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Energy superpower – or sustainable energy leader?

Australia has the potential to become an energy leader in the carbon-constrained future – but first we need to make sure we are heading in the right direction.

Australian Prime Minister John Howard last year coined the phrase 'energy superpower' when he identified the further development and export of energy resources as an ambition to which Australia should aspire.

In his address to the Committee for Economic Development of Australia (CEDA) in July 2006, Mr Howard stated: 'As an efficient, reliable supplier of energy, Australia has a massive opportunity to increase its share of global energy trade … we have the makings of an energy superpower.'

But if the world is to reduce greenhouse gas emissions fast enough to avoid dangerous climate change – which some say could occur within four to five years[1] – should we simply be aiming to be a fossil fuel and uranium exporting superpower, or adopt a broader vision to become a leader in sustainable energy?

Australia consumes about one-third of the energy it produces and exports the balance, which is currently valued at $45 billion – three times the combined export income from meat, grains and wool. In other words, Australia is already punching above its weight in global energy export terms.

On the other side of the equation, Australia imports 30 per cent of its oil – a figure set to reach 100 per cent by 2030 if no further oilfields are discovered to extend known domestic reserves. This will have consequences for Australia's longer term energy sector balance-of-payment figures.

It is difficult to forecast that far ahead, but Australia's Senate Committee on Economics has been told that if current oil prices persist and if the government's best supply forecast is met, imported oil would subtract about $30 billion a year from the national export figure by 2015, according to Barry Jones, representing the Australian Petroleum Production and Exploration Association.

Australia's long-term economic future might be well served by learning from the US, where President George W. Bush in his 2006 State of the Union address committed to a 75 per cent reduction in oil imports by 2025. Iceland and Sweden have also committed to significantly reducing their oil imports over the coming decades.

Runs on the board

Essentially, the federal government's vision to date for achieving 'energy superpower' status has been exporting more of Australia's dominant fuel reserves of coal, natural gas and uranium. However, the government has also taken quite a few initiatives that show how Australia could help create a sustainable energy future. These include:

1 Dunlop I (2007). Prompt action required on sustainability and global equity. *Ecos* **138**, 9–10.

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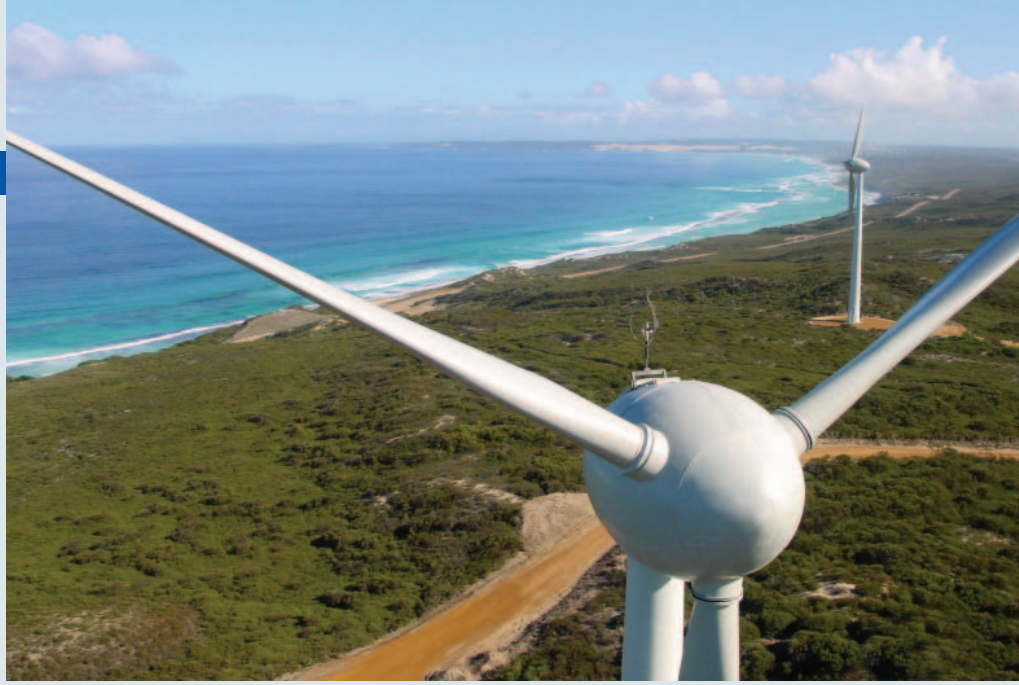

A network of wind farms, like this one at Nine Mile Beach, WA, could supply many thousand megawatts to the national grid. Verve Energy

- The phasing out of inefficient lighting.[2] The European Union and California are looking at doing the same. This will have significant flow-on effects by driving a change among manufacturers in China to focus on more energy efficient products.
- Establishing the world's first 'Solar Cities' program.
- The Department of Industry, Tourism & Resources' Energy Efficiency Opportunities program involving 250 of the biggest energy consuming companies in Australia.
- Higher rebates for solar photovoltaic energy[3] and hot water systems.[4]
- Supporting the CSIRO Energy Transformed Flagship program.

The federal government has also been working with the states through COAG (Council of Australian Governments) to establish and facilitate:

- The National Framework for Energy Efficiency,[5] a COAG initiative to add $1 billion to Australia's GDP through energy efficiency.
- The Australian Minimum Energy Performance Standards (MEPS)[6] for appliances, which have encouraged the refrigeration industry to achieve more than 50 per cent energy efficiency improvements in the last 20 years.

These are positive steps upon which Australia can build a sustainable energy future.

A recent initiative of the CSIRO Energy Transformed is its funding for The Natural Edge Project to partner with Griffith University and the ANU to develop a comprehensive online resource offering relevant information on energy efficiency and low carbon technologies. This online resource is being developed to help Australian firms position themselves for future market growth in new 'clean and green' energy technologies and services.

Natural for renewables

With its ready availability of land relative to population, sunny climate, winds, long coastline and existence of underground 'hot rock' geothermal resources, Australia would seem to have a natural advantage in developing renewable technologies.

But government support to date for renewable energy technologies has been lacking, according to Australian Conservation Foundation President, Professor Ian Lowe.

'It's not just countries like the UK and Germany and states like California that now have serious policies to extend renewables,' said Lowe. 'Even China is aiming at getting 10 per cent extra of its electricity from renewables by 2010.'

As Lowe and other environmentalists point out, non-traditional renewable technologies require a carbon pricing signal to attract investment and become viable. At the moment, with the government's decision to put off a carbon trading framework until 2012, Australia has no such price signal, with the result that some companies have moved offshore.

Australian company Solar Heat and Power, for example, has relocated to California, where venture capital for renewable energy is abundant, thanks to incentives provided by Governor Arnold Schwarzenegger's administration.

Another key reason why renewable energy companies find the climate more favourable overseas is the lack of real renewable energy incentives such as MRETs (Mandatory Renewable Energy Targets).[7]

In 2006, the Australian Government decided not to extend its MRET scheme beyond 2010. But at the time this story was being filed, the government announced, in the run-up to the election, that 15 per cent of Australia's energy would come from 'clean' sources such as wind, solar and clean coal by 2020. Critics claimed that this was simply the sum total of existing and planned targets under Commonwealth and State energy target schemes, and that the inclusion of clean coal with renewable energy sources was 'farcical'.

The economic and environmental opportunities offered by low-carbon technologies – hybrid cars, low-carbon fuels, green buildings, energy efficient appliances and renewable energy – are examined in *The Heat Is On*, a landmark report that documents the findings of the Energy Futures Forum.[8]

This report uses scenario modelling to show the feasibility of using low-carbon technologies and geo-sequestration of CO_2 to achieve a 60 per cent reduction in greenhouse gas emissions by 2050. Here, *Ecos* provides a brief overview of Australia's main energy supply sources for which transitional strategies to a low-carbon future are needed. More detail on energy management and energy efficiency measures will be the subject of a subsequent article.

Coal: an energy staple

Australia is the world's biggest coal exporter. Coal accounts for 30 per cent of world trade, and was worth $24.5 billion in 2005–06.

The future of coal as an energy source and export commodity will be determined by the success of carbon capture and storage (CCS) technology – one of the lowest cost-abatement options for reducing greenhouse gas emissions from coal-based power stations. CCS includes geosequestration, the injection of CO_2 into underground fissures.

2 Department of Environment and Water Resources (2007). World first! Australia slashes greenhouse gases from inefficient lighting. www.environment.gov.au/minister/env/2007/pubs/mr20feb07.pdf
3 Photovoltaic Rebate Programme, www.greenhouse.gov.au/renewable/pv/index.html
4 Solar Hot Water Rebate Programme, www.greenhouse.gov.au/solarhotwater/index.html
5 National Framework for Energy Efficiency, www.nfee.gov.au/home.jsp?xcid=48
6 Minimum Energy Performance Standards, www.energyrating.gov.au/meps1.html
7 Introduced in 2001, the MRET scheme required Australia's electricity industry to source an extra 2 per cent of electricity per year – beyond any current renewable energy – from renewable sources by 2010.
8 EFF (2006). *The Heat Is On: The Future of Energy in Australia*. CSIRO Energy Futures Forum, Canberra.

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However, CCS for power generation is still in its early days. No full-scale plant is yet to be built. The consensus is that CCS technologies are thought to be at least 7–10 years from practical application.

And while Australia may have sufficient underground 'storage capacity' to meet CO_2 sequestration needs for hundreds of years, some critical issues need to be resolved, including reducing the cost, matching emission source and sequestration location, and managing the risk of leakage.

Crude oil: disappearing fast

Geoscience Australia estimates that Australia's known crude oil reserves will last another 10 years.

In 2005, our imports of crude oil substantially exceeded exports of oil-related products.

CSIRO is examining opportunities for innovations that will reduce greenhouse gas emissions from transport by up to 80 per cent by 2040 as we shift to hybrid, and eventually fully electric, vehicles that use alternative fuels, such as biodiesel and liquefied or compressed natural gas.

The long-term aim is to develop technology for hydrogen-fuel-cell cars.

Natural gas: a transitional resource

Natural gas turbine power stations emit about 50 per cent per kWh of the greenhouse gas loads emitted by brown-coal-fired power stations. The contribution of natural gas to Australia's sustainable energy future would be thus important in the short term, as a transitional energy source.

Natural gas generates 14 per cent of the country's electricity and is particularly important in Western Australia, South Australia and the Northern Territory.

Australia has a few 'combined cycle'[9] gas power stations that are proving to be highly cost-competitive.

However, a drawback with gas for domestic consumption is that major reserves are located in north-west fields, such as the Timor Gap, thousands of kilometres from major south-east population centres.

Both liquefied natural gas (LNG) and compressed natural gas (CNG) are likely to play a larger role as transport fuels in the near future.

Uranium: jury's still out

Australia's known economic reserves of uranium totalled 716 000 tonnes in 2005, with production levels in the same year of 9512 tonnes, according to Geoscience Australia.

This equates to a resource life of 75 years, at current extraction levels. With no nuclear power plants yet operating in Australia (the Lucas Heights reactor is a research facility) almost all uranium production is exported.

The conclusion of the Prime Minister's 2006 Task Force – headed by Dr Ziggy Switkowski and set up to review uranium mining processing and nuclear energy – was that the cost of nuclear in 2020 would be comparable with other energy technologies, and therefore economically feasible. It suggested that 25 uranium-fired power stations could meet one-third of Australia's electricity needs by 2050.

However, the Business Council for Sustainable Energy (BCSE) refuted some key assumptions on which the projections were based and presented alternative figures showing that 'nuclear is more expensive than a range of technologies that can be rolled out in large quantities over the next 20 years to meet our growing power needs'.

Other objections to nuclear power include the long lead times for constructing nuclear power plants; the large volumes of water required to operate; the long residence time for radioactive wastes; and the risk of nuclear material falling into the hands of terrorists, a fear recently raised by the government's decision to sell uranium to India, which is not a signatory to the international nuclear non-proliferation treaty.

Geothermal: hot rocks for the outback

Australia has a huge untapped underground energy resource known as 'hot rocks'. Geoscience Australia's energy atlas shows there are hot rocks in all states, and there are now 27 companies exploring for deposits.

Hot rocks are used to generate electricity through a rather ingenious process: groundwater from aquifers is pumped through fractured granite to a depth of several kilometres where the rock is naturally heated to about 250°C; the superheated water is then pumped to the surface, where it drives a steam turbine and generator; after condensation, the water is recycled in the 'closed loop' system.

A geothermal plant is already generating 80 kW of electricity at Birdsville, in south-west Queensland.

The downside of current geothermal projects for large-scale electricity supply is their distance from major cities, which raises the cost of electricity beyond competing sources. But geothermal energy in remote communities obviates the need to transmit electricity from distant power sources.

Solar: innovation reducing costs

Australia has the highest average solar radiation of any continent, and will soon be

Spring Gully, coal gas, Queensland. Origin Energy

Geothermal energy, central Australia. Geodynamics

Carbon geosequestration research. CO2CRC

9 A combined cycle power station produces electricity from both a gas turbine and a steam turbine supplied with the steam generated by the exhaust gases from the gas turbine.

home to one of the world's largest photovoltaic solar power stations at Mildura, Victoria. When complete, it will generate 154 MW of electricity – enough to power more than 45 000 homes.

The two main types of solar technologies currently under development in Australia are photovoltaic (PV) cells and solar thermal systems.

The semiconductor-based surfaces of photovoltaic cells convert solar energy directly into an electrical current. Solar thermal systems use the sun's heat to generate electricity by first heating a fluid such as water, which drives a turbine. CSIRO and the ANU currently have research programs in solar thermal. In addition, there are global efforts underway to significantly reduce the costs of solar thermal and solar PV technologies within the next 10 years.

In 2000, ANU researchers[10] produced a breakthrough photovoltaic technology known as SLIVER, which is now being developed for commercialisation by Origin Energy at a $20 million photovoltaic manufacturing plant in South Australia. Sliver cells use up to 90 per cent less silicon compared with mono crystalline cells of equivalent output, resulting in lower module costs.

Wind: untapped potential

A typical wind turbine can meet the energy needs of up to 1000 homes. In 2006, there were 27 wind farms operating in Australia. Associate Professor Hugh Outhred, who wrote the 2003 *National Wind Power Study* for the Australian Greenhouse Office, estimated that wind farms could potentially supply 8000 MW to the national grid.

Mark Diesendorf, from the Institute of Environmental Studies at the University of New South Wales, has published an argument refuting what he sees as the 'base load fallacy' – an argument that relies on the idea that wind is too unreliable to provide a 24/7 power supply on a large scale.[11]

Diesendorf argues that while a single wind turbine provides intermittent power, a system of several wind farms, separated by several hundred kilometres and subject to different wind regimes, would provide a far more reliable supply. The system could be made as reliable as a conventional base-load power station by adding gas turbines that could be switched on and off to supplement supply.

Biomass: energy from waste

Biomass energy is produced from the combustion of organic matter – including waste from agriculture or forestry. Harvestable stubble from grain crops is currently thought to be the most likely source of biomass.

In *A Clean Energy Future for Australia*, the Clean Energy Future Group, which comprises seven energy associations, says that biomass could generate 26 per cent of Australia's electricity by 2040.

A comprehensive discussion on the issues around ethanol and biodiesel as transport fuels can be found in *Ecos* 133.[12]

Tide and wave power: finding their feet

A number of technologies for harvesting the power of the ocean are under development, including a wave energy system being trialled by Oceanlinx at Port Kembla, NSW. The company says its Australian-designed turbine can generate peak capacity of 500 kW. The prototype plant is expected to generate power at a cost of 15 cents per kW hour – about the same as wind power.

Wave power is especially suitable as an energy source for desalinating seawater. A seafloor-anchored wave-power system known as CETO and featured in *Ecos* 137 is being developed with the aim of powering Perth's large desalination plants.

The key: 'portfolio approach' with demand management

It's clear that Australia's path to becoming a leader in sustainable energy will involve moving from a single dominant energy source – coal – towards multiple sources, such as natural gas and renewables.

A move away from large, centralised power stations to distributed or localised electricity generation will go hand in hand with this complex, mixed-source energy supply.

Co-generation – the combined production of heat and electricity – is another trend likely to take off, according to the Clean Energy Future Group, which points out that the technique is already used by sugar producers, paper manufacturers and the high energy metal refining and processing sector.

But, as stated earlier, Australia has a huge untapped potential for emissions reduction by using less energy at the outset through smarter demand management. That will be the focus of part 2, next issue, along with some good reasons why we should be wary of the 'base load' argument against renewables.

● **Max Berry, Mike Smith and Karlson Hargroves**

SLIVER photovoltaic solar cells. ANU

Grain stubble – biofuels source. CSIRO Land & Water

Wave energy trial, Port Kembla. Energetech

10 ANU Solar Energy Research Groups, http://solar.anu.edu.au/
11 Diesendorf M (2007). The Base Load Fallacy. Energy Science Briefing Papers, no. 16. www.energyscience.org.au/factsheets.html
12 O'Neill G (2006). The biofuels promise: updated thinking. *Ecos* **133**, 22–25.

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