Making sure your home is not an energy sink

When it comes to using energy around the home, people seem to be getting the message that it's important to 'switch off and save'. The next step is understanding how much energy is used by different activities, so we know which to tackle first, advises **Peter Seligman**.

Some modern appliances use more energy on standby than doing their job.

It makes no sense to turn off a light when you leave a room in which an electric heater has been left on. The power used by the light is 100 watts (W), while a heater typically draws 2000 W.

How big a yardstick is 100 W? Let's assume that we leave a 100 W light globe on every night for six hours, which adds up to 2200 hours a year.

To calculate the energy used – measured in watt-hours – over the year, we simply multiply the hours by watts, which in this case is 220 000 watt-hours (Wh). As we know, 'kilo' means 'thousand', so a more manageable way of expressing this figure is 220 kilowatt-hours (kWh).

To most people, including me, a number like 220 kWh doesn't mean much, so let's convert it into something familiar – say litres of petrol – as an energy equivalent.

The best efficiency that can be achieved by burning brown coal to generate electricity is 25 per cent. This means four times the energy that comes through your electricity meter or power point is required to produce the energy you use in your home.

Taking the above example: 4 x 220 kWh, or 880 kWh, is required to produce that amount of electricity.

If we go a step further, a litre of petrol contains about 10 kWh of energy. Thus, the 880 kWh equates to 88 litres – enough for the average car to drive 880 km, or from Melbourne to Sydney. That's just to run one light globe each night for a year!

Hot showers drain hot water five times faster than the time taken to heat it.

The case for shorter showers

Ready for another surprise?

You turn on the taps and jump into the shower. Let's not ponder over how long you stay in there, but rather look at how many light-globe-equivalents of power are used.

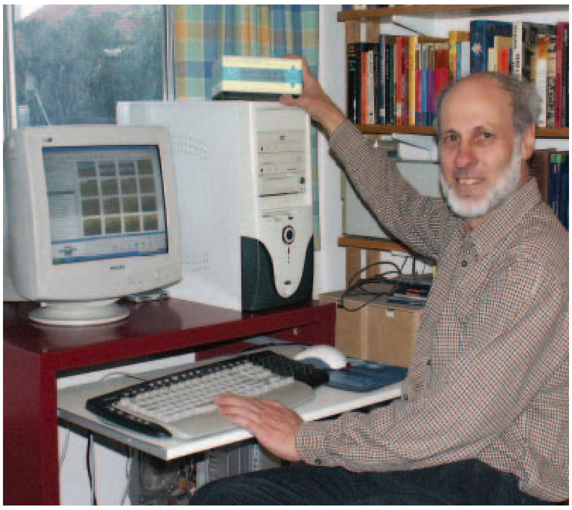
An electric hot water service element typically draws around 4800 W. Translating this into 100 W units (4800/100), we get 48 light-globe-equivalents.

Now let's look at how quickly that water can be used.

If you showered until the hot water ran out, let's assume it would take an hour to drain your hot water service. An electric hot water service generally heats water at night over about five hours. In other words, while you have the hot water tap running, you are using hot water five times faster than you are able to re-heat it.

So the hot water going down the drain is the energy equivalent of – wait for it – 5 x 48 kWh, or 240 light globes.

I suspect that many people might take much shorter showers if they could see the 240 light globes while the hot water tap was on!



Peter Seligman uses a power meter to monitor the energy use of appliances around the house.

A closer look at fluorescent lights

How many of us have heard that fluorescent lights are efficient? While it's true that fluorescent lights are more efficient than incandescent lights, the problem is the sheer numbers of lights installed.

A typical one- or two-person office might have four double-tube fittings. The tubes may be 36 W, but the complete fitting – which includes a transformer-like object called the ballast – uses closer to 45 W. That's about 90 W for each double-tube fitting, so the office is using the equivalent of almost four 100 W incandescent light globes.

Have you heard the myth that it takes more energy to switch lights on and off than leave them on? It isn't true. Its origin can be traced to a time when fluorescent tubes were new, expensive and their life was shortened by frequent switching. But in terms of energy used by modern tubes, an hour switched off is an hour's energy saved.

It's not that fluorescent light tubes are inefficient. In fact, they are more efficient than compact fluorescent lights (CFLs). The problem is in the way they are used and overused.

One new Tri-phosphor tube can adequately light a kitchen or small office. However, boxed lights with diffusers waste a lot of the light. Newer fittings with reflectors and no diffusers are much better. A very cheap and simple solution is to take a quarter of the tubes out. Three new tubes produce the same light output as four of the older type.

More power myths around the home

Now to low-voltage downlights, another energy 'blind spot'. Many consumers take low voltage to mean low energy, but this is not so. These lamps not only light small areas, they use a lot of power. Because of the transformer, each downlight – rated at 50 W – actually uses about 60 W.

The main problem with these lights, apart from their inherent inefficiency, is that too many must be installed to get adequate lighting. It is not uncommon to find six or more in a kitchen – around 400 W.

Fortunately, new compact fluorescent downlight replacements only use about 11 W.

Desktop computers are another power hog. How many of us have a desktop computer churning away all day, maybe all night too?

Home computers typically use about 120–160 W, although this drops to about half if the monitor switches to standby. Nevertheless, an average home computer might use 100 W for six hours per day. Think in terms of that Melbourne–Sydney drive!

The good news is that laptop computers use only about 20 W, even less on standby. LCD monitors use much less power than the older CRT types.

Standby power

You may have heard that some appliances use power all the time, even when they are switched off. Until recently, appliance designers didn't worry about this. Electronic control circuits need a fraction of a watt instead of the many watts they draw, but some modern appliances use more energy on standby than doing their job.

For example, when our washing machine is on standby – not even displaying any panel lights – it uses about 5 W, which is 24 x 5 = 120 Wh per day. However, the machine only uses about 50 Wh (not counting the energy to heat the water) to do a load of washing. Our solution? Turn it off at the power point.

The sheer numbers of these appliances causes the problem – microwave ovens, TVs, VCRs, DVD players, all with individual clocks and displays. A typical house might have 10 such units. So unless it actually has time-setting functions that you need to program, switch it off.

Finally, let's look at solar. A photovoltaic solar panel costs about $10 to provide 1 W when the sun is shining directly on it; this is its 'peak' power.

However, you also have to take into account varying sun angles, night-time and weather. For Melbourne or Sydney, the average power is about one-seventh the panel's peak power. So an average watt costs about $70. Frames, installation, wiring, etc cost about double that again.

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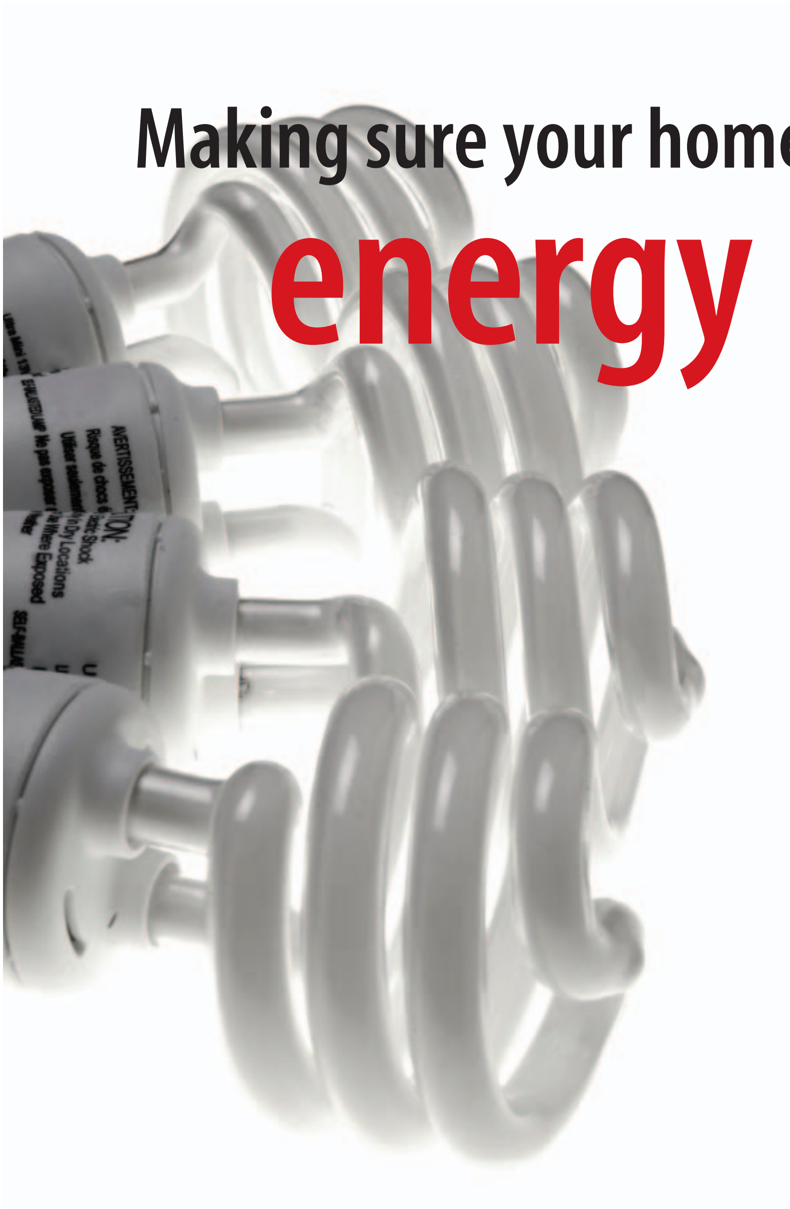
But changing an incandescent globe to a compact fluorescent saves on average 20 W (80 W saving for, say, six hours out of 24). Cost to make the change? About $7 replaced 10 times over 20 years – say $70.

Compare that to the cost for a solar system to provide an average of 20 W: 20 x $70 = $1400. Or if the government is paying half, about $700.

I hope I haven't depressed you too much but the good news is that the potential for saving energy around the house really is huge – if you just understand where that energy is going.

Dr Peter Seligman, a biomedical engineer, was a key member of the team that developed the Cochlear multiple-channel cochlear implant. A focus of his work over the past 24 years has been the development and improvement of speech processors. He is a qualified electrical engineer, holds 25 patents and has been involved in the design of photovoltaic solar energy and solar heating systems.

Making sure your home is not an energy sink 2



The second part of a series in which electrical engineer **Peter Seligman** reveals the hidden patterns of energy consumption and greenhouse gas emissions around the home. In this issue, domestic hot water goes under the microscope.

In the first part, I mentioned how some appliances use a considerable amount of energy when not in use. For example, my son recently installed a 5-star split-system air-conditioner. It draws 10 watts on standby.

If we do the calculations, 10 W (watts) for 24 hours a day, 365 days a year comes to 88 kWh (kilowatt hours) per year.

Now let's work out its likely usage when operating. Say we have 20 hot days a year when the system is running flat out for 8 hours. Let's conservatively assume that running flat out, it draws 550 watts. The sum of 550 watts for 8 hours for 20 days comes to 88 kWh per year.

This 5-star-rated appliance uses as much energy on standby as doing its job. Systems like this should be installed with a switch so they can be turned off completely for most of the year.

Peter Seligman calculated that he saved around 1.7 tonnes of CO_2 emissions per year from his home simply by replacing conventional light bulbs with low-energy ones.

Maciej Korzekwa

Finding the most efficient mix

When I said previously that solar water heating was an excellent idea, I lied! Well not completely. Here's the full story.

Seventeen years ago, I connected solar-water-heating panels to our electric off-peak hot water service. It's still working – that's the good news. The not-so-good news? Before the solar panel installation, we used 4300 kWh a year for water heating; since then, we've used 2800 kWh. This is a reduction of only 35 per cent.

The problem is that the solar component and the electric booster compete with each other. On cloudy days, electricity heats the water overnight. If the following day is sunny, the solar has little to do. The temptation is to turn off the electric heater altogether and go 100-per-cent solar. While this may work in the summer months, the inevitable will happen and hot water will run out on a cold day – and your family will blame you!

If you look at a map showing the proportion of solar contributions in cities around Australia, you will see that people living in Cairns, Brisbane, Perth or Darwin could get more than 75 per cent of their water heating from solar.

Let's consider water heating from a greenhouse gas perspective. If 1 kWh of electricity produced by burning coal produces 1.3 kg of carbon dioxide, our solar panels were reducing our CO_2 from 5.6 to 3.7 tonnes per year. That's moderately good.

What if we had just opted for a natural gas water heater? You can find the answer from a Rheem hot-water manual. (Rheem manufactures both electric and gas heaters.) According to the manual, a natural gas heater would use 62 MJ/day (megajoules per day), equivalent to 6300 kWh a year – more than the energy used by the pre-solar electric tank. However, the CO_2 emissions from the gas system would be only 1.4 tonnes a year – less than half that of the solar/electric system.

Rather than taking out my solar system and replacing it with a gas one, I decided to keep the existing solar as a pre-heater for one of the new-generation instantaneous hot water systems. This is no greenie Heath Robinson idea – at least four major hot-water system manufacturers now offer it. It provides the best of both worlds: a solar system that can do its best without interference from a booster, and a gas heater to do the rest.

Even better, the instantaneous system does not have heat losses associated with having a flue. I was horrified to discover that a conventional gas storage heater uses

25 MJ/day just keeping the water hot without any being used. To supply 150 litres per day, it uses 62 MJ/day. When the unit is idle while you are away on holidays, three 100 W-light-globe-equivalents of heat are going up the flue, all day, every day. It's a pretty good reason for turning it off when you go away.

The electric storage tank, having no flue, has much lower losses: one 100 W-light-globe-equivalent if it is on 24 hours a day. That's equivalent to four Melbourne–Sydney trips a year!

In short, the gas-instantaneous-boosted solar system wins handsomely over the others.

Hot water systems: energy efficiency and CO_2 emissions

Type of water heater	kWh/year	Tonnes CO_2 per year
Off-peak electric	4300	5.6
Solar with off-peak electric	2800	3.7
Gas storage	6300	1.4
Solar with instanta-neous gas boost	3000	0.7

The CO_2 score card: a running total

Water heating accounts for about half the energy used in a household, so let's look at the total picture.

Our household's electricity load minus the water heating is about 2700 kWh/year. Generating this amount of electricity from coal creates 3.5 tonnes of CO_2/year. Before our change to low-energy lamps, it was about 4000 kWh/year – the equivalent of 5.2 tonnes of CO_2/year.

That was a big improvement but what's the next step? Eliminate the 3.5 tonnes!

This could be in done in two ways. We could either spend $18 000 on a grid-connected solar photovoltaic system or, for $150 per year, buy electricity from a renewable source. For a very obvious reason, we chose the second option.

Here's the CO_2 score card:

Action	Tonnes CO_2 for lights, fridge etc.	Tonnes CO_2 for water heating	Total tonnes CO_2 per year
Business as usual	5.2	5.6	10.8
Low-energy lights; solar hot water and electric boost	3.5	3.7	7.2
As above with gas-boosted water heating	3.5	0.7	4.2
Electricity from renewable sources	0	0.7	0.7

As you can see, we have reduced our domestic CO_2 output to one-fifteenth of what it was. And we did it by using standard, available, reasonably priced technology.

With the advent of the ability of individuals to buy 'green' electricity, we have a further option. If we remove ourselves from the peak load, we can remove ourselves from the off-peak load too. It is as if we eliminate ourselves from the fossil-fuel-electricity-generation system altogether. And that has to be better.

Solar pre-heating with instantaneous gas boost provides a hot water option with 'the best of both worlds'. Solahart

A word of warning about 'green' or 'renewable' electricity. You almost certainly have been approached by an electricity company offering '100-per-cent renewable' for no extra cost.

Don't believe a word of it! If you have already signed up for this, check your electricity bill. My first '100-per-cent renewable' bill said 'Total greenhouse emissions for this bill: 1.08 tonnes. Total greenhouse savings for this bill: 0.15 tonnes'! Describing that option as 100-per-cent-renewable is a mystery and pure deception.

GreenPower[1] is the national accreditation program for renewable energy run by the NSW Government that has over 590 000 subscribers around Australia. Accredited GreenPower retailers are required to use a product disclosure label on marketing material, including the percentage of your electricity consumption that will come from accredited renewable sources.

Only the accredited portion shown can be said to be reducing greenhouse gas emissions, as it is this part of your supply that comes from new renewable energy facilities built since 1997. WWF, the Australian Conservation Foundation and the Total Environment Centre provide an annual report rating retailers' GreenPower products by environmental criteria.[2] *Choice* magazine also provides an online price comparison for GreenPower products.[3]

One last point. I have only considered domestic hot water, lighting, cooking and domestic appliances. I have not mentioned space heating, transport, holidays, the workplace and the energy in all the goods and services we buy.

That comes in the next exciting episode!

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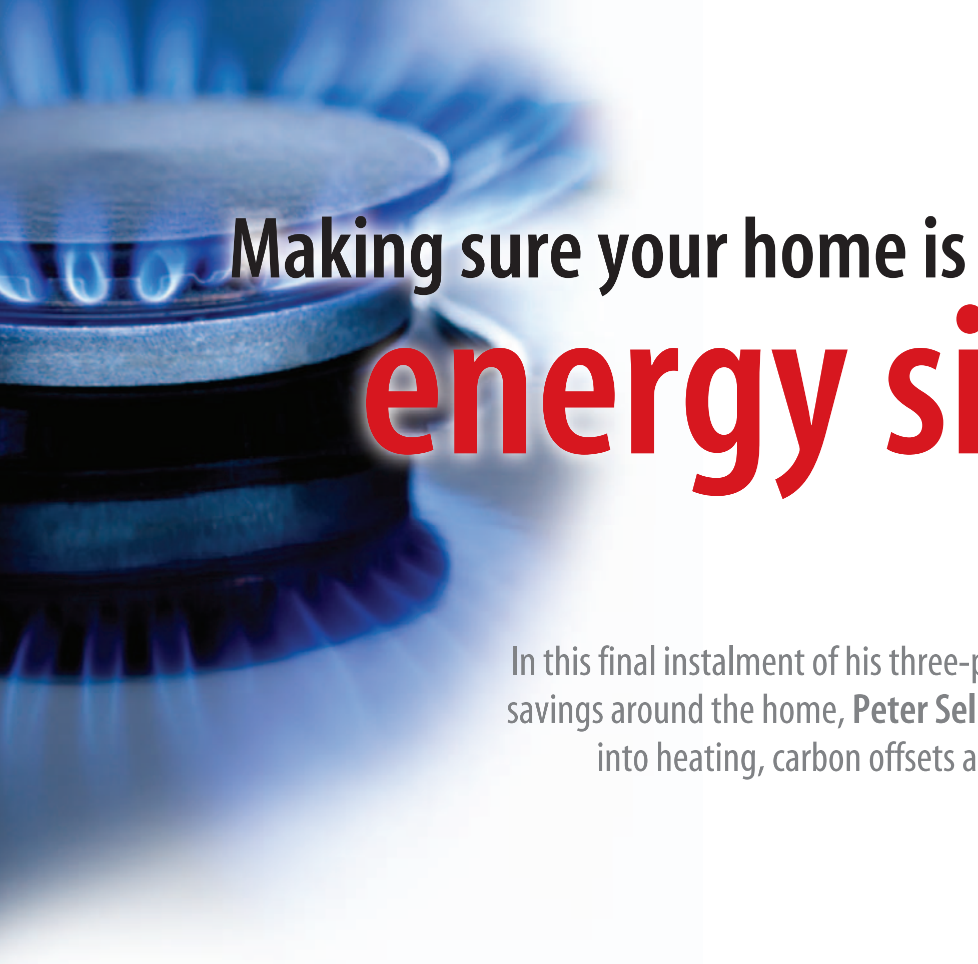
1 See www.greenpower.gov.au
2 See www.greenelectricitywatch.org.au
3 See www.choice.com.au



Making sure your home is not an energy sink 3

In this final instalment of his three-part series illuminating energy savings around the home, **Peter Seligman** provides more insights into heating, carbon offsets and alternative energy sources.

This time, we'll look at space heating. In Melbourne you need it, if you don't want to be the bad guy who goes around telling everybody to put on jumpers instead of heating the house. Our house is heated by gas, and occasionally by a wood fire. Space heating, as you can imagine, is one of the big energy users and also a big CO_2 producer.

In the pre-green 'business as usual' scenario, the central heating accounted for about one-quarter of our home's CO_2 production. We were using around 55 000 MJ (megajoules) per year.

Gas is sold in MJ, electricity in kWh (kilowatt-hours). Both MJ and kWh are units of energy. You can convert MJ to tonnes of CO_2 produced by dividing MJ by 16 000. Our central heating unit was producing (55 000/16 000) 3.4 tonnes of CO_2 a year. It was an older type with a pilot light which, I discovered, was using more gas than the cooktop! We replaced the unit with a 5-star model with electronic ignition. At the same time we added insulation to the ceiling. The combined effect is that we are now using about 39 000 MJ per year – a saving of 1 tonne of CO_2 per year.

After the various energy modifications we made (Figure 1), we are producing about one-quarter of the CO_2 that we produced under the 'business as usual' scenario. Overall, the result is quite satisfying.

Of course our 'journey' wasn't cheap, but it was only a fraction of the price of a 4WD, and will last a lot longer. Here's another way of looking at it. If you decided to buy a large 4WD to replace a normal-sized car, your CO_2 production would increase from about 4 tonnes to 6 tonnes a year. For a fraction of the 4WD's cost, you could reduce your emissions around the house from 14 to 3 tonnes per year – a saving of 11 tonnes! Where are your priorities?

What is the energy or environmental cost of energy-saving measures themselves? For example, how can you calculate the environmental or energy cost of a compact fluorescent lamp (CFL) with its many different components and materials?

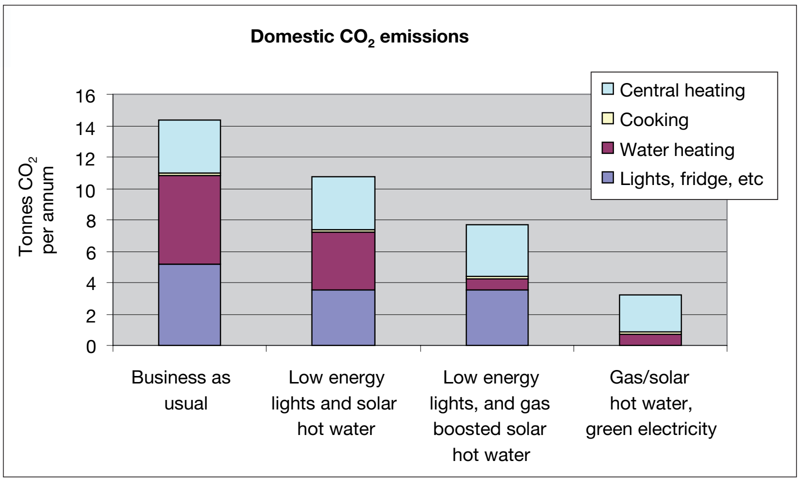


Figure 1: Domestic CO_2 emissions after various energy modifications around the Seligman household.

As far as energy is concerned, if a CFL costs $5, it can only have used $5 worth of energy at an absolute maximum. Otherwise it couldn't be sold for that price. A CFL has the potential to save around 80 watts for 5000 hours, which is 400 kWh. That electricity would cost about $50. So the CFL could save up to 10 times the maximum possible energy cost of its production. So energy wise, it must be worth it.

Carbon offsets

Carbon offset schemes do good, to make up for doing bad. Planting trees is a great example of such schemes. If nothing else, the trees should increase the rainfall and habitat for wildlife – and that's good.

However, you should know that one tree extracts about 60 kg of CO_2 a year from the atmosphere. An average household with average energy use will be putting about 14 tonnes of CO_2 into the atmosphere a year. The car accounts for another 4 tonnes and each overseas trip another 4. Let's say 20 tonnes a year for the purpose of this discussion.

What is 20 tonnes of CO_2 in tree equivalents? At 60 kg per tree that works out to 20/0.06 = 333. Please plant them! Or use an organisation that will plant and maintain the trees on your behalf – Greenfleet, for example, will plant 17 trees for $40.

The problem is that a carbon offset scheme can't go on indefinitely. If you check the CarbonSMART website (www.carbonsmart.com.au) you will see that part of the contract for people growing timber on their properties is that: 'The carbon will remain on site for at least 100 years after the final trade of that carbon'. Say you lend me $100. After a while you come back and say 'what about my $100?' I reply OK, here's $10 – just put it in the bank at 5 per cent interest and in 50 years it'll be worth $115.

A tree will remove the CO_2 *over its lifetime*. Isn't that the same as the $10 repayment?

Fossil fuel alternative – drilling in the Cooper Basin has initiated strong public interest in emission-free geothermal energy. Geodynamics

Where to from here?

While we have talked about how to reduce our energy use and offset the CO_2 we produce, if we are ever going to make serious inroads into the climate change problem, we will have to do more. What we need are serious, affordable alternatives to old-fashioned coal.

Nuclear energy is a divisive issue, because people in the environmental contingent sit on both sides of the nuclear fence. I won't go into it. The same applies to wind power.

Looked at from a purely economic viewpoint, if we are going to make inroads into the problem, we need to maximise the renewable generation capacity we get for our money. The main alternatives as we know them today are shown in Figure 2. In the cases where there are greenhouse gas emissions, the cost of CO_2 has been added at $60/tonne, to give a total effective cost.

A graph such as this is, of course, highly controversial, and various camps will claim much higher or lower costs depending on their particular bent.

Another alternative is hot rock geothermal energy, mentioned in the previous issue of *Ecos* (**139**, p. 20).

Australia's recoverable hot-rock resources are capable of satisfying current electricity consumption for more than 450 years. The Cooper Basin in South Australia alone could provide emission-free base-load electricity for 70 years. Although this new resource presents some technological challenges, they are solvable, with the help of existing oil-drilling technology.

When compared with nuclear's thorny issues of safe disposal and security against terrorism and accidents, hot rock geothermal seems a very attractive proposition.

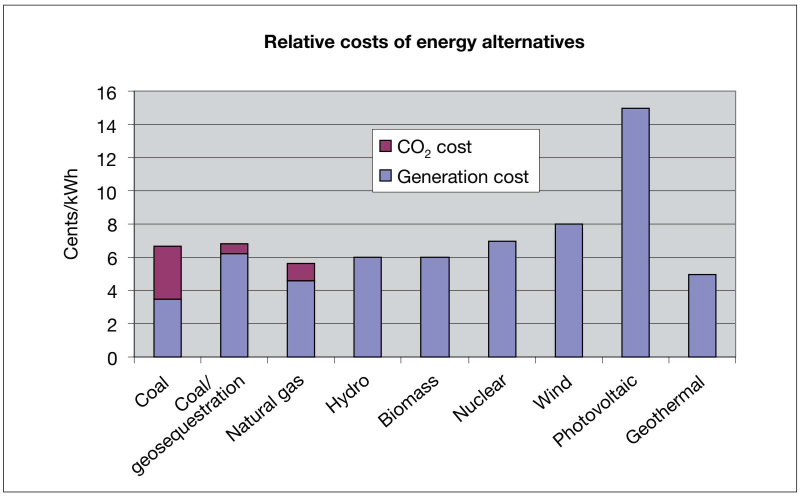


Figure 2: Relative costs of the main energy alternatives available today. The cost of CO_2 emissions has been added to coal and natural gas at $60/tonne, to give a total effective cost.

Our journey

In the first part of this series, I talked about how much energy various domestic appliances use and how we could reduce it. Some surprises included:

- A normal hot shower uses the energy equivalent of 240 light bulbs.
- Leaving a light on every night for a year uses as much energy as driving from Melbourne to Sydney.
- Electrically boosted solar water heating can be worse than gas.
- Fluorescent lights are not necessarily low energy.
- Leaving fluorescent lights on does not save energy.
- Low-voltage downlights use a lot of energy.

After giving you the bad news on the energy consumed by domestic fittings and appliances, we saw how we could do a lot better, by making the right choices and spending a bit of money. By using a combination of tactics, our household managed to get its CO_2 emissions down to one-quarter of its 'business as usual' scenario.

I hope I have alerted you to some of the misconceptions that exist about energy and its use, particularly around the home. My aim was to arm you with information – because as informed citizens, we can all do a better job!

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More information:
CarbonSMART, www.carbonsmart.com.au/pdf/InformationSheet.pdf
Greenfleet, www.greenfleet.com.au