True heat pumps are bidirectional, and when used for space heating and cooling they are more commonly known as reverse-cycle air conditioners. Traditionally, air conditioners were used to cool homes, but some bright spark realised that they could be used backwards and so the reverse cycle system was born.

So what exactly is a heat pump and how can it be more than 100% efficient? As its name suggests, a heat pump pumps heat from one place to another. Instead of turning energy from one form (electricity) into another (heat), it uses electric energy to move heat from one place to another. Because heat is relatively easy to collect and move, heat pumps can move a lot more heat energy than the electric energy they use. For a brief explanation of how heat pumps work, see the 'Heat pump basics' box at right.

Efficiency: COP and EER

The beauty of these systems is that a great deal of heat can be moved from one place to another with a relatively small amount of energy input. This means that you can heat several rooms for the same energy input that would be needed to heat just one room using a resistive-type electric heater. In effect, the system has an efficiency greater than 100%.

Another advantage of using heat pumps is that your greenhouse gas emissions from heating will be much lower than from using electric resistive heating. Further, if you use 100% GreenPower, your heating will effectively have zero emissions.

The efficiency of heat pump systems is given by a coefficient of performance (COP). This is a ratio of the heat moved to the electrical energy input. As an example, if your heat pump uses 1kWh of electricity to move 4kWh of heat from outdoors to inside your home, then it has a COP of 4. There are actually two terms that mean the same thing, but are used in different situations to avoid confusion. When a system is cooling a home, its cooling efficiency is referred to as its energy efficiency rating (EER), while when heating it is called the COP. For this guide, we are only looking at heat pump systems that have COPs of 4 or greater (well, 3.9 or greater to be exact). There are a surprising number of those, as can be seen in the tables.

↑ A complete system consists of the air handling unit (top), the compressor unit and, of course, a remote control.

Other terminology

While we are talking technical, there are a few more terms we should clarify. All of the systems in the tables are what's known as split systems. This means that, unlike the older style air conditioners, where evaporator, condenser, compressor and all the other bits were inside one large box, split systems have them separated and linked by flexible or rigid high-pressure hoses or pipes.

Split systems have the compressor and one set of coils in a box outside, often mounted against a wall. The part that fits inside the home is called the air handling unit and consists of the other set of coils, a fan to force air over them and the electronic controls for the system.

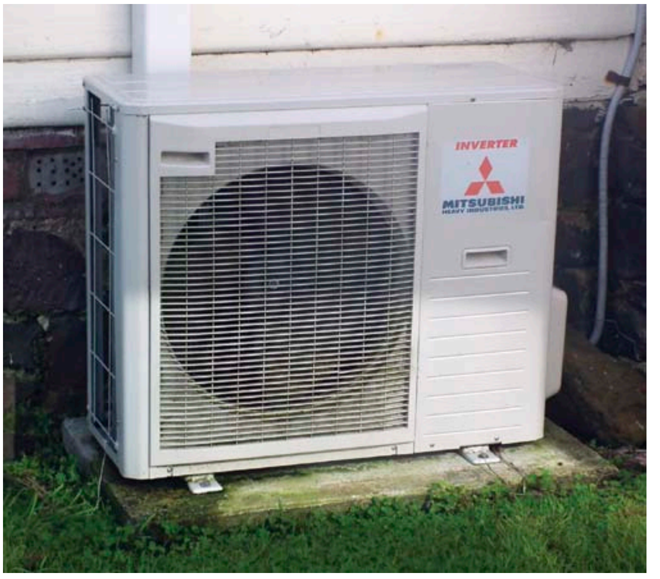
Air handling units are usually 'wall hung' but there are other types, including floor mounted and 'cassette' types, which are mounted in the ceiling.

Virtually all high-efficiency split system heat pumps are of the inverter type. What this means is that instead of the compressor motor simply being on and off (remember the clunk when your old box air conditioner switched its compressor on and off?), the compressor is controlled by a variable-speed drive or inverter. This allows the compressor to only run as hard as required, making the system more efficient and reducing electricity use.

The split system has several advantages over older all-in-one systems. Firstly, the bit inside the home is more compact. Secondly, you don't have to cut a hole in a wall or sacrifice a window to install them. All they need is a couple of small holes for piping and cabling.

Also, because the heating and cooling sections of the system are well separated, there is no leakage of heat from the hot side to the cool side, thus improving system efficiency.

And lastly, because the compressor is outside, they are less noisy as the only noise is from the circulating fan.



→ The compressor unit of a split system. Mounting it in full sun with a deciduous tree for summer shade can improve system efficiency.

Refrigerants

We should take a quick look at one of the critical components of a heat pump—the fluid that does all the work, the refrigerant.

In decades past, all sorts of scary and environmentally damaging fluids were used, including CFCs (chlorofluorocarbons, the ozone destroyers), HCFCs (hydrochlorofluorocarbons—better for the ozone layer, but strong greenhouse gases) and many others. For a full list of the many refrigerants, see en.wikipedia.org/wiki/List_of_refrigerants.

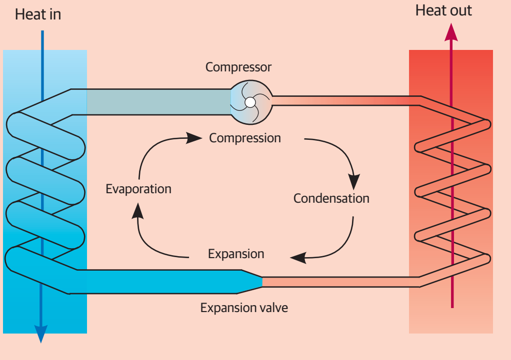
The most common refrigerant in domestic heat pumps seems to be R410A, which is a mixture of difluoromethane (CH_2F_2, called R-32) and pentafluoroethane (CHF_2CF_3, called R-125). While it is ozone-layer friendly, it has a greenhouse-gas potential estimated at around 1725 times that of CO_2.

System compromises

To keep costs down, some manufacturers compromise designs to some degree, which can reduce system efficiency.

The most easily seen example of this is the use of the same size air handling unit on compressor units of different sizes. If you look at the specifications of the different models in some manufacturers' ranges you will see that the air handling units of systems with progressively larger compressors are the same. The manufacturer increases compressor size and therefore heating and cooling capacity, but uses the same sized air

Heat pump basics



Heat pumps use a closed system that contains a liquid with a low boiling point, called the refrigerant. A compressor adds energy to the refrigerant as well as increasing the pressure, forming a superheated vapour. This enters a set of coils known as the condenser where the vapour forms back into a liquid, giving up some of its heat energy in the process. It then flows through an expansion valve where the pressure is abruptly reduced, causing some of the refrigerant to form a vapour. It then flows into another coil called the evaporator where it absorbs heat and flows back to the compressor and the cycle repeats.

In a cooling-only air conditioner, or a fridge or freezer, the evaporator is inside the house or fridge cabinet and the condenser is outside. This is why the back of the fridge gets warm.

In a reverse-cycle system, the system uses a reversible expansion valve and so the inside cooling coils can be either evaporator for cooling or condenser for heating. Of course, the same applies for the outdoor coils.

handling unit for all models. This means the larger capacity models in the range will be less efficient, and you can actually see this when looking at specifications side by side. A manufacturer might compromise efficiency like this to save manufacturing costs—it's a lot cheaper to produce one size of air handling unit rather than a different one for each model in the range. I won't single out individual manufacturers who do this, but bear it in mind when checking specifications.

Improving system efficiency

So, is there anything you can do yourself to improve system efficiency? There are actually a number of things. The lower the temperature differential between the condenser and evaporator, the more efficient the system will run and the less energy it will use to move a specified amount of heat.

The first thing to consider is the placement of the compressor unit. It should be placed outside in full winter sun if possible, but should be shaded with a deciduous tree or shrub during summer. This allows it to be heated by winter sun and so collect heat more efficiently, thus improving system efficiency when heating in winter.

In summer, the compressor will be shaded by the vegetation and so will be more effective in expelling heat. This simple trick can improve efficiency and reduce running costs.

This lowering of temperature differential is also the trick used by a special type of heat pump which rather than using the air as a source or sink for heat, uses the ground or a body of water.

The temperature of the earth even just a couple of metres below the surface is quite stable throughout the year, varying far less than ambient air temperature. By dumping excess heat into the ground in summer and extracting it from there in winter, greater efficiencies in heat pump systems can be achieved.

Such systems are known as ground-source heat pumps (sometimes less accurately called geothermal heat pumps) and although they can achieve quite high COPs, they can be expensive to install. Rather than having a compact external compressor and coil unit, they dissipate or extract heat using a series of coils or pipes buried in the ground, either horizontally (when there is adequate yard space available) or vertically (where space is limited). The big disadvantage with such systems is their cost—they can cost many times what a conventional air-source heat pump will cost, and at current installation and energy prices they may not pay back the difference in many cases. However, if reduced energy consumption is your primary concern, then a ground-source heat pump should be considered.

A compromise between ground-source and air-source heat pumps is the water-source heat pump. These use a body of water for heat extraction and dissipation, so are only applicable to sites where a large volume of water, such as a dam, lake or large water storage tank is available. They cost more to install than an air-source heat pump but less than a ground-source system, as coils are simply placed in the body of water, so there are no drilling or trenching costs.

Having said this, there are very few ground-source or water-source systems available for domestic use in Australia. The ground- and water-source heat pump industry is yet to become competitive, which will ultimately drive prices down. Because of this, we are not looking at these systems further in this guide.

> "Don't get too excited about all the built-in gadgetry—after all, how much of it will you actually use, and how much of it will you forget about after the first week."

Other efficiency measures

Most air conditioners have filters inside the air handling unit to remove dust from the air. These should be cleaned around once a month when the unit is in use. They can usually just be washed with warm soapy water, rinsed and dried.

Like any heating system, a heat pump will use less energy if the home it is trying to heat doesn't leak heat like a sieve. The more efficient your home at preventing thermal transfer, the less energy your system will use and the more comfortable you'll be.

This means that you need to take all the usual efficiency measures, such as insulating roofs and walls (and under floors if possible), sealing draughts, and insulating windows with either double glazing, curtains and pelmets, or both. Remember, the better insulated the home, the less energy needed to heat and cool it, and the smaller, and therefore cheaper, the heat pump system you need to install. In short, spend some money on energy efficiency measures up front and you will save in both the long and short term, especially as energy costs continue to rise.

Features

As technology has improved and manufacturing has become cheaper, a number of features have been added to systems. These include improved filtration (such as long life filters that only need washing every six months), air ionisation (to disinfect the air), high efficiency fan designs to reduce energy use and fan noise, variable speed compressors (usually using DC motors), remote controls with timer functions, adjustable airflow patterns, economy modes, infrared sensors to reduce operation when rooms are empty, humidity sensors, and many other features, which may or may not be of use to you.

When looking for a system, don't get too excited about all the built-in gadgetry—after all, how much of it will you actually use, and how much of it will you forget about after the first week. There's no point paying for extra features if you really don't need them.

Other options

Most manufacturers allow system components to be mixed and matched to some degree, or at least provide several options for each system. For instance, if you only want to heat one room then you might buy one standard air handling unit and the appropriately sized compressor, but if you need to heat more than one room then many systems are available as a larger compressor unit that can have two or more air handling units connected.

Sizing a system

So, you've decided to go for a heat pump system but don't know what size you will need. How do you find out?

All heat pumps have a rated heating and cooling capacity, so you need to have a basic idea of how much heat is flowing into and out of your home.

Doing such an assessment is beyond the scope of this article, and is really something an energy assessor should help you with. There are many assessors available who can provide such services, and a number of online resources available to help you find one in your area, such as the ABSA website (www.absa.net.au) or the NatHERS site at www.nathers.gov.au.

However, if an assessment is not in the budget, then you can make an educated guess with a bit of basic knowledge.

For instance, if you are heating just one room and find that a 2400 watt fan heater can keep up with heat losses, then you know the minimum heating capacity required. Indeed, as crude as it sounds, this is actually one of the simplest ways to find out how much heat you need. Set up a fan heater or two on a cold day and see how it goes. If the room is still cold after half an hour then you have some more insulating and/or sealing to do. If it is nice and toasty warm then simply buy the most efficient system with a rated heat output of at least the fan heater(s) capacity.

You might want to oversize your system a little if you suffer from heat stress during the summer months, but don't overdo it too far as the system will be oversized for at least half of the year.

What about ducted systems?

Ducted systems sound great in theory—you can keep the entire home at a comfortable temperature. However, there's a large price to pay for this, and that's energy consumption (and therefore energy waste). After all, you can only use one room at a time, and most people, even families, will tend to spend most of their time in one room or another, such as the lounge room or study. Heating all the other rooms, whether they are used or not, is a bit pointless. If you need heat in rooms you visit for a few minutes each day, such as the bathroom, then use spot heating such as radiant heaters. A 1kW radiant heater used for 15 minutes uses just 250 watt-hours of energy—much less than if you were to heat that room continuously, even with a heat pump.

Of course, ducted systems can often be used selectively, to only heat a few rooms at a time, but most users tend to not do that and instead just leave all rooms heated. The very nature of ducted systems encourages owners to waste energy heating seldom used rooms unnecessarily.

If you need to heat more than one room, get either several smaller high-efficiency units or a larger compressor that can take multiple air handling units.

About the tables

The table headings are fairly self-explanatory and cover many of the systems available in Australia and New Zealand with COPs of 4 or better. Note that all of these units are split systems with single wall-hung air handling units—that tells you a lot about the efficiency of such a design. Heating capacities range from just over 2kW to more than 11kW—which should be enough to heat a well sealed and insulated home. If you need more than 11kW of heat then there's some more work to do insulating and draught excluding! *

Brand	Model	Air handling unit type	Available	Country of manufacture	Star rating - cooling	Output - cooling (kW)	Power input - cooling (kW)	EER (cooling)	Star rating - heating	Output - heating (kW)	Power input - heating (kW)	COP (heating)	Variable output compressor
Daikin	FTXS20K / RXS20K	Wall hung	Australia, New Zealand	Thailand	4	2	0.45	4.4	4	2.7	0.61	4.4	Yes
Daikin	FTXS20L / RXS20L	Wall hung	Australia, New Zealand	Thailand	4	2	0.45	4.4	4	2.7	0.61	4.4	Yes
Daikin	FVXS25K / RXS25K	Floor mounted	Australia, New Zealand	Thailand	3.5	2.46	0.59	4.2	3.5	3.33	0.79	4.2	Yes
Daikin	FVXS25K / RXS25K, RXS25LA	Floor mounted	Australia, New Zealand	Thailand, Japan	3.5	2.46	0.59	4.2	3.5	3.33	0.79	4.2	Yes
Daikin	FTXS25L / RXS25L	Wall hung	Australia, New Zealand	Thailand	4.5	2.5	0.54	4.6	5	3.4	0.7	4.9	Yes
Daikin	FTXS25K / RXS25K	Wall hung	Australia, New Zealand	Thailand, Japan	4	2.5	0.58	4.3	4	3.4	0.79	4.3	Yes
Daikin	FTYN25K / RYN25K	Wall hung	Australia, New Zealand	Thailand	3	2.5	0.63	4.0	3.5	3.4	0.8	4.3	No
Daikin	FTXR28K / RXR28K	Wall hung	Australia, New Zealand	Thailand, Japan	4	2.77	0.57	4.9	4.5	3.57	0.71	5.0	Yes
Daikin	FTXS35L / RXS35L	Wall hung	Australia, New Zealand	Thailand	3	3.5	0.91	3.8	4.5	4	0.88	4.5	Yes
Daikin	FTXR42K / RXR42K	Wall hung	Australia, New Zealand	Thailand, Japan	2.5	4.2	1.07	3.9	3.5	5.08	1.17	4.3	Yes
Daikin	FTXS50L / RXS50L	Wall hung	Australia, New Zealand	Thailand	3	5	1.32	3.8	3.5	6	1.47	4.1	Yes

Brand	Model	Air handling unit type	Available	Country of manufacture	Star rating – cooling	Output – cooling (kW)	Power input – cooling (kW)	EER (cooling)	Star rating – heating	Output – heating (kW)	Power input – heating (kW)	COP (heating)	Variable output compressor
Fujitsu	ASTG09LVCA	Wall hung	Australia, New Zealand	China	4	2.5	0.58	4.3	4.5	3.4	0.73	4.7	Yes
Fujitsu	ASTG09LUCA	Wall hung	Australia, New Zealand	China	3	2.5	0.58	4.3	4	3.4	0.78	4.4	Yes
Fujitsu	AGTV09LAC	Floor mounted	Australia, New Zealand	China	3.5	2.6	0.6	4.3	3.5	3.5	0.81	4.3	Yes
Fujitsu	ASTG12LVCB	Wall hung	Australia, New Zealand	China	3.5	3.5	0.92	3.8	4	4.8	1.11	4.3	Yes
Fujitsu	AWTZ14LBC	Wall hung	Australia, New Zealand	China	3	4.2	1.02	4.1	4	6	1.35	4.4	Yes
Fujitsu	ASTG18LVCB	Wall hung	Australia, New Zealand	China	2	5	1.53	3.3	3.5	6	1.49	4.0	Yes
Haier	HSU-12HEG03/R2(DB)	Wall hung	Australia, New Zealand	China	2.5	3.5	0.92	3.8	3.5	3.7	0.96	3.9	Yes
Haier	HSU-12HEK03/R2(DB) / HSU-12HEG03/R2(DB)	Wall hung	Australia, New Zealand	China	2.5	3.5	0.92	3.8	3.5	3.7	0.96	3.9	Yes
Haier	HSU-18HEG03/R2(DB)	Wall hung	Australia, New Zealand	China	2	5	1.48	3.4	3.5	5.4	1.4	3.9	Yes
Haier	HSU-18HEK03/R2(DB) / HSU-18HEG03/R2(DB)	Wall hung	Australia, New Zealand	China	2	5	1.48	3.4	3.5	5.4	1.4	3.9	Yes
Hisense	HAC9IR	Wall hung	Australia	China	4	2.6	0.6	4.3	4	2.8	0.65	4.3	Yes
Kelvinator	KSV26NRC	Wall hung	Australia, New Zealand	China	5	2.5	0.5	5.0	5	2.6	0.52	5.0	Yes
Kelvinator	KSV26HRC	Wall hung	Australia, New Zealand	China	3.5	2.65	0.65	4.1	3.5	2.9	0.75	3.9	Yes
Kelvinator	KSV35NRC	Wall hung	Australia, New Zealand	China	3.5	3.5	0.86	4.1	3.5	4	0.99	4.0	Yes
LG	R09AWN-NB10/R09AWN-UB10	Wall hung	Australia, New Zealand	Republic of Korea	4	2.5	0.56	4.5	4	3.21	0.73	4.4	Yes
LG	E09AWN-NB11/R09AWN-UB11	Wall hung	Australia, New Zealand	Republic of Korea	4	2.5	0.56	4.5	4	3.21	0.73	4.4	Yes
LG	R09AWN-NB11/R09AWN-UB11	Wall hung	Australia, New Zealand	Republic of Korea	4	2.5	0.56	4.5	4	3.21	0.73	4.4	Yes
LG	M09AWN-NB11/R09AWN-UB11	Wall hung	Australia, New Zealand	Republic of Korea	4	2.5	0.56	4.5	4	3.21	0.73	4.4	Yes
LG	E12AWN-NB11/R12AWN-UB11	Wall hung	Australia, New Zealand	Republic of Korea	3	3.5	0.9	3.9	3.5	4	0.98	4.1	Yes
LG	M12AWN-NB11/R12AWN-UB11	Wall hung	Australia, New Zealand	Republic of Korea	3	3.5	0.9	3.9	3.5	4	0.98	4.1	Yes
LG	R12AWN-NB11/R12AWN-UB11	Wall hung	Australia, New Zealand	Republic of Korea	3	3.5	0.9	3.9	3.5	4	0.98	4.1	Yes
LG	R22AWN-NC10/R22AWN-UC10	Wall hung	Australia, New Zealand	Republic of Korea	2.5	6.3	1.8	3.5	3.5	7.1	1.82	3.9	Yes
LG	E22AWN-NC11/R22AWN-UC11	Cassette	Australia, New Zealand	Republic of Korea	2	6.5	1.92	3.4	3.5	7.1	1.82	3.9	Yes
LG	UTN24WH/UU24WH	Cassette	Australia, New Zealand	Republic of Korea	2	7	2	3.5	3.5	8	1.94	4.1	No
LG	UTN36WH/UU36WH	Cassette	Australia, New Zealand	Republic of Korea	3	10	2.6	3.8	4	11.2	2.54	4.4	Yes
Mitsubishi Heavy Industries	SRK20ZJ-S1	Wall hung	Australia, New Zealand	Thailand	4	2	0.44	4.5	3.5	2.7	0.62	4.4	Yes
Mitsubishi Heavy Industries	DXK09ZJ-S	Wall hung	Australia, New Zealand	Thailand	3.5	2.5	0.58	4.3	4.5	3.2	0.7	4.6	Yes
Mitsubishi Heavy Industries	SRK25ZJ-S1	Wall hung	Australia, New Zealand	Thailand	3.5	2.5	0.58	4.3	4.5	3.2	0.7	4.6	Yes
Mitsubishi Heavy Industries	DXK12ZJ-S	Wall hung	Australia, New Zealand	Thailand	3	3.3	0.87	3.8	3.5	4	0.96	4.2	Yes
Mitsubishi Heavy Industries	SRK35ZJ-S1	Wall hung	Australia, New Zealand	Thailand	3	3.3	0.87	3.8	3.5	4	0.96	4.2	Yes
Panasonic	CS_CU-E7MKR	Wall hung	Australia, New Zealand	Malaysia	3.5	2.05	0.46	4.5	4	2.8	0.62	4.5	Yes
Panasonic	CS-RE9MKR/CU-RE9MKR	Wall hung	Australia, New Zealand	China	3	2.5	0.65	3.8	3.5	3.3	0.81	4.1	Yes
Panasonic	CS_CU-E9MKR	Wall hung	Australia, New Zealand	Malaysia	4.5	2.6	0.55	4.7	4.5	3.6	0.75	4.8	Yes
Panasonic	S-100PU1R5/U-100PE1R5	Cassette	Australia, New Zealand	China	3	10	2.38	4.2	4	11.2	2.6	4.3	Yes
Samsung Electronics	AQV09KWAN/AQV09KWAX	Wall hung	Australia, New Zealand	China	5	2.4	0.47	5.1	5	3.1	0.6	5.2	Yes
Samsung Electronics	AQV09UWLN/AQV09UWLX	Wall hung	Australia, New Zealand	Thailand	4	2.5	0.56	4.5	4.5	3.2	0.7	4.6	Yes
Samsung Electronics	AQV12KWAN/AQV12KWAX	Wall hung	Australia, New Zealand	China	4	3.5	0.82	4.3	4	4	0.89	4.5	Yes
Samsung Electronics	AQV12UWLN/AQV12UWLX	Wall hung	Australia, New Zealand	Thailand	3	3.5	0.92	3.8	3.5	4	0.99	4.0	Yes
Samsung Electronics	NS1004ZXEA/RC100ZHXEA	Under ceiling	Australia, New Zealand	Republic of Korea	4	10	2.33	4.3	4.5	11.2	2.46	4.6	Yes
Samsung Electronics	NS1004PXEA/RC100PHXEA	Under ceiling	Australia, New Zealand	Republic of Korea	3.5	10	2.5	4.0	4	11.2	2.61	4.3	Yes
Solakool	CSE-35GW	Wall hung	Australia, New Zealand	China	3.5	3.6	0.86	4.2	3.5	3.91	0.95	4.1	Yes
Toshiba	RAS-10SKVR-A + RAS-10SAVR-A	Wall hung	Australia, New Zealand	Thailand	3	2.5	0.6	4.2	3.5	3.2	0.75	4.3	Yes
Toshiba	RAS-10SKV2-A + RAS-10SAVR-A	Wall hung	Australia, New Zealand	Thailand	3	2.5	0.6	4.2	3.5	3.2	0.75	4.3	Yes
Toshiba	RAS-10SKVP2-A/RAS-10SAVP2-A	Wall hung	New Zealand	Thailand	4.5	2.51	0.49	5.1	4.5	3.21	0.63	5.1	Yes
Toshiba	RAS-10SKVP2-A + RAS-10SAVP2-A	Wall hung	Australia, New Zealand	Thailand	4.5	2.51	0.49	5.1	4.5	3.21	0.63	5.1	Yes
Toshiba	RAS-10SKVP2-A + RAS-10SAVP2-A	Wall hung	Australia, New Zealand	Thailand	4.5	2.51	0.49	5.1	4.5	3.21	0.63	5.1	Yes


Waterless Toilets...
Save thousands of dollars
and 35,000 litres of water per year!
ECOFLO's toilets are manufactured to resemble flushing toilets but require no plumbers, septic tanks or water.
Pictured on the right is the Classic 750-2 which retails at $2450. Other models are available from $795
Visit ecoflo.net.au for product information or CALL 1300 768 013
ECOFLO
WATER MANAGEMENT


Eco Friendly
building solutions
Solar Power
Solar Hot Water & Heating
Efficient Lighting Products & Design
HELP US LIGHT UP
East Timorese homes with solar
We will donate a complete solar lighting system to a family in Timor leste, when you install solar power with EnviroShop Solar.
And RECEIVE 15% OFF THE PRICE OF YOUR SYSTEM*
ATA
Call us to find out how much we can save you!
1300 30 58 33
* For new solar power quotes only. Visit www.enviroshop.com.au/timor for full terms & conditions
enviroshop
THE SUSTAINABILITY EXPERTS
Solar
www.enviroshopsolar.com.au


NOW
ARCHITECTURE
ENVIRONMENT • INTERIORS • DESIGN
www.nowarchitecture.com
Contact us now to find out how we can we make a difference for your project.
• 27 years ESD experience
• Fully integrated Sustainable Design
• Multi-award winning practice
• Timeless quality & Innovative solutions
• 3D Visualisation for all projects
46 St. DAVID ST, FITZROY (03) 8412 8200


ecoLED Tube
Saving Energy & the Environment
No mercury - Friendlier alternative to fluorescent lamps
Install in its place
C-Tick Approved For Australia & New Zealand
Half your energy bills
18W for 4ft (120cm)
9W for 2ft (60cm)
WHY CHANGE TO ECOLED TUBES?
Saves energy costs - half the power
Long life - 50,000 hours
Eco friendly, no mercury, no lead
No glass to break
Steady light, no strobing, no interference
No flicker, no buzz, no irritation
High brightness, high efficiency
Direct replacement for T8 fluorescent tube
No starters - no maintenance
TENROD
Serving you with 20 years of LED experience
Website: www.tenrod.com.au
E-mail: sales@tenrod.com.au
Sydney: Tel. 02 9748 0655 Fax. 02 9748 0258
Melbourne: Tel. 03 9886 7800 Fax. 03 9886 7799
Brisbane: Tel. 07 3879 2133 Fax. 07 3879 2188
Auckland: Tel 09 298 4346 Fax. 09 353 1317

Understanding EV emissions
Are electric vehicles really so great?

Does it really make a difference to your emissions if you buy an EV but run it on fossil-fuel-generated electricity, compared to sticking with the petrol guzzler? Bryce Gaton examines this issue.

↑ Will buying an electric vehicle like the Nissan Leaf really reduce your emissions compared to a petrol car?

YOU'VE bought an electric vehicle (EV), so you're no longer using fossil fuel, right? Not quite: if you use electricity generated from fossil fuels, you're still causing CO_2 emissions somewhere—just not in your immediate vicinity.

The question that I address in this article is: Does owning an EV make any difference to your personal transport emissions? To investigate this, I will look at three scenarios for calculating your personal transport CO_2 emissions:

1. Buy an EV for city driving, but do no other CO_2 reduction measures
2. Combine an EV with a solar array at home
3. Other methods for reduction of CO_2 for EV electricity consumption.

Scenario 1: Buy an EV for city driving, but take no other CO_2 reduction measures

For this scenario, the exact answer will depend on where you live. Burning different fossil fuels, such as brown or black coal, or natural gas, produces different amounts of CO_2 and other greenhouse pollutants (together referred to as CO_2-e: see note 2). On top of this, some states also use hydroelectricity and wind power, which produce significantly less CO_2-e emissions.

Therefore, as individual states and territories use different mixes of brown or black coal, natural gas, hydro and wind to generate electricity, any analysis of electricity CO_2-e will need to take account of where the EV is used.

A second complication is that the figures generally stated for CO_2 emissions for new internal combustion engine (ICE) cars are not the full story. The best figure to use, and the figure used in carbon accounting processes, is CO_2-e. A comparison of EVs on fossil-fueled electricity and ICE vehicle emissions needs to be made on an 'apples with apples' basis.

For calculations 1 and 2 below, the data is sourced from the Green Vehicle Guide website (www.greenvehicleguide.gov.au) and the *National Greenhouse Accounts (NGA) Factors* report published by the Department of Climate Change and Energy Efficiency in July 2011.

Calculation 1: Internal combustion engine CO_2-e emissions

Vehicle: Current model Toyota Corolla; 1.8L petrol, auto, city cycle, 9.9L/100km

Assumptions:

- Vehicle travels 10,000km per year
- Rounding of 9.9 to 10L/100km in initial calculation for simplicity
- City cycle chosen as most comparable to EV use.

Calculations:

- 10,000km per year at 10L/100km gives a total of 1000L used in a year (= 1kL)
- Direct emissions = burning of the fuel: 2380kg of CO_2-e (see table 4 in *NGA Factors*)
- Indirect emissions = extraction, transport etc of fuel: 181kg of CO_2-e (see table 38 in *NGA Factors*)
- Grand total: 2.561 tonnes of CO2-e per year to run your Corolla. (Note: exact figure using 9.9L/100km is given in Table 1.)

Vehicle	City: L per 100km/tonnes CO_2-e per 10,000km	Combined: L per 100km/tonnes CO_2-e per 10,000km
Land Rover V8 5.0L	20.8/5.33	14/3.585
Commodore V6 3.0L	12.3/3.15	8.9/2.279
Toyota Corolla 1.8L	9.9/2.536	7.5/1.920
Mazda 2	8.9/2.280	6.8/1.741
Smart Fortwo	6.3/1.613	4.9/1.255

Table 1: CO_2-e emissions for a selection of petrol-powered vehicles.

For completeness, Table 1 shows the calculations for five vehicles in both the combined and city cycles, as given on the Green Vehicle Guide website. I have selected the automatic option for all five cars as automatics are the most common transmission choice in Australia.

Calculation 2: So what about your EV?
Vehicle: Current model Mitsubishi iMiEV; 135Wh/km (see note 3). Mass-market vehicle chosen in order to make like-for-like test cycle comparisons with ICE vehicles. For owners of retrofit EVs, try swapping your own figures into the calculations below.

Assumptions:

- Vehicle travels 10,000km per year
- EV wall-charger efficiency of 93%

Calculations:

- Vehicle usage per year: {135 x 10,000 x (100/93)}/1000 = 1452kWh
- Table 2 shows the CO_2-e emissions calculations for the Mitsubishi iMiEV in each state and territory in Australia.

Conclusions from scenario 1

Unless you are replacing a small to micro ICE car (e.g. Mazda 2 or Smart Fortwo) for a combination of city and extended driving in Victoria, you have reduced your CO_2-e emissions. By running an EV as your substitute city-driving vehicle, you reduce your CO_2-e emissions from around 14% (Mazda 2 replacement for city driving in Victoria) to 90% (Land Rover V8 replacement for city driving in Tasmania).

Scenario 2: Combine an EV with a solar PV system at home

The first consideration is whether any solar PV system could supply enough electrical energy to meet the annual needs of both a home plus EV charging. A few more calculations are in order.

Assumptions:

- An energy conscious, energy-efficient home using 5kWh per day (see note 5)
- Mitsubishi iMiEV travelling 10,000km per year and using 135W/km.

Calculations:

- Home usage per year: 5 x 365 = 1825kWh
- Vehicle usage per year: {135 x 10,000 x (100/93)}/1000 = 1452kWh
- Total energy consumption for home and EV per year = 3277kWh.

Assuming a 2.5kW PV system generates 3300kWh per year, a system this size would be the minimum required to meet the total energy consumption requirements of 3277kWh. Realistically, a 3 to 4kW system would provide a more balanced energy supply over the summer/winter generation peaks and troughs, depending on individual household usage patterns. To properly match a PV system size to an individual household is beyond the scope of this article, so I will assume a 4kW system is ample.

Conclusions from scenario 2

The simple answer is yes—combining a suitably sized solar PV system, an energy efficient lifestyle and an EV could be argued as together making your home and EV energy consumption 'carbon free'.

However, most of your EV charging will be done when at home during the night. So is it really carbon-free energy at a time when your PVs produce no power and you are potentially charging your EV via coal- or gas-fired electricity generators? It is certainly far cheaper to charge your EV on off-peak power, (especially if you get a premium feed-in tariff for your PV system during the day), but the sun going down does not magically increase the energy potential (or decrease the CO_2-e) of a lump of brown coal!

On the other hand, it certainly can be argued that a grid-connected PV system 'banks' excess generation in the day and 'redraws' it at night. It follows that by having a grid-connected PV system, you have prevented the need for building bigger generators (with bigger base-load CO_2-e emissions) to provide energy in peak periods. However, it still is a fact that in this scenario something like 40% of an EV-owning household's electrical energy usage is potentially running off fossil-fuelled generation.

State/territory	kg CO_2-e/kWh See note 4	kg CO_2-e /10,000km	tonnes CO_2-e /year
New South Wales and Australian Capital Territory	1.06	1.06 x 1452	1.539
Victoria	1.35	1.35 x 1452	1.960
Queensland	1.00	1.00 x 1452	1.452
South Australia	0.81	0.81 x 1452	1.176
South West Interconnected System in Western Australia	0.93	0.93 x 1452	1.350
Tasmania	0.33	0.33 x 1452	0.479
Northern Territory	0.75	0.75 x 1452	1.089

Table 2: CO_2-e emissions for Mitsubishi iMiEV, in each state/territory in Australia.

Therefore, the more nuanced answer to scenario 2 is that yes, you have reduced your CO_2-e emissions further by installing PV panels to go with your EV, but you are not yet carbon neutral.

Scenario 3

So how can you make your EV have no net effect on your overall CO_2-e emissions? This is where scenario 3 comes in, with additional methods for reduction of emissions.

One solution to address the emissions of your increased overnight usage (or for those unable to access enough sun, wind, micro-hydro or other renewable energy) is to subscribe to 100% GreenPower or related offerings. These utilise large-scale renewable forms of electricity generation, such as wind, solar or hydroelectric generation, instead of fossil fuels (see note 6).

Another solution for those with solar PV systems is to install a rechargeable battery system in combination with your PV system. The batteries are charged by the PV system during the day and so you can recharge your EV at any time without resorting to drawing much, if anything, from the grid. Until now, such systems have been quite expensive. However, at least one new entrant to the EV market (EDay Life) will soon be offering a 'home energy management system' using this approach.

In conclusion

In almost all circumstances, buying an EV does reduce your personal transport energy CO_2-e emissions, even if you do nothing else. Furthermore, buying an EV gives you the potential to decouple from fossil-fuel dependence in a way that using the EV's ICE-propelled cousins doesn't.

Additionally, with a tailored combination of grid-connect solar PV, green power and/or a battery backup system, these emissions can be quite significantly reduced.

So good luck on your EV journey and enjoy the performance, silence and lack of petrol station visits along the way! ✱

Bryce Gaton is a member of the ATA's Melbourne Electric Vehicle Group, which meets on the 4th Wednesday of each month at Swinburne University. See www.ata.org.au/branches/melbourne-ev-branch.

Notes:

1. This article is limited in scope to the consideration of whether using electricity instead of fossil fuel for your vehicle is capable of making a beneficial change in your carbon footprint. Lifestyle and policy considerations around and beyond that (including public vs private transport debates, embedded emissions, emissions due to building roads vs public transport infrastructure) I leave to other forums and articles.
2. For example, the CO_2-e for burning transport fuels includes the direct greenhouse potential from NH_4 and N_2O as well as the CO_2 from combustion, as well as the indirect emissions from extraction, refining and transport.
3. The Mitsubishi iMiEV is the only EV currently on the market here that is listed on the Australian Green Vehicles Guide. For comparative purposes, I have stuck to the one Australian site to ensure like-for-like test cycle consumption comparisons. Other sites (e.g. the US site: www.fueleconomy.gov/feg/evsbs.shtml) use different test cycles and give different EV and ICE consumption values—but they are not directly comparable to the Australian test cycles and results so have not been used.
4. Direct and indirect electricity CO_2-e emissions per state, per kWh: NGA factors; July 2011, table 39
5. In my work as an energy auditor, I find home energy usage varies incredibly widely. However, 5 kWh/day for a well-run, reasonably efficient home of 3–4 people is an achievable target, and so have chosen this number based on my experience.
6. The economics, politics and credentials of green power and related offerings are discussed in other *ReNew* articles and are beyond the scope of a short paragraph in this article!

Solar PV and the meter box equation
Understanding your PV system better

There's more to what your home's energy meter is doing than meets the eye. Richard Keech takes an energy-accounting approach to understanding the energy measurements associated with domestic PV systems.

THE way solar electricity flows are accounted for in a typical domestic electricity meter is not always well understood. Central to this is a perspective on the energy flows encapsulated by a simple equation that I call the meter box equation. The meter box equation can help you answer questions such as, "how much money is my solar installation really saving me?"

This equation follows from the fundamental physical principle that energy is never created or destroyed—the first law of thermodynamics. Applied to electricity this is normally known as Kirchoff's current law but it's all much simpler than it sounds. In the case of generation from a grid-connected solar PV installation, this is about four different energy flows:

1. generated electricity, G, measured on your inverter
2. electricity imported, I, from the electricity grid, measured at your meter
3. electricity consumed by the household, C, which is not normally directly measured
4. electricity exported back to the grid, E, also measured at the meter.

Your electricity retailer simply sees all electricity flowing into your property as being consumed, but what goes on behind the meter can be a much more complex story. Electricity imported from the grid (I) is not necessarily the same as total electricity consumed by the household (C).

Meter basics

The old accumulation (spinning disc) meters have only one measurement element, in the same way that a car has one odometer. Imagine if driving backwards caused your odometer to wind back (it doesn't actually do this, as Ferris Bueller discovered the hard way in the movie). This is actually what happens, though, with the old spinning disc meters.

Modern digital meters can typically record electricity flow in two directions. These are generally called bi-directional or even 'smart' meters (with the 'smart' part generally referring to additional remote communications and control capability).

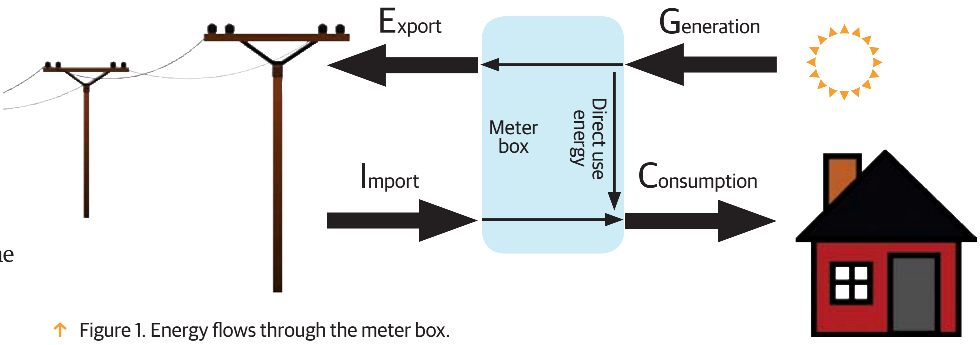
However, even though these meters can measure flows in both directions, they usually have just one measurement element. If the energy flows inwards, then one counter increments; if the energy flows the other way, then the other counter increments.

This is a bit like if our cars had a separate counter for the distance driven in reverse. You could imagine that forward distance is a bit like imported energy, and reverse distance is a bit like exported energy. Only one counter can be incrementing at any one time—just as a car can't be driving forward and backward simultaneously.

Typically known as import/export or net metering, when solar generation is in place these meters record the resultant electricity import or export after household consumption is taken into account.

As an example, if you consume one unit of electricity in your house at the same time as your PV generates one unit of electricity, then your meter will measure zero change

↑ What's really happening here?



↑ Figure 1. Energy flows through the meter box.

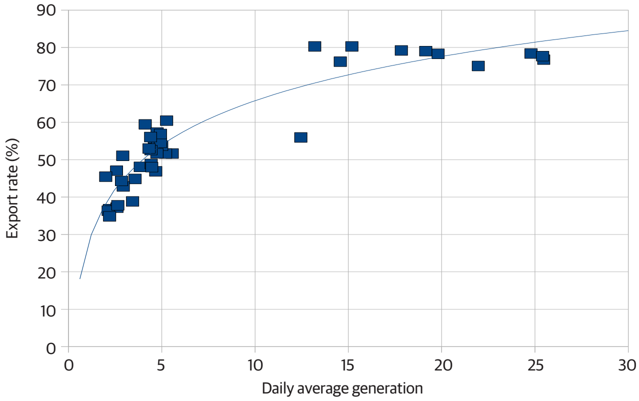


Figure 2. Generation versus export rate. Note the increase in PV capacity from 1.3kW to 5.0kW in 2011 led to higher generation and a higher export rate.

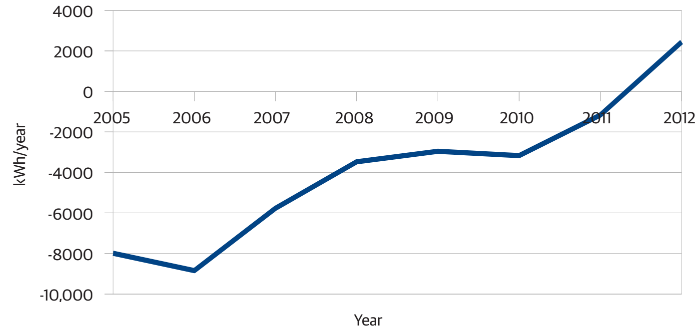


Figure 3. Richard's household energy balance. He should be achieving an energy surplus in 2012.

with regard to both imported and exported energy from the grid. If you consume two units of electricity in the house and are still only generating one from your solar system, then you will import (and purchase) an additional one unit from the grid—which will be recorded by your meter.

I've seen misunderstandings arise from not appreciating this meter box arrangement; for example, the person who says, "my meter is showing lower generation than my inverter, so my inverter must be lying". This person perhaps fails to see how solar generation and export to the grid are not the same thing.

Some meters have two measurement elements, and measure the full amount of solar generation as well as the import energy—this is known as 'gross' metering. Gross metering is not, however, typically in place in most states in Australia.

Calculating consumption

In its most simple form, the meter box equation is:

$$I + G = E + C$$

This expresses how electricity into the meter box equals electricity out. A typical PV installation will allow you to directly measure I, G and E in kWh using the meter and inverter.

The first useful implication of this formula is that it gives us a way to calculate C, the energy used by the household:

$$C = I + G - E$$

In the pre-PV household, one could simply assume that C = I since G and E are zero.

The term G - E corresponds to that part of the solar energy which is consumed directly in the household at the time it's generated. Let's call it the direct-use energy as in Figure 1. The equation tells us that this is the same as C - I, i.e. G - E = C - I.

Export rate

A concept often cited with respect to PV installations is the export rate, which is the proportion of generated electricity that is exported, i.e.

$$\text{Export rate} = E/G$$

The larger the PV installation for a given dwelling, the higher the export rate. This can be seen in Figure 2 reflecting an increase in my system's PV capacity from 1.3kW to 5.0kW in 2011.

Another useful way of looking at the same relationship is as:

$$E - I = G - C$$

This represents the energy balance over the period in which the measurement is taken. For example, if we have E and I measurements for both start and end of year, then (E_{end} - E_{start}) - (I_{end} - I_{start}) expresses whether the premises is a net importer or exporter of electrical energy for that year—or, to use economist speak, whether we're in surplus or deficit. In my own case, my quest to achieve energy surplus is shown in Figure 3, showing a projected surplus for 2012.

Calculating benefits

We can build on this to calculate economic benefit by including tariffs. Let's call the tariffs (in $/kWh) T_{peak} and T_{export}. Your electricity account will include a credit for E x T_{export}.

But a full reckoning of the benefit of solar includes an allowance for the avoided import, i.e. the cost of the energy you would be paying for if you didn't have the solar. Just looking at peak tariffs, this benefit is (G - E) x T_{peak}.

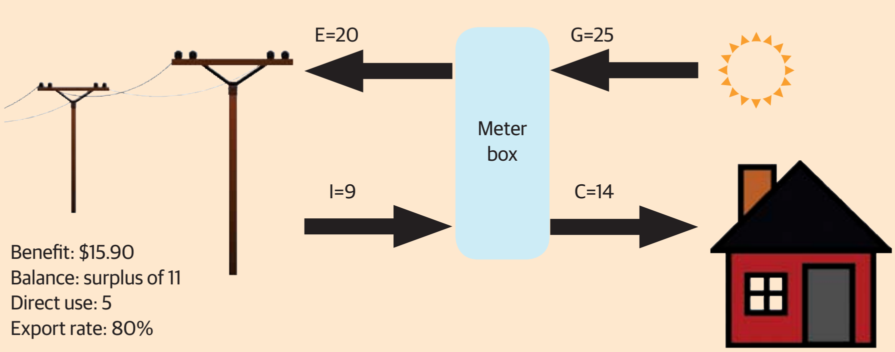
So the overall saving, S, from having the PV installation becomes:

$$S = E \times T_{export} + (G - E) \times T_{peak}$$

This notation becomes a useful way of visualising and summarising the performance of an installation. Figure 4 shows my own system for January 2012.

The meter box equation, and different variants, are useful in better understanding the energy that a PV system produces. ✷

Figure 4. Solar summary for January 2012 (figures in kWh per day).



Reducing computer e-waste
Don't junk it, upgrade it

Every year, many thousands of computers are replaced by new ones in Australia. But is this really necessary? Lance Turner explains how to make that old PC run like new.

THE BIG problem with so many computers being replaced is that most areas of Australia still don't have convenient recycling facilities. Sure, councils offer hard waste collection, but most of that goes to landfill. For computers, especially older ones which contain toxic materials such as lead and brominated fire retardants (BFRs), placing them in landfill is about the worst thing that can happen to them, as the toxic materials will eventually leach out and end up in groundwater.

But is it possible to make an older computer run much faster—fast enough to compete with a more modern machine? Provided you're not into heavy video editing or gaming, the answer is, yes, you can. If you're like the average person and mostly browse the web, write letters and edit your happy snaps, then an older machine can easily take the place of a newer model. Even for more demanding tasks, an older PC can be made to perform very well.

↑ It may be eight years old, but with a cleanup and an upgrade or two it runs almost as fast as a new PC.

What slows them down?

Computers get slower for two main reasons. Firstly, the demands on them increase over time. As new versions of software are released with more features, the amount of code in the software and hence the memory it requires to run also increases. Whether it is your operating system or one of your favourite applications, new releases can slowly degrade performance until the computer feels like it's running at a snail's pace.

Also, many people have a habit of installing software they simply don't need. Google, Yahoo and Ask toolbars in browsers and iTunes, Google and Adobe updaters are common forms of this, but there are many others. And what makes things a whole lot worse is that many of these applications will load part or all of themselves when the computer first boots. If you are not using that application, then it is running for no reason and simply sucking up computer resources (memory and processor time) for no reason. The more programs running on your PC at any one time, the slower it runs.

But unwanted or unneeded software is not just of the type you have deliberately installed. There's a lot of malware (viruses, trojans etc) out there that can become installed on your PC without you even knowing. These can be as benign as simply wasting processor power, or they may make your PC part of a botnet, all without you being aware of it. All you know is that your PC is running slowly and you are using more internet data than you should be.

The other problem for many PCs is sort of hardware related. The hard drive is where all files are stored and storage is a rather haphazard affair unfortunately. With the regular writing and deleting of many files you eventually end up with file fragmentation, where large files are broken up into smaller pieces in order to use up all the smaller spare spaces on the hard drive. Now, when you go to read that file again, the hard drive has to go in sequence to each place on the drive where the pieces of the file are stored and read them. The hard drive, being a magnetic storage system, has heads just like the heads on your old cassette player—they are just a lot smaller and fixed to the end of pivoting arms. Because it takes a certain amount of time for the hard drive heads to move into position and start reading from the correct part of the hard drive disks (more correctly called platters), this all adds time to the retrieval process, thus slowing the computer's ability to retrieve data from the hard drive.

What makes this problem much worse is if the computer doesn't have enough working memory (RAM) and starts using the swap file, which is an allocated part of the hard drive that acts as an extension of the RAM. If the hard drive is badly fragmented, the computer can slow to a dawdle.

Remove unwanted software

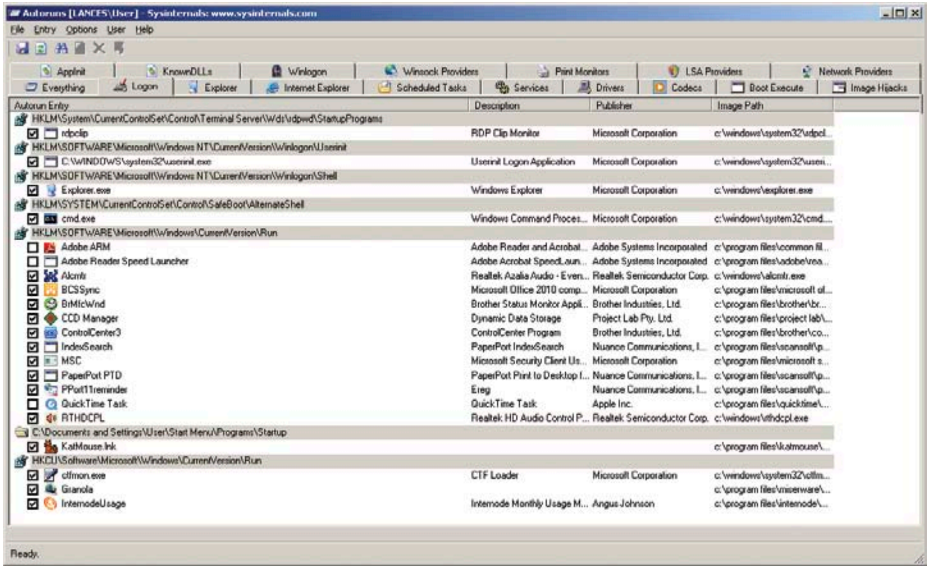
This is where the fun begins. The first thing to do is to remove software you don't need or use. In Windows, you go to Control Panel in the Start menu and select the 'Add or Remove Programs' option (for Windows up to XP) or 'Programs and Features' in later versions. Select the program you want to remove and click the remove or uninstall button and wait for the removal to complete. If the system tells you to reboot, do so.

Once you have removed all the rubbish that you really don't need, you can move on to the next step, which is to stop so many programs from starting when the computer boots.

There are a couple of places that should be looked at, so let's start with the easy one first. Click Start/Programs/Startup and have a look at what's in the startup folder. In most cases there will be a few icons in here and each one of those programs will be run when the system starts. If you find icons for programs you rarely use, delete them from the Startup folder. Just right-click the icon and select 'Delete'. This will just remove the icon from the folder, it won't stop you using the program later.

Now we need to delve a little deeper, and there are two ways to do this. The first is to install a new bit of software called Autoruns. This is a small application that goes through your entire system and shows you everything that runs at startup. You can see what each component is, get more information on it and turn it on and off. Autoruns can be downloaded at bit.ly/eKWDZj and the version to run is autoruns.exe (autorunsc.exe is a command prompt version and is only for tech heads).

Most people will be amazed at the sheer number of things that run when their computer boots. The main tab to look at in Autoruns is the Logon tab. Here you will find most of the applications that are running at startup. Some will be needed, such as sound card drivers, but others won't. Look especially for anything Apple or Adobe; both of these software vendors have the habit of adding all sorts of background software such as updaters and fast booters (QTTask and ipod service are just two) to the system startup, regardless of whether you want them to or not. Turn them off. However, like all things, if in doubt, don't touch, or Google it first to see if it's required.



↑ Autoruns allows you to see everything that runs when your computer boots. You can use it to turn off all those annoying programs that run when not needed.

The other way to see what's running at startup is to use the built-in Microsoft utility which is like a tiny version of Autoruns. Called msconfig, you just click Start/Run and type msconfig and press enter. Check what's running in the Startup tab and also the Services tab (select the 'Hide all Microsoft services' option to see third-party services only). One thing to note with this utility is that it will run again at next startup. When it does, just select the checkbox to stop it doing this and click OK.

Once you have turned off all the programs you don't want running, you should reboot. You should notice an appreciable decrease in the time it takes to boot. But we are nowhere near finished yet.

Install decent antivirus

The next thing to do is to make sure you have decent antivirus software and then scan your PC. There are a lot of paid and free antivirus packages around but recent tests by one of the leading PC magazines found Ad Aware (see www.lavasoft.com) to be one of the best all-rounders. The paid version of Ad Aware is pretty full on and it slows the machine somewhat, but even the free version works well.

If you already have antivirus software that you are happy with, use that, but if you plan to upgrade to something else then remove your current antivirus first. Having two antivirus packages running at once can result in false positives and a seriously slow computer. Once that's done, you should give your PC a full scan.

There's one more application that you should consider. Crap Cleaner (or Ccleaner) which you will find at cnet.co/9WygCR is great for cleaning up your computer. It will allow you to clean up unwanted and redundant files left by old programs, as well as redundant entries in the registry (the registry is a large file that contains entries or 'keys' that tell the operating system where to find things).

However, Ccleaner's registry cleaner is not the most extensive so you might also want to look at a dedicated registry cleaner such as Eusing Free Registry Cleaner (www.eusing.com) or RegSeeker (www.hoverdesk.net/freeware.htm).

Defragment your drive

Once you have done all this cleaning up, the hard drive will be a bit of a mess, so you need to defragment it to make all the files contiguous and remove all the 'holes' that were mentioned earlier. Before doing this, run the built-in Windows disk cleaner utility (Start/Programs/Accessories/System Tools/Disk Cleanup) to make sure there are no more junk files and then run the defragmenter (Start/

Programs/Accessories/System Tools/Disk Defragmenter) and let it run. This can take up to several hours, but it's interesting to watch the drive slowly become more compacted.

Other tweaks

One thing I hate about Windows is that the default settings are for maximum 'prettiness' instead of performance. All those animated windows and menus and funky skins take processing power to display. The first thing I often do on a slow Windows machine is go to Control Panel and select the System utility. Select the Advanced tab and then the Performance button and select 'Adjust for best performance' and all that stuff will be turned off. It won't look as nice but it will work better!

Also go back to Control Panel and Sounds, click the Sounds tab and select 'No sounds' as the sound theme. Each time your PC has to play a sound it has to find the sound file on the hard drive, load it and run it through the audio chip, all of which is a waste of processor time and slows the machine.

This next tweak is a very important one. As mentioned above, Windows has an area on the hard drive which works like an extension of the RAM. This file is called the swap file or the paging file, and the default setting in Windows is for a system-managed size. What this means is that the size of the file varies, and so like any other file it becomes fragmented. The trick is to create a contiguous swap file of a fixed size. To do this, go to Control Panel/System/Advanced/Performance/Advanced and click the Virtual memory Change button. Now select the C: drive (the drive where your swap file should reside) and select 'No paging file' and click 'Set'. Once done, reboot the computer. It might tell you there's no paging file, just ignore that and immediately do a file cleanup and defrag as outlined above.

As soon as the defrag is done, go back to Control Panel and reset the paging file settings to Custom size and set the size in both boxes to be the same and click 'Set'. You should make it around twice the size of your system RAM, so if you have 1GB of RAM, make it 2GB in size (2048MB). Now reboot.

Hardware fixes

Now that we've done everything we can do easily on a software level, we need to look at the hardware. This means opening your PC, which sounds scary but really isn't. There are a few basic precautions to take. The first is to make sure the PC is turned off and unplugged from mains power. Unplug everything from the back of the machine so that there are no leads connected at all. Don't worry about remembering where each one goes, most will only fit one socket and those that are generic, such as USB leads, will work in any port (although there are different speeds for USB 1 and USB 2). If you're unsure, just draw a basic diagram before you start!

The other precaution is to be careful with static electricity. Wear non-static-causing clothing (cotton is good) and make sure you touch the metal frame of the computer to dissipate any static charge before you touch any internal components. You can buy anti-static wrist bands that have a lead that clips to the computer's case to keep you permanently connected, but they are unnecessary if you're sensible. In over 20 years of fixing PCs I've never damaged one with static electricity.

Now that the warnings are out of the way, let's look at the guts of the machine and what the bits do. Start by removing the cover. There are lots of methods for holding covers in place, but on the generic tower cases you normally remove a couple of screws and slide the side of the case towards the back. Some cases just use buttons that you press in. The PC's manual should tell you how to do this. If not, look closely, as it should be fairly obvious.

Check the heatsinks

Inside every PC there are several ICs that generate a fair bit of heat, so they have heatsinks attached to them. These heatsinks have thermally conductive compound between them and the IC to allow efficient heat transfer, but this compound can dry out. If your PC has this problem, especially on the main microprocessor, then it can slow down dramatically as the microprocessor seeks to protect itself by reducing the work it's doing, or it can even cause complete failure.

If you suspect heatsink problems then it's worth removing the heatsinks and cleaning the old heatsink compound off both surfaces and applying a new high-grade compound such as one of the Arctic Silver (www.arcticsilver.com) compounds (use a soft compound, not a glue). Just make sure the heatsinks are refitted correctly before booting the PC.

Got enough memory?

Your computer's RAM is its short-term working memory. When you run a program, this is where it's stored while in use. RAM is fast, far faster than your hard drive, so you want as much RAM as your computer can handle. If it was made in the last 10 years or so it should be able to handle a fair bit. Most motherboards (the main board inside your computer that everything connects to) will have two to four RAM slots, each one capable of handling RAM modules (or 'sticks') of sizes up to between 512MB and 4GB or more. If you have only two 512MB slots then the most you can install is 1GB, but most machines made in the last decade should be able to take at least 2GB in total.

Windows XP can only realistically use 3GB while later versions can use more, so don't install 8GB in an XP machine and expect to be able to use it! For XP you want at least 1GB and for Win 7 at least 2GB.

Unfortunately, as technology improved and processors became faster, RAM bus speeds increased and RAM types changed, so there are many types and speeds of RAM available.

Profiles

Many computers often have redundant profiles on them. A profile is a group of files, folders and settings that are reserved for a particular user. If you are the only user of your computer then there should only be one profile—yours.

To remove unwanted profiles, go to Control Panel/User Accounts and select 'Change an account'. Select the account to delete and select whether you want to keep the account's files and settings. If you opt to save them, Windows will put them in a folder on the Desktop of your user account. If you are sure you don't need anything from the old account, just opt to delete the files. Note that this will not delete any programs, just files in the My Documents folder for that account, plus any user settings such as the desktop layout etc.

To delete accounts, your current user account must have Administrator status, so if you can't delete accounts, that's probably the reason. You need to log in as an administrator and make your own account an administrator account in order for it to have permissions to delete other accounts. If this doesn't make sense to you then you are best not going further, just leave the accounts alone.

> "One thing I hate about Windows is that the default settings are for maximum 'prettiness' instead of performance. All those animated windows and menus and funky skins take processing power to display."

For older machines you might, for example, need PC133 RAM, whereas newer machines might use PC2700, 3300 or higher, and DDR (dual data rate), DDR2 etc. You need to check the motherboard manual (if you have it) or find out what motherboard your computer uses and find out what RAM it needs. This sounds hard, but is easy if you look at the motherboard and find the model number, which is usually printed on it somewhere. Then just go to the manufacturer's website (the motherboard manufacturer, not the PC manufacturer, if they are different) and search for your model. If it's not there, you might have to Google it. Alternatively, see if the RAM that's currently installed is labelled. It might have all the information you need printed on it.

As an example, my main home computer is an eight-year-old Paragon desktop machine with an Intel D865GLC motherboard with a 2.8GHz Pentium 4 processor and 1.5GB of RAM. Information on this unit is still available on the Intel website even though it became obsolete years ago.

Once you know what RAM you need, you'll need to find it. eBay is a great place to start, but there are many online computer parts stores that might have older RAM. Second-hand RAM is usually available in most types and provided the supplier is a reliable one, you should be okay. Computer swap meets are another great place to find the bits you need. RAM should be relatively cheap, but you might even pick it up free; old computers seem to be everywhere nowadays because most people think they need a new, faster model.

Putting the new RAM in the PC is usually easy. The modules are held into their sockets by metal or plastic clips. Most RAM sockets require you to slide the module in vertically and press it down until the plastic lever clips lock into notches in the module. Be gentle until you get the feel for how it works, and take note as you remove the old RAM.

On some compact (or poorly designed) computers you will find other components in the way of the RAM slots. You might have to move cables out of the way or even move a hard drive to get proper access to the modules. If this is the case, don't try and force modules past these obstructions for the sake of not having to undo a couple of screws. You might damage the motherboard or RAM modules or some other component.

Once you have your new RAM installed, put the case back together, plug in all the leads and turn the machine on. If all goes well the computer will boot normally and tell you that it has more RAM. Sometimes you will need to go into the BIOS utility that's part of the motherboard, usually by pressing 'Delete' or F2 in the early stages of booting. If this is needed, the computer will tell you. Even if it is needed, often you have to make no changes—the PC will do it for you, it just needs to go into the utility that one time.

If your PC makes more than one beep and doesn't boot, then either there's something wrong with the RAM you installed (wrong speed, type etc) or the modules are not installed properly. Or, if you had to move other components to install the RAM, you might have forgotten to plug them back in!

Your PC should now work better, but there's one thing to do and that's reset the size of the swap file to around twice the size of your new RAM, as explained previously.

Long-term memory

Just as the RAM is the computer's short-term memory, the hard drive is the long-term memory, where everything is permanently stored even when the computer is turned off. Hard drives are mechanical things. You have one or more circular platters that spin at high speed, from 4200rpm to more than 10,000rpm, depending on drive size, type and model. Each of these platters has a tiny magnetic head on each side that reads data from the platter (see photo next page). The head skims just above the surface of the platter, held away from the surface by the gas (often nitrogen) inside the drive as the gas is dragged around by the platters' surfaces. The heads are fixed to pivoting arms that are controlled magnetically.

While hard drives are amazingly reliable considering their complexity, the fact that they have moving mechanical components means there's a limit to how fast they can access information. Speeds have improved over the years, but the drives in older computers are often pretty slow and it's here where the single largest speed increase can be realised.

There are two common hard drive interfaces: parallel ATA (PATA, also called IDE) and serial ATA (SATA). Strangely, SATA is the faster of the two and the new standard which has replaced PATA in more recent computers.

↑ The motherboard in my old Paragon machine is quite compact. Near the front are the four RAM modules (note the plastic lever catches at the end of each module) and above them is the main processor and heatsink. The red cable at front-left goes to the new solid state hard drive which was removed for the photo (seen in inset at right).

↑ Hard drives (right) have a number of platters and heads at the end of each pivoting arm. Being mechanical devices, they have several drawbacks. Solid state drives (left) have no moving parts, instead having a bunch of flash RAM chips to store the data.

If you have an older computer you could have either interface. In my Paragon desktop machine the main drive was a 40GB PATA drive, despite there being two SATA I ports (there are several SATA standards including the original SATA I, the faster SATA II etc) on the motherboard. At the time it was made, PATA drives were common and SATA drives were not, so the manufacturer installed the more common and cheaper of the two.

As any computer tech knows, a seven-year-old hard drive that's had a lot of work is running on borrowed time, and my PC has had a LOT of work. I use this machine for writing a lot of *ReNew* as well as for my main media PC. While it only has a relatively small primary hard drive, it has an external USB drive tank (a case that holds multiple drives) with 9TB of drives in it which hold all my media files.

My computer also has a huge number of software packages installed, from circuit board design software through to desktop publishing and photo editing software, media converters and many others. And, of course, the 3GB swap file also resides on this old 40GB drive. Despite that, there's over 15GB free on the drive as all of my working files are saved to the drive tank.

So I decided to give my PC a drive upgrade to a new SATA drive to improve software response and loading speed. But not just any SATA drive, I wanted speed, so I decided to go to a solid state hard drive (SSHD or SSD).

Unlike a mechanical drive, an SSD is just a bunch of flash RAM chips (similar to those used in SD cards, USB flash drives etc) and a flash RAM controller, all wrapped up in a case to make it fit in a standard hard drive bay. Because there are no moving parts, SSDs are very fast.

I did a bit of research and found that OWC SSDs (see bit.ly/dvo4Pj) seem to be popular and they are cheaper than some other brands. I bought a Mercury Extreme Pro 40GB unit from an Australian eBay seller for $100 including express shipping—you can't argue with that! I also needed a SATA cable and a power splitter as there were no spare leads in the computer.

I opened up the PC and realised there was nowhere to mount the SSD so I removed the old floppy drive as it hadn't been used for years. The bottom half of the floppy drive case made a nice tray to sit the SSD on and it fitted the drive bay inside the computer perfectly.

Once the SSD was fitted I booted the PC and initialised and formatted the SSD. It works just like a regular drive and you treat it the same. To initialise a drive for the first time you go to Control Panel/Administrative Tools/Computer Management/Disk Management. You will see a list of all drives and partitions including the new drive. You just right-click and create a partition and initialise it and you're done. When formatting the drive, make sure you format it in NTFS format!

And that was it: the drive was ready to use. Now all I had to do was clone my old hard drive onto the new one. There are a number of utilities out there that will do it but one of the easiest to use is Casper. This is available as a free 30-day trial, the only limitation being that in the trial version, volume sizing is disabled, which means your original and new disks must be the same size. If you use it to clone a small disk onto a larger one, the finished larger disk will act like it's a small one. But for my purposes this wasn't an issue as both my disks were the same size.

The clone was very easy and took less than 20 minutes. Once done, I shut down the computer, disconnected the old hard drive (leaving it in place as a backup in case something went wrong in the cloning) and rebooted. Lo and behold, the PC treated the new SSD as its primary boot drive, reassigned it drive C status and booted perfectly. It doesn't get any easier than that!

Was it worth it?

So what sort of improvements did I get? Well, for a start, the PC boots a lot faster. It also shuts down in under five seconds because Windows can now save settings so quickly.

But the real improvements were in the speed that applications launch. Some programs that took 30 seconds or more to start previously now launch in a few seconds. The computer is more responsive and can handle more processes at once—the lag with using the hard drive as extra memory (the swap file) is almost eliminated now. There's no doubt that replacing an old drive with a solid state drive is about the best hardware upgrade you can do, especially when combined with a memory increase.

Oh, and another benefit is that SSDs don't need defragging as they have their own method of distributing data evenly across the data cells to maximise the life of the drive. Indeed, you shouldn't defrag an SSD as it wears the cells out prematurely, although they do have long lifespans.

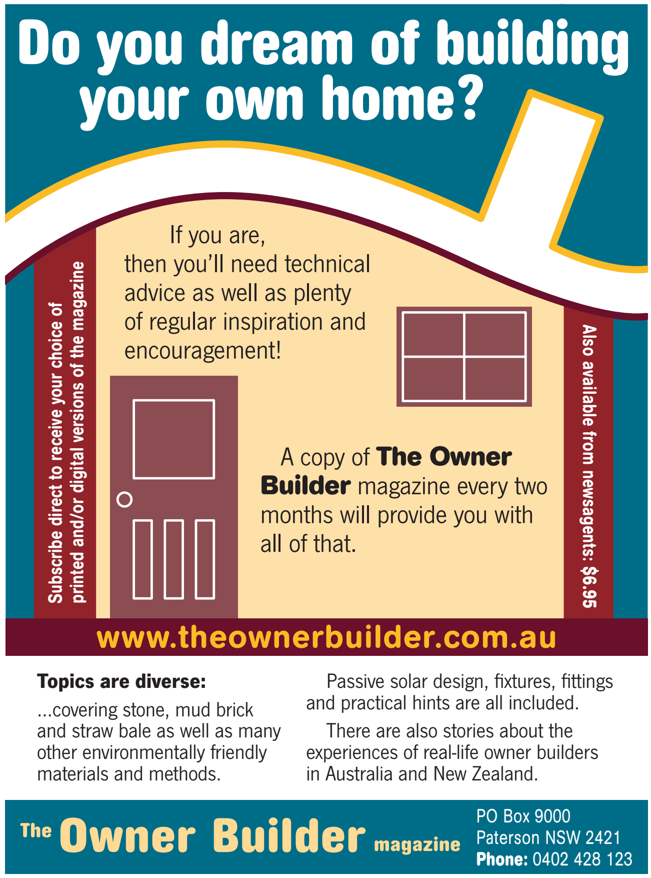
No SATA? No worries!

But what if your computer doesn't have any SATA ports on the motherboard? Well, there are two ways around that. The first is to get a SATA to IDE converter. These are readily available on eBay and many other online places but they vary in speed and quality. And going down this route will mean that the new super speed SATA drive is limited by the speed of the older IDE interface.

The better option is to get yourself a good quality SATA PCI expansion card. These plug into a spare PCI slot (the slots on the motherboard where you can plug in expansion devices) and give you up to four SATA ports, sometimes including eSATA ports (external SATA—the same as SATA but with a more robust connector for connecting external hard drives). These cards can be bought for under $30 from many computer stores and online retailers (such as bit.ly/ig5ktE) and are a great way to enable high speed hard drives to be used in an older PC.

So, after my upgrades I now have a PC that's almost as fast as my much newer machine in the office, and indeed, in some cases it's faster, especially booting software—you just can't beat the access speeds of an SSD! It is indeed viable to do some maintenance on your old PC clunker and increase performance dramatically. You'll not only save a lot of money over buying a new machine, you'll eliminate the need to dispose of your old PC, at least for a few more years. ✱


SPLASH
monitoring
The latest in low-cost, web-based monitoring.
See your data come to life as a real time animation with sound, graphs, reports and much more!
Use on a lobby display to maximize PR and educational value of installed systems including...
✓ Solar water heating
✓ Solar photovoltaic
✓ Heat pump water heating
✓ Energy management
✓ Power supply consumption
...yet flexible and adaptable to suit any application. And setup is easy: just plug and play!
www.splashmonitoring.com
Brought to you by Energy Conscious Design, New Zealand's leading solar water heating engineers.
ecd


Do you dream of building your own home?
If you are, then you'll need technical advice as well as plenty of regular inspiration and encouragement!
A copy of The Owner Builder magazine every two months will provide you with all of that.
Subscribe direct to receive your choice of printed and/or digital versions of the magazine
Also available from newsagents: $6.95
www.theownerbuilder.com.au
Topics are diverse:
...covering stone, mud brick and straw bale as well as many other environmentally friendly materials and methods.
Passive solar design, fixtures, fittings and practical hints are all included.
There are also stories about the experiences of real-life owner builders in Australia and New Zealand.
The Owner Builder magazine
PO Box 9000
Paterson NSW 2421
Phone: 0402 428 123


Power up your knowledge and stay sustainable!
Stay up to date with renewable energy design and installation solutions with our range of books and training manuals for consumers, business owners, trade and industry.
GSES is Australia's leading renewable energy educator and resource provider for government agencies and private enterprise.
Titles include:
• Grid-Connected PV Systems Design and Installation
• Stand Alone Power Systems Resource
• Solar Entrepreneurs Handbook
• Earthscan – Grid-Connected Solar Electric Systems
GRID-CONNECTED SOLAR ELECTRIC SYSTEMS
GSES trade accreditation training manuals and books are now available online www.gses.com.au
GSES® global sustainable energy solutions
creating sustainable change through education, engineering and leadership
FREE CALL: 1300 265 525 | tel: +61 (0) 2 9024 5312 | fax: +61 (0) 2 9024 5316 | info@gses.com.au | www.gses.com.au

Upcycling: a fresh look at materials reuse
Turning fridges into worm farms

Tim Frodsham takes the Cradle to Cradle approach to building worm farms from municipal tip waste.

WHILE it's almost certain that most avid readers of this publication will have come across the concept of using discarded fridges as worm farms, I took a different perspective on what the longer term implications are of reusing such waste materials. In the book, *Cradle to Cradle*, the authors Michael Braungart and William McDonough propose the concept of 'upcycling', whereby a product, or the materials it's made from, can be infinitely reused or recycled into other forms, with no loss of energy in the transition of forms and no release of environmentally harmful by-products.

Cradle to Cradle is an aspirational attempt to reconcile the anti-consumerist sentiments associated with the green movement of the last 40 years with the endlessly resource-hungry needs of a geometrically expanding global industry. What the book proposes are some startlingly creative design solutions that revolutionise the idea of waste and it radically asserts new protocols for material consumption and material disposal.

Examples include car tyres and shoes that release particles of 'nutrient' laden non-toxic material as they wear down on roads and running tracks and serve as food for plants by the roadside. Disposable cups that are rapidly compostable and contain embedded seeds for regrowth of barren and degraded land, or computer housings and encasements that could be reused as, well, computer housings. Too good to be true? With these inspirational ideas I set out to emulate, but unfortunately not quite replicate, the same upcycling concept. At the end of the article, and in hindsight, I suggest some ways it could have all been done differently.

↑ One of the completed worm farms, minus the roof cover.

Recycled materials

I retrieved three old fridges from the metal pile at the municipal tip. Then from the wood pile I laid hands on some old timber beams from what looked like the remains of someone's plantation-pine pergola. These would form the support frames for the worm farms. I found some old Phillips head self-tapping screws in an old tool bag I recovered from the tip shop.

Before I left the tip with the fridges, I 'gutted' them of their internal racking. I unbolted the now defunct heavy compressor motors and also the copper grid mesh and coils at the back, making sure to keep them all airtight to avoid the plaintive venting sounds of the freon gas escaping into the troposphere. Doing this made the fridges much lighter and easier to move onto the roof racks on my tiny economy car. When I got home with it all, I denailed the 'four by two' (about 100mm by 50mm) pergola beams. I even straightened the nails for reuse in building the support frames. The focus was on reusing everything, or at least as much as possible.

Constructing the worm farms

The first step was to sand back the rusted

Ventilation is fitted to provide the worms with plenty of air to survive.

parts of the external fridge panels and paint them with an anti-rust type of oil-based paint. This took about 45 minutes per fridge using an angle grinder fitted with a rotating steel brush. I used paints retrieved from the tip shop for the undercoat. For speed, I used a spray paint from the local hardware shop for the top coat.

I used a 50mm hole-saw fitted to my drill to cut through the bottom of each fridge for the drain hole. This proved easy through the plastic and light sheet-metal inner and outer layers of the cases. Care had to be taken not to slip and damage the foam insulation between the two layers. I then fitted a flanged tank washer to seal the hole to prevent any liquid seeping into the insulation between the fridge panels. I then attached a 50mm threaded barb fitting, designed for low density polypipe.

The next step was to install ventilation in the fridges so there was enough air to keep the worms alive and working in what would otherwise be an oxygen-starved environment. Using an angle grinder with a stone cutting wheel I cut rectangular holes in two of the four sides of each fridge. I used silicone sealant to fix mesh that I'd cut out of a trampoline floor, then framed each mesh on the inside with strips of metal, screwed into the fridge. For rodent proofing on the outside of the mesh I screwed on the grill plates I'd cut out of ovens and ventilation plates from the backs of microwave ovens, also recovered from the metal pile at the tip. These can be seen in the photo above.

That task completed, I then applied silicone sealant to plug up the holes in the plastic panelling inside of the fridge. There were holes for racking, internal lights and refrigerant coil connections.

Weather protection

While I let it dry overnight, I fitted a piece of disused corrugated roofing iron to the door of the fridge. The iron was spaced away from the door by sloping wooden blocks that I cut from the pergola timber. The idea behind this was to provide weather protection for the worm farm, with enough overlap on the ends and sides for shading the top of it from the hot summer sun, and to reduce the rust caused by rain in winter.

There were holes in the corrugations, so I siliconed up those as well. There was about a 50mm gap between the roof sheeting and the fridge door, to allow for air flow and drying of any moisture otherwise pooling on the door panel. I used any old roofing iron, as long as it was not rusted.

Support frames

Next I built the wooden support frames for the worm farms. I used a 250mm drop saw and power drill to do this. I built them to be about 350mm high, so they are low enough for waist-high access that's easy on the back, and high enough for gravity drainage from the worm farms to the citrus trees I parked them next to.

To protect the legs of the frames from rotting and insect borer attack, I soaked them overnight in waste vegetable oil that I collected from the back of the local fast food outlet. Along the same lines, I mounted the frames' legs on top of bricks to separate them from the soil.

The finished farms

I then filled the fridges with successive layers of weeds, food scraps, soil, grass clippings and worm castings I'd taken from a previous worm farm. Four weeks later and, so far, it's looking good.

The best things about these worm farms were that I had reused a waste material that

The worm farm before treatment.

A completed fridge worm farm, with 'roof' fitted

worked well for the worms, as they benefit from the insulation and the shaded structure, and that the citrus trees are provided with the nutrient-rich worm castings. If properly managed, each of these worm farms will process over 1000kg of organic waste every year, thus keeping the equivalent amount out of landfill. It was a good and satisfying use of hands and mind with re-worked materials. Or was it?

Post-build thoughts

Upcycling in the way defined by Braungart and McDonough wasn't really achieved here, as I was simply keeping waste materials out of the waste stream a bit longer, in this case fridges before they became too rusted to be reused. And eventually the plastics in them would become too degraded by the intense biochemical reactions of the worms and bacteria they were holding, and they too would become an environmental liability. And the oil-based paint I used to arrest the rusting of the outside of the fridge surfaces, albeit also reclaimed from waste paints from the local tip shop, would also eventually flake off, causing something of a toxic liability for the soil underneath.

And what about all that precious copper I'd left behind in the metal pile at the tip? I knew very well it would be melted back into a diluted blend of other base metals, degrading the value and ductility of this original metal. In the worst case scenario, I had created a 'monstrous hybrid', the thing that Braungart and McDonough refer to as an ill-adapted re-use of toxic technology, not meant for any intended new application of the materials they were made of. While no one could dispute the good intention of keeping waste out of landfill for a bit longer, what has been done does not really address the legacy aspects of technology and design that fails to address the end-of-product life cycle. Until a design revolution comes about to herald the amazing shifts flagged by the authors, what to do?

What could be done differently

On reflection, there are a few things here that could be changed:

- The use of low embodied energy materials with low toxicity and which don't need painting such as rough cut hardwood timber
- Using hand tools rather than power tools to construct a similar unit, with wooden joiners rather than steel ones
- Building dry stone containment walls to hold the worms, rather than using timber
- Considering the use of more chemically inert media to line the internal walls of the fridges, such as thinly cut sections of house bricks
- Constructing one larger unit rather than smaller units to give a better marginal return on the invested time and labour required
- The use of materials that are 100% reusable and cut the cycle of re-migration to landfill. *

Cradle to Cradle: remaking the way we make things, by William McDonough & Michael Braungart, North Point Press, 2002.

Home electroflocculation
Clean up your dirty water

It's been a long time since we looked at electroflocculation in *ReNew*. Terry Tranter explains how to electroflocculate your water until it's clean.

I HAVE read countless alternative magazines over the last 50 years or so and I have never found a DIY water cleaner in any of them. So to fill in the gaps and keep the shed-dwellers busy, here's how it's done. This project is particularly useful for those living in rural and remote areas.

The technique I've used involves electroflocculation, a method at least 40 odd years old. Commercial units are available for a few thousand dollars or you can try my ten dollar job which works very well.

Electroflocculation is not unlike electroplating but with a different outcome.

Materials

You will need:

- A 200-litre food-quality plastic drum with a tap in the base. Do not use a metal drum!
- Something to stand the drum on
- Two aluminium pans from the tip. Frying pans are preferable but not compulsory
- An insulator, such as a piece of 25 x 50mm pine offcut 100mm long or a chunk of thick plastic sheet
- Some red and black automotive or similar insulated wire
- A pair of wire strippers
- A well-charged 12-volt car battery or a 12-volt high-current power supply
- Something to stand the battery on to bring it above the height of the drum
- A piece of masonite or a paint scraper for scraping off the foam
- A jug of clean water
- A multimeter (optional)
- A large plastic drink bottle with the bottom cut off
- Some polyester pillow stuffing to pack inside the bottle as a filter
- A bit of wire to hang the bottle from the drum rim.

↑ The finished product should be crystal clear water—and all you need is a few basic materials and a car battery.

The process

Put the drum on the stand and fill it to overflowing with contaminated water.

Remove the handles from the pans. Screw one pan onto each side of the insulator (see photo at right), making sure the screws don't meet in the middle and short the battery or power supply. Strip both ends of the black and red wires and screw one wire to each pan.

Place the battery on the stand close to the drum. Lower the pan contraption into the drum, leaving a 50mm clearance from the bottom. Wrap or clamp the free ends of the wires around the battery terminals. The electroflocculation process now begins!

At first you will notice a few tiny bubbles rising, but be patient. After twenty minutes the water's surface will be covered with foam.

↑ The pans are screwed to either side of the insulator to acts as electrodes.

↑ It looks scary, but the foam is all of the water's contaminants being removed by the electroflocculation process.

Scrape this off and top up the drum with clean water to maintain overflow conditions. Every 15 to 20 minutes, continue to scrape off the foam and top up.

The process takes about two hours, or until foaming ceases. Unhook the pans and gently lift them from the water so as not to disturb the sediment. Leave the drum to settle until crystal clear, which is about an hour.

Set the multimeter to 'ohms' and dip the meter probes into the water. The meter should read infinite resistance as current only travels through contaminated water.

Turn the tap on to flush it and then fill a glass with water. Have a taste. Cheers!

The bottle with polyester stuffing can be used to act as a sediment filter. Hang it off the rim of the drum with a bit of wire so that it hangs under the tap and the water then passes through the filter before you collect it.

It's not necessary to use this filter but it may ease your mind until you are comfortable with the electroflocculation process and are comfortable that the water you are making is indeed clean. If you are really unsure, you can always have the water tested before and after the decontamination process to waylay any worries you may have.

I don't, as I trust the method and know it works. My bore water is in a cow paddock and when it rains it looks like tea—yet after processing, the water is always crystal clear. ✱

Terry has self-published a ten-page booklet on the process with plenty of photos. It's available for $20 by writing to T Tranter, 106 Haywards Lane, Henty VIC 3312.

Electroflocculation and water quality

Electroflocculation is a process whereby an electric current is passed through sacrificial electrodes immersed in contaminated water. This results in ions from those electrodes entering the water and combining with the contaminants. The coagulated material floats to the surface or sinks to the bottom where it is skimmed or otherwise removed.

Electroflocculation is an electricity-based version of conventional flocculation. In conventional flocculation, coagulation chemicals are added to the water where they combine with contaminants and so remove them from the water.

Electroflocculation is usually used for the treatment of waste water to allow it to be reused, and indeed, there are commercially available systems, such as the Clearmake Electropure. However, for potable water use, some issues should be addressed, including the level of metal introduced into the water by the process.

Aluminium has been implicated in some health issues. It is thought to be a factor in the development of Alzheimer's disease, although more recent studies have challenged that view. However, it seems that the jury is still out, so ingesting excessive aluminium and other metals unnecessarily is not recommended.

When performing electroflocculation, it is important that the resistance test be performed accurately to ensure that the water contains little or no free ions. As mentioned in the article, a completely ion-free water will have infinite resistance. If your multimeter tells you your water won't conduct electricity then you can be pretty sure that there are no excess metal ions in the water.

Electroflocculation also kills pathogens, but if your water has high pathogen levels then you might want to consider an extra level of treatment such as boiling or UV treatment before drinking.

There are a couple of options for testing your water. The first is to send a sample off to a testing lab. However, this can take a while for results to come back and a standard lab fee is involved.

The other option is to use a DIY testing kit. These are available in many forms. Some test for one specific mineral or bacteria whereas others test for a whole range of potential pollutants. Suppliers of these include:

- Apps Labs: www.appslabs.com.au
- The Lead Group (for testing lead content): www.lead.org.au
- Northern Water Solutions: www.northernwater.com.au
- Tankworx: www.tankworx.com.au
- G Warehouse: www.gwarehouse.com.au
- H2O Kits: www.h2okits.com
- Simpltek: www.simpltek.com

The Pears Report
Energy efficiency ignored again

Energy efficiency measures have huge potential for delivering climate change abatement, and yet they are often overlooked in the debate on climate policy. Alan Pears explains.

MANY people watched the recent ABC documentary and panel show on the climate change debate. It was interesting to hear that both Clive Palmer and Nick Minchin were prepared to support renewable energy—if it were cost-effective. However, apart from a couple of passing mentions in the panel session, a sustainable energy option that already meets their criteria for cost-effectiveness and climate change abatement was ignored.

Most international experts, including the International Energy Agency, expect energy efficiency to deliver a third to half of all energy-related abatement over the next 20 years. Yet, if it's mentioned in Australian climate policy discussion, it's almost always an afterthought.

It's not that policy people and commentators don't think energy efficiency is a good thing, but it's not 'top of mind'—mostly they have to be prompted. And they tend to see it as a fairly small contributor to solutions. One British study recently estimated that 88% of all energy used globally is wasted before it delivers a useful service: so the potential for efficiency improvement is enormous.

There seems to be some kind of deep cultural driver for Australians to focus on supply-based solutions. I really don't know how we can overcome this, because it is so pervasive.

At least there is some money (thanks to the cross benches, especially the Greens) in the Clean Energy Futures package for energy efficiency—although much less than for low-emission energy sources. But we will have to withstand yet another attempt by econocrats to cut energy efficiency programs because they fail the 'complementary to carbon pricing' test. That won't be easy, and it will divert our efforts from delivering results to defending the validity of energy efficiency—yet again.

My recent submissions

I've been busy recently producing a few submissions to government inquiries (see links at the end of this article).

My submission to the Draft Energy White Paper is in two parts: part 1 is my annotations on the whole document, while part 2 is a 20-page submission summarising my key points. My main recommendation is that they start again with a new and more inclusive process that reflects a 'whole of government' perspective and engages households and services sectors as well as big industry.

In my submission to the Victorian Competition and Efficiency Commission inquiry into feed-in tariffs (FiTs), I pointed out that the whole debate is focused on the wrong issue: it's not about how much PV saves the energy industry. If we step back, distributed generators should have the right to sell power to neighbours at whatever price they can negotiate: that's how markets are meant to work. So the retail price is the right benchmark for pricing FiTs. Further, there is a legitimate argument for additional subsidies of distributed generation as an emerging technology that competes with powerful entrenched interests. I proposed that a FiT that provides the same price for exports as for consumption has many advantages.

I also made a submission on the proposed National Energy Saving Initiative. I argued that we need two kinds of certificates, as we have for renewable energy. This will allow flexibility to ensure the scheme really works to deliver outcomes and reward reductions in peak demand and other benefits beyond energy savings.

Passing the buck

The Australian Government's failure to set up a proper accounting system so that businesses, local and state governments and households can qualify their energy efficiency and renewable energy action as 'additional' to the carbon target is now visibly backfiring.

Photo: Valvecosy

↑ Energy efficiency measures needn't be complex or costly. Valvecosy is an insulated cover that reduces heat loss from domestic hot water service pressure-release valves, thus saving energy. It's easily installed by the homeowner and is available from shop.ata.org.au.

"If energy efficiency is mentioned in Australian climate policy discussion, it's almost always an afterthought."

The new Victorian and Queensland Governments have slashed programs on energy efficiency and renewable energy because, under the carbon pricing scheme, reducing emissions would simply leave more room under the carbon cap for other states to increase their emissions.

Under the carbon target, reducing emissions is now the federal government's responsibility. See www.vcma.org.au for detail on the problem and the solutions. How can such a perverse situation be allowed to occur?

Feedback from a reader

In my previous column, I included some thoughts about public transport funding. One reader has responded to my comments. I'm pleased, as I was hoping to provoke some discussion. [Ed note: the reader's letter appears on p17.]

The fact that I proposed two diametrically opposite ideas on rail crossings (one to reduce road delays and the other to allow more delays due to rail crossings) shows that I was floating ideas rather than taking a position.

But to clarify my suggestion that congestion due to rail crossings could be allowed to increase as a way of limiting traffic growth, there are some fundamentals here.

Overwhelming evidence shows that if you increase road capacity, it simply fills up to a new, higher level of traffic without solving the congestion problem. Further, if your policy objective is to reduce car usage, you need to increase capacity of alternatives while also reducing road capacity. Otherwise cars come from elsewhere to fill up the freed-up (effectively lower cost in terms of travel time) space. Economists propose road pricing as a way of limiting road use, but this has equity issues.

I was trying to point out that rail crossings can act as a policy tool to limit car usage and increase pressure on road users to shift to other options. It is imperfect, but all the options have their problems. And the money saved from avoiding construction of grade separation could be spent on extending public transport (PT) and buying more rolling stock.

With regard to the reader's comment on my proposed PT property levy, his comment is focused on a group of workers who happen to live near good PT but work in PT-poor locations. This is a legitimate concern, but the situation is complicated. First, as congestion (or road pricing) increases, those with the cheapest or most practical options tend to change behaviour first, so this should leave more room for those who really need to use cars. Indeed, giving people who live near PT free or discounted PT travel to offset the levy cost provides an incentive to change behaviour and free up road space. The levy also creates a new incentive for PT agencies to improve and extend PT because they are rewarded with more funds. As our reader points out, we need to find more money to improve and extend PT, and this is one possibility.

The situation for tradies is challenging, but there are some options. First, as a rider on early trains into Melbourne, I'm seeing increasing numbers of tradies on PT, complete with wheelie bags of tools. Obviously this only works where there is PT, or where the tradie can travel part of the way by PT and leave their vehicle somewhere secure where PT finishes, so the trip can be completed by ute.

Second, for tradies working on new housing, there is potential to shift a lot of building construction from on-site work to housing manufactured off site. This would significantly increase productivity by reducing travel time and avoiding rain delays and damage. Countries such as Germany are able to produce high-quality, diverse housing using this approach.

For tradies involved in appliance maintenance, smart appliances and mobile phone cameras increasingly allow remote diagnosis and accurate identification of models, so they can spend less time travelling, and may even be able to carry a lot fewer spare parts.

My key point was that we need some creative ideas because present approaches to transport are not working very well. I hope the debate continues and more ideas flow! ✱

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's recent submissions

Draft Energy White Paper:
bit.ly/APearsDEWP

Victorian Competition and Efficiency Commission Inquiry into Feed-in Tariffs:
bit.ly/APearsVCEC

National Energy Saving Initiative:
bit.ly/APearsNESI

Browser

Future Sparks

Future Sparks is a Green Cross Australia project aimed at providing teachers and students with information about climate change, what we need to do to adapt to it and how to make changes in our lives to help prevent it.

The site encourages students to 'get their thinking caps on' and come up with ideas and solutions to help the planet—and make videos of their ideas so that others can benefit.

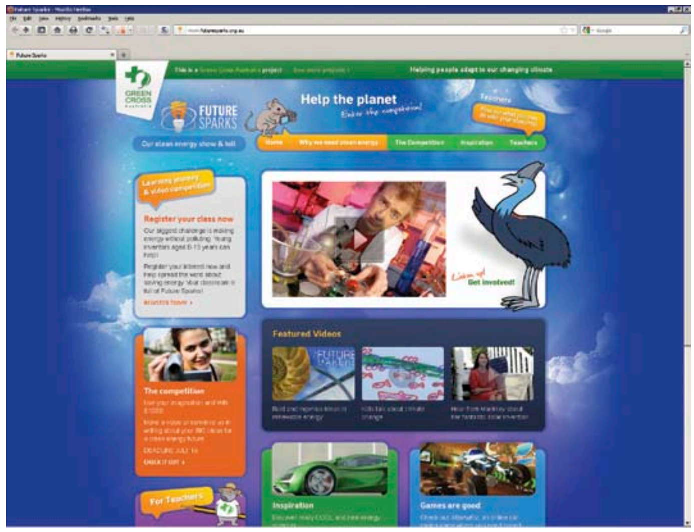
The site also touches on social problems, such as wealth and energy inequality. It explains how we currently use energy, what clean energy is and how we can move towards a clean energy future rather then the status quo of fossil fuel use.

The site details why and how the climate is changing, with links to resources from CSIRO and elsewhere.

There are numerous videos that help get the message across in a simple, clear and concise way. Maybe all the climate change deniers need to have a look.

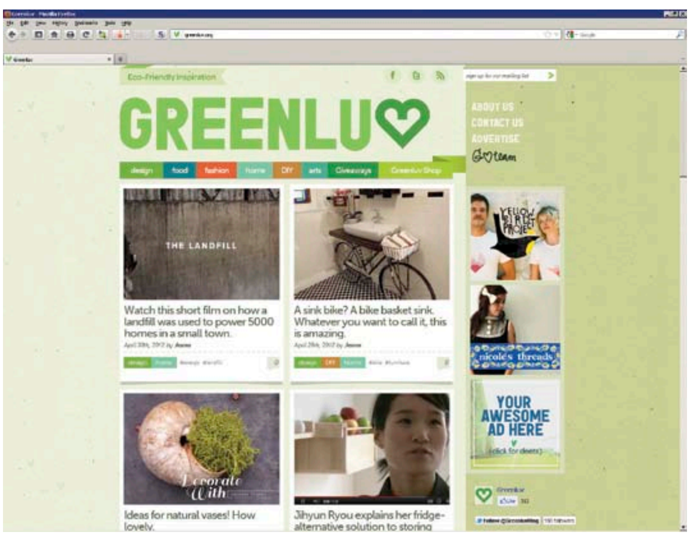
Of course, it wouldn't be a child-oriented site without some form of interactive competition, and kids can enter their ideas either as videos or just by writing them down—you don't need to be a budding Steven Spielberg to enter! There are plenty of online resources to help entrants make the best entry they can.

Lastly, there's an area designed for teachers, where interested teachers can have a chat with an expert, access a list of resources



including lesson plans and many fact sheets, and learn how they can host a community show-and-tell event for showcasing students' ideas.

If you are a teacher or a student interested in environmental issues in education, this is a good site to check out.
www.futuresparks.org.au



Greenluv

Greenluv is a green-oriented lifestyle website aimed at supporting and promoting the creative people of the world who do their thing in a green manner.

To quote the site: "We're into good design, delicious-n-nutritious food, and inspiring art, but we feel like all of these things become way more interesting when crafted in a environmentally and socially responsible way."

We couldn't agree more, so recommend that anyone with a green leaning (and you probably wouldn't be reading this if you didn't have one) check out this site for some great creative ideas and products.

The site appears quite new, with fewer posts and articles than you would expect from an established site, but we expect this will change as the site grows and matures, as all such websites have done over the years.

The main categories are design, food, fashion, home, DIY and arts. There's also a Giveaways area where you can go into the running to get a freebie just by leaving a comment.

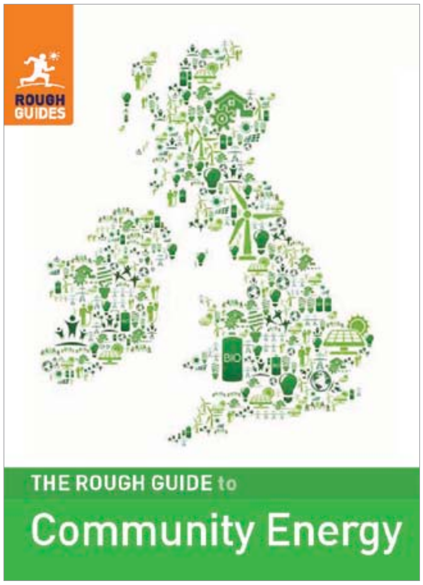
There are some really impressive projects on the site, such as furniture made from old guardrails from the Golden Gate bridge, a DIY cork trivet and some cool DIY lampshades made from bamboo. Many of the posts are very brief, with links back to the more detailed original source websites, which makes a lot of sense as there's no point duplicating other websites' posts word-for-word.

While this site probably won't appeal to the more techie DIYers out there, if you have an arts and crafts leaning and like great looking projects and products with a green bent, then this is a good site to drop by.
www.greenluv.org

Understanding community generation

UK Community Energy Handbook

Rough Guides Ltd
ISBN: 978-1-40538-652-4



CHANGE in energy generation and consumption in many European nations over the last 20 years has seen a significant increase in renewable energy supply and considerable focus on energy efficiency. One interesting facet of these changes has been the increase in community-based energy systems often owned by individuals or co-operatives. For example, one report indicates that in 2010, of the 53GW (as an interesting aside this is comparable to the nameplate capacity of Australia's total grid) of renewable energy generation in Germany, 51% was owned by farmers and individuals.

In Australia, we have seen substantial uptake of rooftop solar, some areas with substantial amounts of rooftop solar hot water and some community-based schemes such as Hepburn Wind. For those interested in developing community energy projects the *Rough Guide to Community Energy* (published in the UK in 2011 and available for free download at www.roughguide.to/communityenergy/RG_Community_Energy.pdf) may be useful.

The handbook covers what community energy projects mean; how they can contribute to the energy mix in the UK; how a community energy group can start and work to deliver renewable energy projects, from feasibility study to maintenance of an operational system; and the important contribution energy efficiency can make. The authors point out using case studies how community energy projects can improve social equity, increase energy resilience, keep money spent on energy within the local economy, provide valuable and trusted demonstration sites, and help build stronger and more integrated communities.

The book briefly describes a number of renewable electricity and heat technologies including biomass, solar, wind, anaerobic digestion, heat pumps, hydro and energy efficiency. Some of the example systems are more relevant to the UK. The energy-use data, tariffs and incentive schemes will differ to those in Australia but much of what's covered is useful to groups wishing to build Australian low-carbon, renewable-energy-powered communities. There's a notable emphasis in the handbook on Transition Town energy-based initiatives in the UK.

Many of the local climate change groups in Australia seem to have a primary focus on lobbying government. It's arguable that their relevance and impact would be enhanced significantly by delivering projects such as those described in this handbook. Other entities with a community-based focus such as councils who have facilitated group PV purchases through schemes such as Solar Suburbs, the BREAZE initiative in Ballarat and the Hepburn Wind Co-op are a start, but this field has really opened up over the last 20 years. There is just so much good quality cost-effective technology available now at the domestic and community scale. This handbook offers useful advice and case studies on what can be done. Now it's up to us!

Review by David Coote

Q&A

Did you know that wind turbines don't work well in most urban locations? And that there's an art to getting your cable sizes correct when installing solar? Ask *ReNew* your question via renew@ata.org.au.

Off-grid cable sizing

Q —

We have been living in a remote area in the south west of WA for over 20 years. We are not grid connected and rely on solar for all our power needs. Over the years, my biggest problem has been with the wiring. The cable has either melted the insulation or been so large that I get voltage drop. I have been buying your magazine since the days when it was *Soft Technology* but I can't seem to find an article on how to work out the cable size needed, from both panel to regulator, and battery to individual loads. If it has been done, let me know and I will buy the back copy.

I also have some small solar panels (3.6 volts) from outdoor LED spot lights that I want to wire up to Cree LED star modules for use as lighting in areas that don't need bright light, and so reduce the load on our house power. I had hoped to use the panels and their batteries to light these areas. Will it work? How do I work out what size resistor I need? — Peter Brindley

A —

Cable sizing is seen as a bit of a black art by many, but it's actually pretty simple. There was a sizing guide in *ReNew 59* with some ideas on how to do it, but the important things are:

a) Make sure the cable is large enough to handle the maximum current. A good rule of thumb, up to 50 amps or so, is that you need 1mm² of cable cross-sectional area per 10 amps of current. Above 50 amps or so, thermal issues come into play. Thicker cables have a lower surface-area-to-volume ratio than thinner cables, so there is more heat retention and you have to reduce the current per square millimetre.

b) Make sure the cable is large enough to prevent voltage drops over the required distance. You can work out the drop using Ohm's law and the resistance of copper. There's a table in the guide mentioned above and a number of resources online that give approximate resistances for larger cable sizes.

The trick is to make sure cable sizes are within both requirements. Generally, a 5% voltage loss at the maximum expected current is the most loss you should aim for.

Regarding using the LEDs, the battery voltage is almost the same as the Cree LEDs, so you will need a low-value resistor, something in the order of a 1-ohm, 0.5-watt resistor will do it. The LEDs will need some heatsinking, of course. There's a useful LED resistor calculator at www.ledcalc.com.

Bear in mind that running the LEDs at 300-400mA will drain the batteries fairly quickly. Although you don't say what capacity they are or the output of the panels, I'm assuming they are small units as used in solar garden lights. You might want to increase the resistor value to decrease the running current and extend the running time. — Lance Turner

Wind turbines

Q —

After reading Martin Chape's article in *ReNew 119*, my appetite has been whetted to include a wind turbine like his.

We have a 2.1kW solar system on our roof and it has been highly successful in south Gippsland, Victoria. The inverter on my system is rated at 2kW, which is at the top of our system's generating range.

I've always felt the loss of sunlight due to night time as a bit of a sore point. Would it be possible to fit a wind generator for night-time use of the type Martin has fitted, and still use my current inverter? There would have to be some type of automatic shut-off device to stop power entering the inverter from the wind generator after the solar panels kick in.

The simple answer, I know, would be to fit a larger inverter. The cost is a bit prohibitive whereas the turbines (from bit.ly/JmonvO) seem extremely well priced. — Chris Seaborn

A —

They are a neat-looking little turbine but output is pretty low, just 10 watts at 4m/s and 80 watts at 7m/s, so whether it's worth including will depend on whether you have a seriously good wind regime at your place.

To feed into the grid via your current inverter you would need the turbine to have an output compatible with your current inverter's input range. It's not clear from the product info on this turbine but many wind turbines require a diversion or shunt controller to maintain a load on the turbine, at least in high winds, so if you were disconnecting it from the grid during the day you might need to feed its output into a dump load. This can be in the form of a simple power resistor or a heating element in your water heater, which would make better use of the energy, albeit small.

Personally, I would look at using such a turbine only if I had excellent wind at the site (at least 5–6m/s average) and would use it to charge a standalone system for use in the home, say to provide backup power, or for lighting or similar. If you want to grid feed the turbine then I would recommend a small independent inverter designed for wind turbine inputs, such as the SWEA units from Ladder Technologies (www.laddertech.com.au). — Lance Turner

Electric heating

Q —

I've come across ceiling heating with a client and am trying to quantify the efficiency of the system compared with both an electric in-slab system and a heat pump system.

Do you know the efficiency of these units, or an organisation that might? — Andrew Bell

A —

All resistive-type heaters are 100% efficient in that all the energy going in turns into heat, but once you have that heat, how effective it is depends on the placement of the heat source. Placing heating elements in a ceiling is a problem, as heat rises so it will first heat the air near the ceiling and will take a long time to heat the room. Yes, there's radiant heat from such systems but it's low level. Frankly, a heated ceiling makes no sense.

A heat pump has an efficiency well over 100%, simply because it uses electricity to concentrate heat and move it from outside to inside, rather than actually generating heat. Most heap pumps have an efficiency (actually a co-efficient of performance, or COP) of at least 2 (200%) and some exceed 5 or more. So, with a COP of 3 for instance, 1kWh of electricity moves 3kWh of heat from outside into the home. For more information, see the heat pump buyers guide in this issue.

When it comes to electric heating, heat pumps (along with their more efficient, but more expensive cousins ground-source heat pumps) are by far the most effective system for the energy used, unless the home is extremely draughty. But in that case, you would fix the air leaks first anyway.
— Lance Turner

Solar upgrades

Q —
I installed eight 180W solar panels (1.44kW) and a 1.5kW grid-tied inverter just over one year ago and I am very pleased with the result. I am a pensioner and this cost me $2800 after rebates.

I would like to increase the size of the system to 3kW and here is the problem. The people who sold me the system want to charge me $5400 to increase the number of panels to 12 and sell me a 'bigger and better' 3kW inverter. I thought that maybe it would be cheaper to buy a whole new system similar to what I already have and run it as a separate system in parallel to the first one.

Is this technically okay and would I get the same rebates as the first system—or am I only allowed one bite of the cherry? I had the electricity switchboard upgraded at the time and Ergon installed the appropriate meter.
— David Wakeham

A —
Personally, I would go for a second parallel system. There are a few reasons for this.

Firstly, replacing the smaller inverter with a larger one leaves you with a used inverter that you then have to sell. I expect the resale value of them would not be high, as second-hand equipment is not eligible for a rebate.

Secondly, when you get a rebate there are restrictions regarding what you can do with the system. I seem to recall no changes can be made to the installed system for the first five years, but that may have changed; you would have to look at your documentation for details.

Thirdly, a single large inverter gives no redundancy. Should it fail, the whole system is down until it's replaced. Two smaller inverters mean that if one fails, at least half the system is still operational.

There is a new player on the market fitting micro-inverters to 240-watt panels, with the equipment all made in Australia. They are called Tindo Solar (www.tindosolar.com.au), and to my mind this is a simple and easy way to expand any system without the extra cost of DC wiring. All you need is fixed AC wiring points for each panel, something a standard electrician can do. — Lance Turner

DC solar fans

Q —
I'm building my own house but am hitting a brick wall with searching for a couple of technical options as the house nears completion.

Specifically, I am searching for the existence of small, cheap solar-powered fans for use in 100mm diameter cooling tubes running up behind my fridge (to help air circulation across the heat-exchange coils), and where I could potentially put the PV cells to power them on top of my electricity meter box. I've heard of their existence but don't know where to get them! —Julian Rutt

A —
The best source of fans for this sort of work is computer fans: they can move a lot of air and there are low-noise models available. In most cases you can connect them directly to a small solar panel without any other circuitry, although some fans can be damaged if the panel voltage gets too high.

The 12-volt rating on a panel is the nominal system voltage it's designed for. The maximum power voltage is usually closer to 17 volts, with an open circuit voltage closer to 21 volts. This voltage can be enough to damage some fans.

Fortunately there's a simple solution—either a three terminal regulator IC (available in a kit with circuit board from places such as Jaycar Electronics) or even just a simple 5-watt Zener diode connected across the fan. Just select a 15V Zener and make sure the panel is rated at less than 5 watts (which it will be as a 120mm computer fan draws about 2 watts), and you're fine.

Another option is a bilge blower, such as this unit from Whitworths Marine: bit.ly/KJlOrS. — Lance Turner

Notes and errata: Issue 119

In the article *Cute Little Ute* on page 18 of *ReNew* 119, Ralph Hibble's surname was misspelt as Hibberd. Apologies Ralph!

Write to us

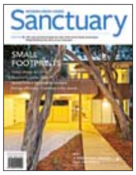
We welcome questions on any subject, whether it be something you have read in *ReNew*, a problem you have experienced, or a great idea you have had. Please limit questions to 200 words.

Send questions to: *ReNew*, Level 1, 39 Little Collins St, Melbourne VIC 3000, or renew@ata.org.au

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.



Sanctuary: modern green homes issue 19

Price: $11.95

Featuring inspiring sustainable homes, green design for denser cities, a beginners guide to solar PV, tips on draught proofing your home and insulating tricky spaces, and more.

LED downlight insulating cover

Price: $18.60

Retrofit your halogen downlights with energy-efficient, cooler-burning LEDs, and add these insulating covers to reinstate the integrity of the insulation in your ceiling that was compromised when the halogens were installed.

Solar system for an East Timorese family

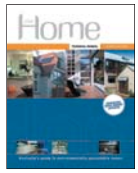
Price: $250

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.

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.



Your Home building manual

Price: $49.50

Australia's best-selling handbook on sustainable and stylish living provides a step-by-step guide for matching building designs to your local climate.

(No member discount on this item.)

ReNew back issues

Price: $7.50 (print) and $5 (PDF; free for ATA members)

Missing an issue from your collection? Looking for a particular article? Back issues of *ReNew* are available in print format (while stocks last) or as PDF downloads. **Tip:** find the issue you're after by searching for articles in the ATA library: www.ata.org.au/library

LED halogen replacement bulb

Price: $9.50

An easy replacement for a standard MR16 halogen downlight, these warm-white LED units draw only 7W yet are as bright as a 50W halogen. As well as using less energy, they generate far less heat than the halogen equivalent.

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. They reduce heat loss, conserve energy and save you money.

SEND ME BOOKS OR PRODUCTS

ITEM OR CODE	QTY	PRICE
		$
		$
		$
MEMBER DISCOUNT (15%)		– $
POSTAGE — Flat rate of $10 per order, regardless of the number of items, or $3.50 for booklets, magazines and CD ROMs.		$
PLEASE ACCEPT MY DONATION — Donations are tax deductible ☐ Send me a tax deductible receipt		$
TOTAL (all prices in $AUD and subject to change)		$

Post to: ATA, Level 1, 39 Collins St, Melbourne VIC 3000

MY DETAILS (PLEASE PRINT):

NAME

ADDRESS

STATE POSTCODE PHONE

EMAIL

PAYMENT DETAILS:

CARD TYPE ☐ VISA ☐ MASTERCARD OR: ☐ CHEQUE ☐ MONEY ORDER

CARD No:

EXPIRY DATE NAME ON CARD

SIGNATURE

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

DIY project competition
Send us your video and WIN!

Do you have a creative, quirky or interesting DIY project you'd like to share with other *ReNew* readers? Maybe you've done an inspiring house retrofit, rigged up a unique greywater system, made a gadget or converted a petrol car to electric.

It doesn't have to be fancy. Grab your camera or even your phone, and send us a video of under five minutes showing the steps you took in your DIY project, and how it improves your life, saves energy or water, or reduces waste. Submissions will feature on the ATA YouTube channel to help inspire others.

Prize

The winner will receive a $500 EnviroShop gift certificate to spend on a wide range of green products and energy saving technology. Check out the online shop at www.enviroshop.com.au.

How to enter

1. Download and install the free filesharing program **Dropbox** (www.dropbox.com), and create an account
2. Save your video file into the **Public** folder in your Dropbox account
3. Right click on the file and choose **Dropbox > Copy public link**
4. Send an email with the link and 50 words about yourself to renew@ata.org.au, with 'DIY video competition' in the subject line.

Entries close on **31 July 2012**.

Proudly supported by:

enviroshop THE SUSTAINABILITY EXPERTS Solar

Full details at renew.org.au.
The ATA reserves the right to moderate videos submitted.
By entering, you grant the ATA permission to upload your video to the ATA YouTube channel and to use it in ATA promotional activities.

Classifieds

When selecting an installer, get two or three quotes and check accreditation/references.
✻ indicates this provider offers discounts to ATA members.

Bio Products
Paint made from natural and non-toxic ingredients! Wall Paint, Enamel Paint, Varnishes, Oils, Waxes and Thinners.
25 Aldgate Tce,
Bridgewater, SA 5155.
Ph: 1800 809 448.
www.bioproducts.com.au

Brett Carter Solar Energy (TAS)
Renewable energy consultant, designer and installer of remote and grid systems. System maintenance and power audits. Full BCSE accreditation.
mob: 0419 528 048
E: brettcarter02@gmail.com

EcoInnovation
Manufacturer of cost effective water and wind turbines using converted Smart Drive motors. Our manual details the conversion of Smart Drive motors to generators.
E: enquiry@ecoinnovation.co.nz
www.ecoinnovation.co.nz

Eco options (NT) ✻
Skylights, solar powered roof vents, Rota-Loo products, Modwood decking, Solacoat reflective coating, E-therm Insulation, Bokashi buckets and more.
10 Witte St., Winnellie NT.
Ph: (08) 8947 7373
www.eco-options.com

Green Shoots Financial Planning
Direct the future. Advice for saving, superannuation and retirement supported by ethical investments. Authorised representative of Sentry Financial Planning AFSL 247105
ABN 74099029526
www.greenshoots.net.au

Insolar Partnership Opportunity
Insolar has just turned 9 years old, and Stephen the owner has just turned 65. He's looking for a young energetic partner to buy in to the business and eventually gently ease Stephen out.
After 20 July contact
Stephen@insolar.com.au

Latronics Inverters
Reliable and performance enhanced true sinewave inverters. Stand alone and grid connected inverters from 400W to 7000W. Designed and manufactured in Australia.
Ph: 1300 550 204, www.latronics.com
E: sales@latronics.com

LEDsales
LEDs for DIY projects, including Cree and other brand name LEDs. DC and mains LED drivers, 12VDC LED ribbon and many other LEDs and related devices. If we don't have it, we can usually order it in!
E: orders@ledsales.com.au,
www.ledsales.com.au

Classifieds

When selecting an installer, get two or three quotes and check accreditation/references.
✻ indicates this provider offers discounts to ATA members.

Advertiser directory

Advanced ECO Solutions........24, 80
Aquamonitor........17
AusIndustry........43
Aussie Batteries & Solar........52
Australian Clean Energy Fund – Aquatronic........33
Australian Correspondence Schools........69
Australian Ethical Investment........IBC
Building and Home Improvement Expo........81
DC Solutions Australia........1
EcoFlo Water Management........66
EcoInnovation – Powerspout........69
Energy Conscious Design/Splash Monitoring........77
EnviroShop........66
Excelsior Power........24
Geomaster........59
Global Sustainable Energy Solutions........77
Green Moves Australia........59
Green Shoots Financial Planning........12
Home For Sale – Beechworth, VIC........59
Home For Sale – Glenrowan West, VIC........69
Jaycar Electronics........2–3
Landcom Eco Living Display Homes........15
Latronics........IFC
Lightway Australia........13
Low Energy Developments........92
Midland Insurance Brokers........80
MPower........25
MR Components........12
NOWarchitecture........66
PowerSupplies Australia........53
Powerup Lawncare Products........9
Prestige Lighting........38
Rainbow Power Company........24
Run On Sun Australia........19
Si Clean Energy........OBC
Soanar EcoTech........59
SolarWorld........7
Solazone........38
Something Solar........87
Steplight........53
Successful Solar Books........81
Sungrow Australia........39
Tenrod........66
The Natural Paint Company........52
The Owner Builder Magazine........77
Watersweet Pty Ltd........52

Dynamic dynamos
A super bicycle light alternator

Bike lighting needn't have the hassle and expense of flat batteries—you can power your lights with energy from your own muscles. Julian Edgar describes his amazing bicycle alternator.

BICYCLE lighting has advanced in leaps and bounds in the last five years. No longer do you have to peer ahead, trying to find your way through the blackness—and neither do drivers have difficulty in seeing you! However, nearly all current high-quality bike lights use batteries to power the system. But if one reason you are riding a bike is because of its energy efficiency and low greenhouse gas emissions, why aren't you generating the power for the lighting as you ride along?

Here's how to make your own bike generator—and it's a beauty that will produce a lot of power and yet cost you almost nothing! But a word of warning: to do a good job, it's not a five-minute exercise; you'll want to put aside at least a day to build this design.

Generating power

A traditional bicycle 'bottle' dynamo uses an eight-pole circular permanent magnet that spins between two coils. The power rating is generally 3W at 6V. In all designs that aren't electronically controlled, output voltage increases with speed. To prevent the bulb filament burning out at high speed, the output is governed by a relatively high (e.g. 14 ohms) internal coil resistance. In other words, go really fast and you're putting in lots more energy without getting any more out.

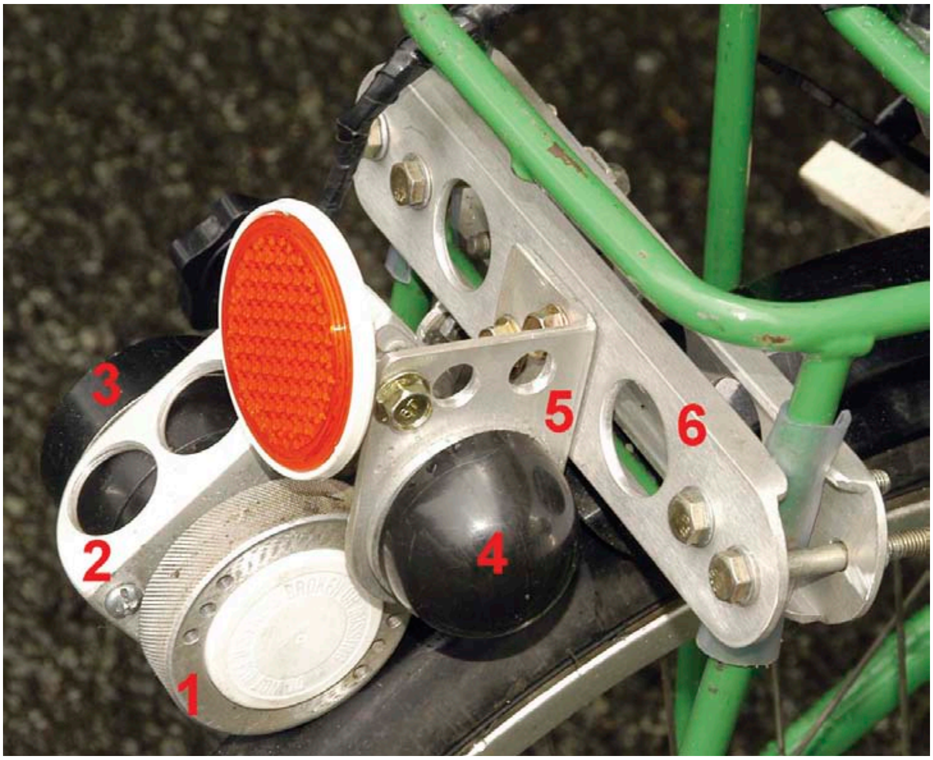
A more expensive approach—one that isn't normally used in bicycle applications—is to use a stepper motor as an alternator. Taking this approach has the advantage that a high output can be gained at low speeds without unduly compromising the output at higher speeds. The total power output can also be much greater than is achievable with a traditional bike dynamo. If the stepper motor alternator is used to recharge a battery pack, the output voltage of the alternator will also vary little over a wide range of speeds.

So, how much output are we talking about from a stepper motor alternator on a bike? Well, on my 63-speed recumbent trike I've measured a maximum output of 54 watts! That's around 18 times the power of a normal bike dynamo. Even when charging a 12V battery pack it's possible to achieve a continuous power output of 10W at normal road speeds.

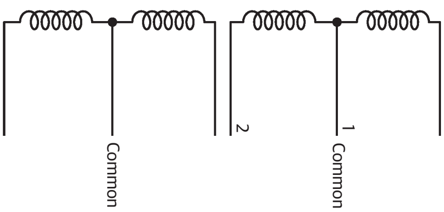
Selecting the stepper

Suitably sized stepper motors are available for nothing from a wide range of discarded goods such as photocopiers, large printers and big old electric typewriters.

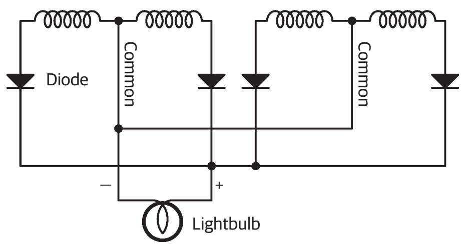
To find the best stepper motor for this application, salvage a pile of them and check them in turn—it's unlikely that the first you find will be ideal. However, stepper motors often look much the same, so how do you pick the most suitable?



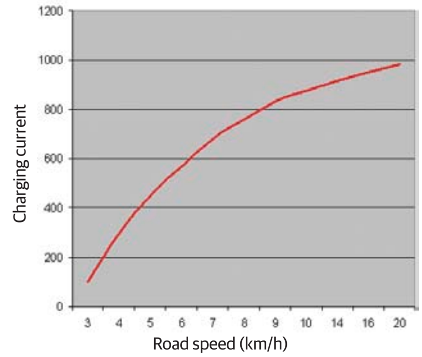
↑ The bike alternator system, seen from the right. (1) Knurled aluminium roller made from a video drum (the white centre cap is from the top of a vitamin jar), (2) Alternator support frame, (3) Stepper motor being used as an alternator, (4) Cover over end of video drum bearing (the cover is the cap from a deodorant bottle), (5) Bearing support, (6) Bike support frame.



↑ Figure 1. Six-wire stepper motors have internal wiring that looks like this. When sorting through a batch of stepper motors, place a LED across a pair of wires (e.g. connections 1 and 2) and spin the stepper to give a quick and easy indication of its potential power output.



↑ Figure 2. A further test can be made by driving the stepper motor with an electric drill while the stepper is connected to a suitable load such as a 6V, 3W incandescent bulb. The higher the output, the better. As a guide, the stepper shown here developed 8.4V at 0.6A when running a 6V 3W bulb and being rotated at 900 rpm.



↑ Figure 3. The current achieved when charging a 4.8V battery with a six-wire stepper motor with specifications of 4V, 1.8 degrees per step, 1.8A per phase. The alternator uses a 63mm diameter knurled roller. Note the high output at very low road speeds—even when using the large diameter roller—800mA charging is achieved at just 9km/h.

Firstly, select a stepper that is a decent size. For example, the one I use is 55mm in both length and diameter. This size of stepper normally has sealed ball bearings rather than plain bushes, but pull it apart to make sure that's the case.

Most steppers will be six-wire designs with, as Figure 1 shows, two electrically separate centre-tapped windings. Use a multimeter to measure the resistances of the coils until you ascertain which wires are which. Place a normal high-intensity LED across a winding (e.g. connections one and two in Figure 1) and give the stepper a spin. The stepper you want will light the LED brightly, even with a slow shaft speed.

Next, short those two wires together. If it's the stepper you want it will now be much harder to turn, with a gritty 'cogging' action.

Now measure the DC resistance across the same two wires. The stepper that's best suited will have the lowest winding resistance—e.g. less than five ohms.

Finally do a last check. Connect four 1N4004 diodes (available from an electronics store such as Jaycar Electronics) to the output windings and connect a load such as a normal bicycle headlight. Use an electric drill to spin the stepper motor and measure the loaded output voltage and current (Figure 2 shows all the connections). The higher the output the better, but as a guide, the stepper shown here developed 8.4V DC at 0.6A when running a 6V 3W filament bulb and being rotated by the electric drill at a nominal 900 rpm.

Installing the alternator

To drive the alternator from the tyre you'll need a knurled aluminium or steel roller that's about 30 to 60mm in diameter and is a press-fit on the shaft of the stepper.

Said in one sentence that sounds easy but the reality is often much different. I have a metal-turning lathe and so the task of making the roller was straightforward, but if you aren't so equipped you might need to approach a local engineering works or tech teaching school (also see the "Video head roller" box on the next page for an easy solution). It is imperative that the roller is both perfectly round and concentric with the shaft. The diameter of the roller is also important—we'll come back to this in a moment.

Rather than take the traditional approach of the roller pushing against the sidewall of the tyre, I chose to run the roller against the tread of the tyre. This allows the use of a larger diameter roller while still letting the roller run 'true'. However, there is a problem with this approach. Most salvaged stepper motors have only a short length of protruding shaft. If you mount a wide roller on this, much of the roller isn't supported by the shaft and so the roller will have a tendency to wobble. I was able to instead use a narrower roller that is better supported by the shaft but bears against only the centre of the tyre tread. This works very well—even in wet conditions there's no detectable slippage.

However, if the bike is to be used in muddy conditions or has a deeply treaded tyre, a smaller roller should be used that bears against the tyre sidewall.

The alternator/roller combination needs to be mounted so the assembly can pivot, pushing the roller against the tyre. At its simplest, this requires only a few brackets and a normal door hinge but I decided to make a more elaborate mount.

As a ready-made pivoting assembly I used the components from a couple of video drum assemblies salvaged from VHS video cassette recorders. To suit my purposes, the main shaft support, which contains two widely spaced bearings, was reduced in diameter, as was the spinning head.

The stepper motor was attached to the cut-down spinning head via a bracket made from aluminium angle. The other part of the drum assembly, comprising the precision sealed ball bearings and support, was attached to another aluminium angle which in turn was bolted to a plate. The plate was attached to the cycle carrier. The aluminium plates and angle were drilled for lightness.

The video drum shaft running in bearings thus forms the pivot on which the stepper motor/roller assembly rotates, allowing it to be pressed against the tyre while rigidly keeping the stepper motor shaft and the cycle wheel axle parallel.

Because a large diameter roller is able to be used with stepper motor alternators, the roller does not need to be heavily pushed against the tyre. A light spring will do the job without great tyre deflection—and so without the frictional tyre losses that would otherwise result.

I also added an over-centre linkage in parallel with the spring that allowed the alternator to be held captive in a lifted position if required.

Roller diameters

In addition to the characteristics of the stepper motor and load, the electrical output depends on how fast the alternator turns. Alternator speed is determined by the drive roller diameter and how fast you ride. This latter point is often forgotten, but if you seldom exceed 10km/h, the gearing of the alternator will need to be quite different than if you frequently ride at 25km/h.

An alternator subjected to a load will have a current output that initially rises with speed then plateaus as the speed rises further (see Figure 3). If the alternator is geared too high, the output current will plateau early. This is bad as you'll be pedalling hard but getting no more out of the alternator.

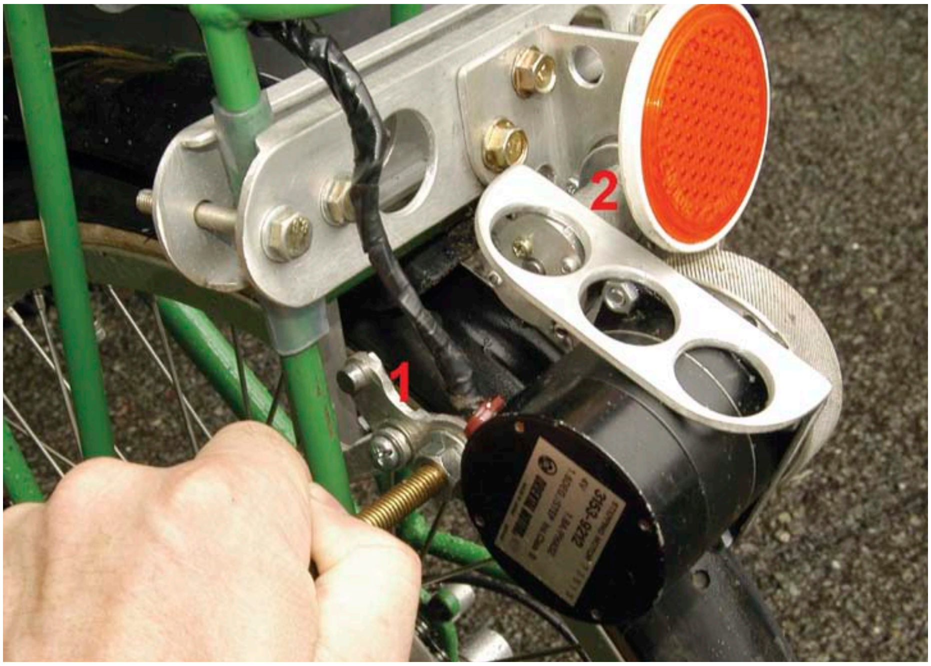
On the other hand, if the alternator is geared too low, the electrical output will always be less than it could otherwise be.

Making it even more complex is that the slower the alternator turns, the lower are its internal losses—but of course, the electrical output of the alternator is also lower. Because the optimal alternator gearing depends on the load, the characteristics of the alternator and how fast you ride, the best approach is to try some different diameter rollers.

The first roller I made was 33mm in diameter. This gave excellent electrical output but the pedalling effort (even with no current draw) was relatively high. (This parasitic load is due to the internal losses.) Using this roller, 0.8A at 12.7V was available at 15km/h when charging a nominally 9.6V battery pack. At over 10W output there was power to spare, so I decided to try a larger 63mm diameter roller to slow the alternator and so decrease the parasitic losses. With the new roller, the pedalling load was reduced but the electrical power output remained very respectable.

Conclusion

It's not a five minute job, but turning a salvaged stepper motor into a high-powered bike lighting alternator is satisfying and very effective. ✱



↑ When the over-centre lever (1) is released, the alternator/roller assembly pivots so that the roller contacts the tyre. The pivot is formed from a cut-down video drum assembly (2) that uses high quality ball bearings and a precision shaft.

↑ When the over-centre lever is released by turning the knob clockwise, the roller is pulled against the tyre by the action of the spring. A strong spring is not required as the large diameter knurled roller grips even a slick tyre very well.

Video head roller

As I've covered previously (see Salvage It! in *ReNew 112*), video heads from VHS video cassette recorders are very useful items to salvage. In fact, one of these can even be used to make the roller that drives the bike alternator.

When you pull the video drum assembly apart, you'll find a hardened steel shaft that runs on sealed ball bearings. At one end of the shaft is a brass collar that is a push-fit on the shaft. Bolted to the collar is the part of the drum that spins. This comprises a 61mm diameter, 12mm wide aluminium disc.

The shaft of the video drum is a little smaller in diameter than the shaft of most medium-sized stepper motors. So if the brass collar is removed (easily done by using a vice to support the collar, and a drift and a hammer to push the shaft through it) the collar can be carefully drilled out to become a push-fit on the shaft of the stepper.

If the hole in the brass collar ends up a fraction too large to be a genuine push-fit, squeeze the shaft of the stepper in the hardened steel jaws of a vice. This will raise bumps which will then grip the collar very well. For additional security, apply some liquid thread locker.

The drive surface of the aluminium disc can be knurled in a lathe (or have lateral striations cut across it with a file or hacksaw) and then bolted to the brass collar.