
Introduction

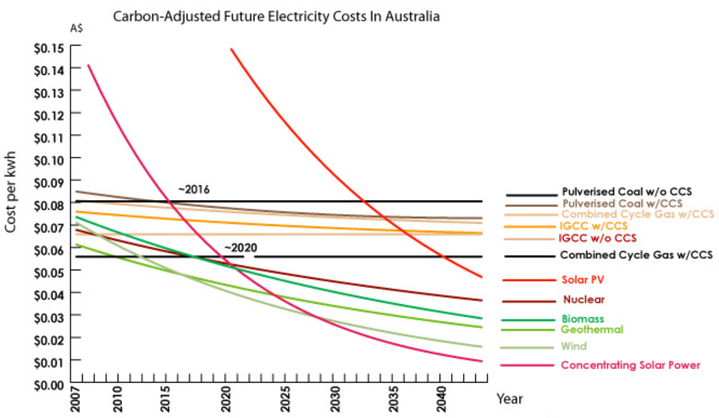
Climate change is not a *technology* problem. Climate change is an *economic reform* problem.

If market forces are unleased against climate change, Australia can enjoy higher living standards, an improved economy, a healthier natural environmental and increased global economic and political power. With unrivalled resources of low emission energy, all cheaper over the long-term than carbon capture and storage or nuclear, Australia can become a global "clean energy superpower."

The economics of renewable energy are now compelling. This is due to the "*Learning Curve*," the renewable energy industry's equivalent to the information technology industry's "*Moore's Law*." Both quantify the compound impact over time of rapid innovation on quality and price. The effects of *Moore's Law* have been huge in information technology. The effect of the *Learning Curve* is just as powerful in renewable energy.

Twenty years of rapid innovation in the renewable energy industry (through the *learning curve*) has created an entrenched, declining cost juggernaut. The ongoing effect is so dramatic that many forms of renewable energy *will be cheaper than fossil fuel by 2015.* This is very significant. That's because 2015 is the year Australia's first carbon capture plants *might* be ready. By 2020, most renewables will be cheaper than nuclear. This is also significant. That's because 2020 is the year Australia's first 'next generation' nukes *might* be available.

It's impossible to overstate this point. Write it on your forehead. Do anything you can to memorise it. ***Renewable energy technologies are cheaper over the long-term than fossil fuels or nuclear.***



Renewable energy costs are falling so rapidly that virtually all will be cheaper than coal in 2016, and cheaper than nuclear by 2019
Sources: International Energy Agency, Intergovernmental Panel on Climate Change, Australian Nuclear Science Technology Organisation, ABARE, among others

This upends the thinking and political conditioning Australians have long been subjected to. Realizing and applying this truth will have huge positive implications for Australia, the global economy and mankind's quality of life in the second half of the 21st Century. Once this principle is acknowledged, it leads naturally to the following set of policy settings for Australia.

*"**Deep cuts in emissions are compatible with continuing strong economic growth** and improvements to living standards."*
CSIRO
Response to Issues Paper,
Prime Minister's Task Group on Emissions Trading

*"**Long-term economic health depends on environmental health**; it is truly a symbiotic relationship."*
Sydney Morning Herald

*"**Global warming has the potential to focus our national imagination**."*
Michael Pusey,
sociologist
UNSW School of Social Sciences

*"**If stated emissions reduction objectives are to be achieved, the energy profile of the economy will have to be fundamentally changed, with market-based incentives needing to play a leading role.**"*
Australian Treasury Red Book, 2008

*"**We don't have a past, a history or a database that allows us to explore the simultaneous impact of recessions, disruptions to the energy supply and climate change.**"*
Bill Reinert,
US national manager for advanced technology
Toyota

*"**Climate change is happening faster than the scientific models' ability to keep up.**"*
Jeremy Rifkin,
president, Foundation on Economic Trends

*"**The world needs all countries to work together and agree on actions** to address this common challenge of climate change."*
Penny Wong,
Australian Minister for Climate Change and Water

The Seven Tenets of a Smart Energy Future For Australia

1. Impose a carbon tax of A$40 per tonne on greenhouse gas emissions. This will embed climate change costs into transactions and change economic behavior. Experts concur carbon prices around A$40 per tonne should be enough to put mankind on the path toward avoiding the worst impacts of climate change. Forty dollars a tonne is also the price the Australian coal industry claims is necessary to make "clean coal" viable. A $40 carbon tax will thus level the playing field between uproven 'clean coal' and proven renewables. The proceeds can be used to ease the retrenchment and dislocation suffered pain in sunset industries. This is not a technology issue. It's an economic reform issue.

2. Institute 10-year transitory premium *feed-in* tariffs for renewable energy while reducing subsidies for fossil fuel. Over a decade, falling fossil fuel subsidies can fund transitory renewable energy premiums -- creating a zero sum for the Treasury. At the end of 10 years, Australia will have completed the transition to a newer, more competitive, *cheaper* energy industry and a retrained workforce skilled in tomorrow's technologies. This is not a technology issue. This is an economic reform issue.

3. De-emphasise use of natural gas for base load power. Natural gas (and hydro)'s quick start up times are an invaluable attribute in a future energy system dominated by fluctuating supplies of renewable energy. Therefore, future electricity generation capacity additions in natural gas should be directed to meeting high-priced peaking power markets. Doing so *doubles* the global gains in reducing carbon emissions. That's because Australia reduces its own greenhouse gas emissions by shifting baseload power provision to low emission technologies, while other countries (that *would* have used coal) can buy marginally freed up Australian gas supplies, lowering their greenhouse gas signature. In doing this, Australia will improve its trade balance through greater exports by concentrating on its natural comparative advantages. As a result, everyone comes out ahead. This is *not* a technology issue. This is an economic reform issue.

4. Progressively idle, but not dismantle, existing coal fired power plants. Progressively idled coal-fired capacity can provide Australia a crucial insurance policy against future demand surprises. With air conditioning and consumer gadgetry proliferating like mad, it's a sure bet electricity demand will rise. As dirty, geriatric coal-fired plants reach their retirement dates, they can be mothballed but kept ready to meet excess demand, should it materialise. This is not a technology issue. This is an economic reform issue.

5. Restrict *new* coal-fired power capacity to Victoria. The La Trobe Valley has large supplies of brown coal supplies unsellable on international markets. Carbon capture and storage technology should be tried there. If this technology proves safe and cost-effective, it can be rolled out elsewhere. If not, Australia will already have developed ample supplies of renewables. This is not a technology issue. That's because carbon capture and storage *doesn't even exist* yet. This is a prudent economic risk management issue.

6. Upgrade Australia's electricity transmission infrastructure to provide a level playing field for new energy sources, particularly those located in remote areas. Create common-carrier tariffs on new, high capacity power lines to pay down the costs. Open access will increase competition, lower greenhouse emissions and lower consumer prices for electricity. Eliminating impediments to production are beneficial to any economy, since the market then picks winners. Opening up access to the electricity grid, and building needed infrastructure is not a technology issue. It's an economic reform issue.

7. Allow nuclear power generation in Australia, PROVIDED:
a. It is approved by national referendum in 2017
b. Australia's entire nuclear industry is located in Roxby Downs, South Australia.
c. Uranium is mined, enriched, burned and buried within a small radius of Roxby Downs.
This will "close the nuclear cycle,' eliminate proliferation risk, generate cheap, clean power and provide Australia's cities a safety buffer against dangerous nuclear accidents.

Next -- Australia's Situation

We can make substantial cuts in emissions while still continuing to enjoy strong economic growth. *The sooner we make those cuts, the easier it is.*
Steven Hatfield Dodds, CSIRO economist

Australia can afford to take a leadership position *in committing to substantial reductions in our net greenhouse emissions, in order to help manage the economic risks to Australia and to contribute to the global momentum to avoid dangerous global climate change.*
Climate Institute Leader, Follower or Free Rider, 2007

We cannot long continue to use the atmosphere as an unpriced sewer.
Stephen Schneider, Adelaide Thinker in Residence, 2006

We will have to find ways of satisfying our energy needs with near-zero net emissions. This will require an almost complete turnover in the world's energy infrastructure.
International Energy Agency

*By 2030, **additional installed generation capacity to match Australia's electricity demand growth will cost at least $35 billion.***
Energy Reform Implementation Group, Council of Australian Governments, Energy Reform: The way forward for Australia, January 2007, 14/5

"***Climate change isn't just another environmental health hazard.*** *This ... is threatening the processes underpinning our economy, social stability and life processes."*
Tony McMichael, National Centre for Epidemiology and Population Health Australian National University

*"If Australia is to effectively confront the challenges of the future, **we need to develop an agreed national direction that looks at the next 10 years and beyond.**"*
Kevin Rudd, Prime Minister, Australia

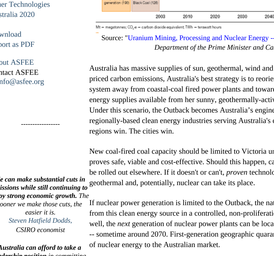
"***The Government's interest is in harnessing and harvesting ideas ... that are capable of being shaped into concrete policy options.***"
Kevin Rudd, Prime Minister, Australia

"***Government funding for FuturoGen and any other clean coal pipedreams should be withdrew in favour of renewable technologies that are up and running now.***"
Christine Milne, Greens Senator, Australia

Australia's Situation

In coming decades, the world must undergo a turnover of energy-generation capital stock unprecedented since electricity was invented.

The *International Energy Agency* estimates US$20 trillion must spent on energy infrastructure globally between now and 2030. Australia must spend A$20-35 billion between now and 2020 to keep the lights on. The reason is that, both in Australia and overseas, clapped out existing capacity must be replaced at the same time as electricity consumption is rising. This must also be done while reducing greenhouse gas emissions. All up, it's a big task.



Source: "Uranium Mining, Processing and Nuclear Energy -- Opportunities for Australia," *Department of the Prime Minister and Cabinet*, 2006

Australia has massive supplies of sun, geothermal, wind and uranium. In a world of high-priced carbon emissions, Australia's best strategy is to reorient her national electricity system away from coastal-coal fired power plants and toward nuclear and renewable energy supplies available from her sunny, geothermally-active, uranium-rich interior. Under this scenario, the Outback becomes Australia's engine room. This will develop regionally-based clean energy industries serving Australia's energy hungry cities. The regions win. The cities win.

New coal-fired coal capacity should be limited to Victoria until carbon capture storage proves safe, viable and cost-effective. Should this happen, carbon capture and storage can be rolled out elsewhere. If it doesn't or can't, *proven* technologies like solar, wind, geothermal and, potentially, nuclear can take its place.

If nuclear power generation is limited to the Outback, the nation can enjoy bountiful power from this clean energy source in a controlled, non-proliferation-prone manner. If all goes well, the next generation of nuclear power plants can be located closer to Australia's cities -- sometime around 2070. First-generation geographic quarantine must be the price of entry of nuclear energy to the Australian market.

The plan outlined above offers gains but requires compromises from everyone.

Civil society must accept nuclear power. In turn, it gains a vast expansion and a leg up for low greenhouse emission technologies that could, repeat could, render nuclear energy unnecessary. For its part, the nuclear industry gains a toehold in the Australian market. But it will have to prove the technology economic credentials in 2017 and also will have to yield on a buccaneering insistence upon locating nuclear plants on the fringes of Australia's most populous cities. In 2070, the relationship can be reassessed.

In "Securing Australia's Energy Future," the Howard government claimed Australia's economic competitiveness hinged upon low energy prices. If so, this is placed at risk by adopting only *unproven* clean coal while discouraging and excluding better, cheaper, *proven* renewable energy. Why not let the market decide? The 'grand bargain' above offers the the best short-term and long-term outcome through creating a future-proof infrastructure that allows relative pricing to work. The market will do the rest.

Introduction

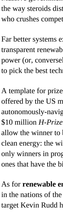
Australia gets 80% of its electricity from dirty, global warming brown and black coal. This rips up the landscape, consumes huge subsidies and ruins the climate. Worse, Australia is among the world's worst greenhouse gas emitters on a per capita basis -- even though it has ample supplies of clean energy.

Figure 6: Comparative GHG emission data 2003

	GHG total Emissions 2003[2] (million tonnes)	GHG Emissions per Capita 2003[3] (tonnes per person)	Emissions per unit GDP generated 2003[4] (tonnes per million USD)
United States	6,803.81	23.44	533.52
Japan	1,339.13	10.49	309.52
Germany	1,017.51	12.34	423.04
Canada	740.21	23.49	897.12
France	569.06	9.26	325.57
Australia	527.06	26.11	1,016.74
New Zealand	75.34	19.44	987.08

Australia has per capita greenhouse gas emissions and emissions per unit of GDP that are MULTIPLES of some other major economies

Source: "Carbon Disclosure Project Report 2007," *Investor Group on Climate Change/Australia-New Zealand*



Australia is an even worse greenhouse gas emission offender when compared against emerging nations.

Source: *International Energy Agency*

The problem in Australia today is bad government policy. These bad policies are **perverse subsidies**, **low renewable energy requirements**, and no **carbon taxes**.

Start with **perverse subsidies**.

During 10 years in Canberra, the Howard government sought a favored place for nuclear and coal in Australia's economy over the next half century. This occurred through government programs such as the economically-distorting Low Emissions Technology Demonstration Fund, in which 82% of the handouts went to fossil fuels. Had the Howard government been re-elected, a second round of grants under the LETDF would almost certainly have been heavily skewed to nuclear. This was bad policy and bad economics.

Government support under the Low Emission Technology Demonstration fund overwhelmingly flowed to dirty fossil fuels

The problem with the LETDF fund's $20 per Australian tax transfer from the public to the coal and fossil fuel industry was that the Howard government sought to pick winners in the energy game, and lost. Since the money was awarded, the United States has axed its own $2 billion Futuregen clean coal project, a big brother to Australia's own clean coal initiatives. This indicates a lower level of confidence by the United States in single big clean coal projects.

Massive government grants to a few favoured industries distort the economic playing field the way steroids distort sporting results. They *create artificial winners*. A doped-up athlete who crushes competitors can may stand on the winner's podium. But did he *win*?

Far better systems exist. One is offer prizes based upon objective criteria, or to impose transparent renewable energy targets or offer premium wholesale prices for low emission power (or, conversely, carbon taxes for big pollutors). That allows markets, not politicians, to pick the best technology.

A template for prizes could be the *X-Prize* for suborbital flight, or the $2 million prize offered by the US military research organisation DARPA for the winner of an autonomously-navigated vehicle race across the Mojave desert. A template could be the $10 million *H-Prize* for breakthrough technology in hydrogen. Competitions like these allow the winner to be chosen by competition. Conversely, carbon taxes act like prizes for clean energy: the winners win by not paying the taxes. The losers lose by paying them. The only winners in programs like the Low Emission Technology Demonstration Fund are the ones that have the biggest lobbying contingents in Canberra. The losers are everyone else.

As for **renewable energy standards**, the graph below shows renewable energy standards in the nations of the EU, many of which have already exceeded the 20% renewable energy target Kevin Rudd has set for 2020.

Australia has a very low renewable energy target compared to other rich countries

Source: International Energy Agency

For their part, **carbon taxes** are highly economically efficient because they are transparent and non-discriminatory. The *Intergovernmental Panel on Climate Change*, a 400-member panel of the world's best climate minds, estimates the cost of C02's environmental damage at US$25-30 per tonne. Those are the same conclusions reached by the Stern Review and broadly echoed by Deutsche Bank. For its part, Australia's ABARE estimates carbon prices may rise to US$40-50 per tonne by 2030. Within just a short time, a reasonable "consensus range" has emerged across experts on what the costs of carbon are to human society, and what price needs to be put on carbon to fix the problem.

The next step is to integrate these prices into economic decision-making so capital allocation decisions can be based upon them. According to the theory of rational expectations, people mentally budget for both the real and intangible costs of their own decision-making and adapt their behaviour accordingly. Australians are already mentally budgeting for carbon taxes, and are ready to alter their behaviour when these are made suitably visible. A recent AC Nielsen poll showed 91% of Australians believe global warming is a problem, and 63% are prepared to pay more for goods and services to reduce greenhouse emissions.

US$ Carbon Price Estimates			Organisation
Low	High	Average	
$25	$30	$28	Stern Review
$24	$41	$32	Deutsche Bank
$25	$30	$28	IPCC
$40	$50	$45	ABARE (By 2030)
$25	$25	$25	Proposed WA Carbon Tax
$28	**$35**	**$31**	US$ Average
$37	**$46**	**$41**	In A$

In 2004 Australia emitted 564.7 million tonnes of CO2 equivalent. That's about 28 tonnes per person. At A$33 per tonne, that's $924 worth of unpaid climate damage incurred by each person living in Australia and $18 billion annually for the nation. For Earth to remain liveable, these bills need to be paid. At present, these bills are being paid by insurance companies, farmers, cattlemen, polar bears and Tuvaluans. The sooner these costs are spread more broadly over society, the sooner positive change can occur.

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*"By 2030, **additional installed generation capacity to meet Australia's electricity demand growth will cost at least $35 billion.**"*
Energy Reform, The way forward for Australia
A report to the Council of Australian Governments by the Energy Reform Implementation Group
January 2007

"We will have to find ways of satisfying our energy needs with near-zero net emissions of greenhouse gases in order to avoid the worst damage from climate change. This will require an almost complete turnover in the world's energy infrastructure."
International Energy Agency

"The current total worldwide annual subsidies for fossil fuel and nuclear energy is $500 billion. Renewables have been subsidized at $2.5 billion per year on average.
Peter Lynch, legendary investor
Backup

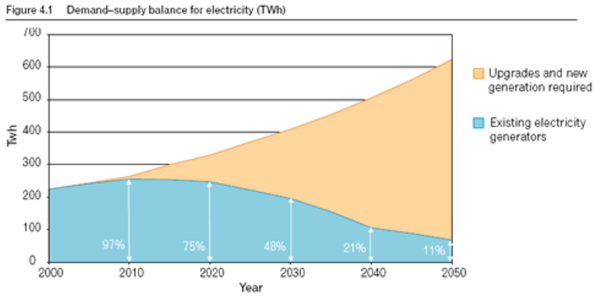
***"Climate change is a problem we must as a global community tackle effectively in the next few years** if we are to avoid unacceptable levels of risk."*
Economist Ross Garnaut

Background

Carbon emissions come from a number of sources.

Two-thirds comes from fossil-fuel electricity generation and the tailpipes of vehicles. In electricity generation, coal represents 80% of Australia's production. That makes it king of the hill when it comes to climate damage in Australia.

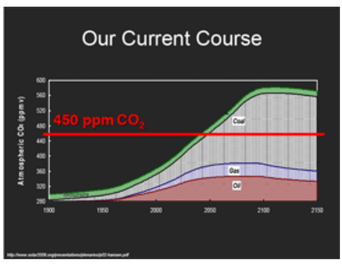
The *Australian Coal Association (ACA)* recommends that coal-fired power plants be replaced after 45 years. Therefore, it's easy to get an idea of the replacement cycle.



"Uranium Mining, Processing and Nuclear Energy -- Opportunities for Australia?,"
Office of Prime Minister and Cabinet, 2006

Below is a list of Australia's fleet of coal-fired power plants. These can be broken down into four groups: plants **overdue for retirement** (1.6% of current capacity), plants **needing replacement by 2020** (17.5% of capacity), plants **needing replacement by 2030** (66.2% of capacity) and plants **needing replacement by 2040** (98% of capacity). It's during this period between now and 2040 that the battle against climate change will be won or lost.

OVERDUE				Replacement	
State	Capacity	Built	Name	Date	Owner
Victoria	90	1958	Morwell	2003	Energy Brix
Victoria	75	1958	Morwell	2003	Energy Brix
South Australia	240	1960	Playford	2005	NRG Flinders
Victoria	30	1962	Morwell	2007	Energy Brix
	435	Capacity			
	1.6%	**% of National Total**			
By 2020					
New South Wales	1,000	1969	Munmorah	2014	Delta Electricity
Victoria	160	1969	Anglesea	2014	Alcoa
Queensland	500	1970	Swanbank B	2015	CS Energy
New South Wales	2,000	1971	Liddell	2016	Macquarie Generation
Queensland	25	1973	Gladstone	2018	Queensland Alumina
Victoria	720	1973	Yallourn	2018	Yallourn Energy
Queensland	38	1974	Queensland Nickel	2019	Queensland Nickel
	4,443	Capacity			
	15.9%	% of National Total			
	17.5%	**Cumulative**			
By 2030					
New South Wales	600	1976	Wallerawang C	2021	Delta Electricity
Queensland	1,665	1976	Gladstone	2021	NRG
New South Wales	1,320	1978	Vales Point B	2023	Delta Electricity
Victoria	720	1981	Yallourn W	2026	Yallourn Energy
New South Wales	2,640	1982	Bayswater	2027	Macquarie Generation
New South Wales	2,640	1982	Eraring	2027	Eraring Energy
Queensland	1,400	1984	Tarong	2029	Tarong Energy
Victoria	2,085	1984	Loy Yang A	2029	Loy Yang Power
South Australia	520	1985	Northern	2030	NRG Flinders
	13,590	Capacity			
	48.7%	% of National Total			
	66.2%	Cumulative			
By 2040					
Queensland	700	1988	Callide B	2033	CS Energy
New South Wales	1,320	1992	Mt Piper	2037	Delta Electricity
Queensland	1,400	1993	Stanwell	2038	Stanwell Corporation
Victoria	1,000	1993	Loy Yang B	2038	IPM Eagle
Victoria	1,600	1994	Hazelwood	2039	International Power
Queensland	96	1998	Collinsville	2043	Transfield Holding
Queensland	33	1998	Collinsville	2043	Transfield Holding
Queensland	66	1998	Collinsville	2043	Transfield Holding
Western Australia	330	1999	Collie	2044	Western Power Corp
New South Wales	150	2001	Redbank	2046	National Power (US)
Queensland	920	2001	Callide C	2046	CS Energy
Queensland	852	2002	Millmerran	2047	OzGen
Queensland	443	2002	Tarong North	2047	Tarong Energy
	8,910	Capacity			
	31.9%	% of National Total			
	98%	Cumulative			



In order to avoid the worst ravages of climate change, carbon dioxide must be capped at 450 parts per million in the atmosphere. That means huge cuts in coal emissions.
Source: Khosla Ventures

Victorian brown coal fired power plants are among the dirtiest in the world

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*"**We could have 100 per cent of our electricity coming from renewable energy** in coming decades if we really wanted to, assuming solar and geothermal sources play a significant role,"*
Mark Diesendorf,
University of New South Wales

*"**Solar thermal technology will be on the ground and operating**, certainly in the United States and many other countries, **long before so-called clean coal and nuclear power.**"*
Mark Diesendorf,
University of New South Wales

*"Concentrating solar power can move much faster than nuclear and on an unsubsidised basis. **Concentrating solar power will be cheaper than nuclear power, and should be cheaper than integrated gasification combined cycle coal-based power**."*
Vinod Khosla
Silicon Valley venture capitalist

***Solar thermal technology, for example, provides a very plausible path to providing renewable energy cheaper than coal**.*
Larry Page, co-founder, Google

***Within two decades, energy from solar thermal power plants will become the least cost option for electricity** (below 4 ct/kWh) and desalted water (below 0.4 €/m³),*
Concentrating Solar Power for Seawater Desalination, German Aerospace Center (DLR), 2007 Challenge CRC

***Almost 40% of (US greenhouse gas) abatement could be achieved at 'negative' marginal costs, meaning that investing in these options would generate positive economic returns over their lifecycle.** The cumulative savings created by these negative-cost options could substantially offset (on a societal basis) the additional spending required for the options with positive marginal costs."*
Reducing US Greenhouse Gas Emissions: How Much and At What Costs?
McKinsey and Co, Dec. 2007

***Increased global demand for solar power in the mid-range case would foster important learning rate improvements** in solar photovoltaics, resulting in grid-parity cost in select regions by 2020.*
Reducing US Greenhouse Gas Emissions: How Much and At What Costs?
McKinsey and Co, Dec. 2007

Future Energy Prices in Australia

If a huge electricity-generation replacement cycle lies ahead for Australia to replace the current fleet of aging coal-fired power plants, what technologies offer the best deal?

Coal

In November 2005, the *Intergovernmental Panel on Climate Change* released a report entitled "Carbon Dioxide Capture and Storage." In it are some estimated costs of carbon capture and storage (CCS), which raises significantly the cost of fossil-fuel generated electricity.

Table SPM.3. Costs of CCS: production costs of electricity for different types of generation, without capture and for the CCS system as a whole. The cost of a full CCS system for electricity generation from a newly built, large-scale fossil fuel-based power plant depends on a number of factors, including the characteristics of both the power plant and the capture system, the specifics of the storage site, the amount of CO_2 and the required transport distance. The numbers assume experience with a large-scale plant. Gas prices are assumed to be 2.8-4.4 US$ per gigajoule (GJ), and coal prices 1-1.5 US$ GJ-1 (based on Tables 8.3 and 8.4).

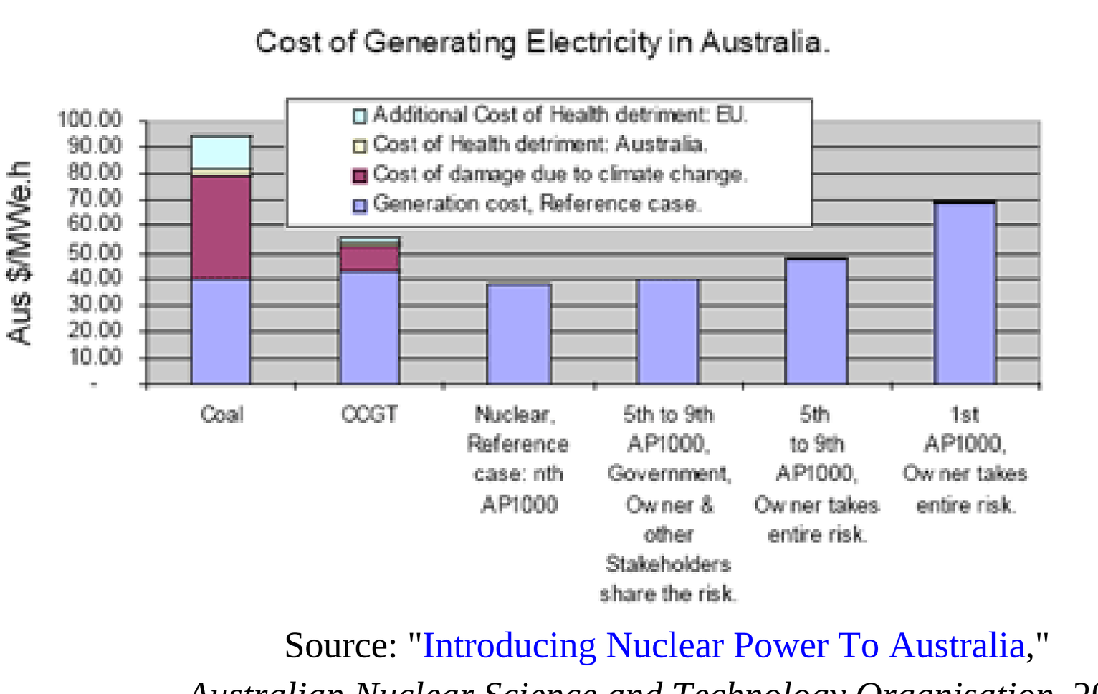
Power plant system	Natural Gas Combined Cycle (US$/kWh)	Pulverized Coal (US$/kWh)	Integrated Gasification Combined Cycle (US$/kWh)
Without capture (reference plant)	0.03 - 0.05	0.04 - 0.05	0.04 - 0.06
With capture and geological storage	0.04 - 0.08	0.06 - 0.10	0.05 - 0.09
With capture and EOR[17]	0.04 - 0.07	0.05 - 0.08	0.04 - 0.07

Source: "Special Report Carbon Dioxide Capture and Storage," *Intergovernmental Panel on Climate Change*, 2005

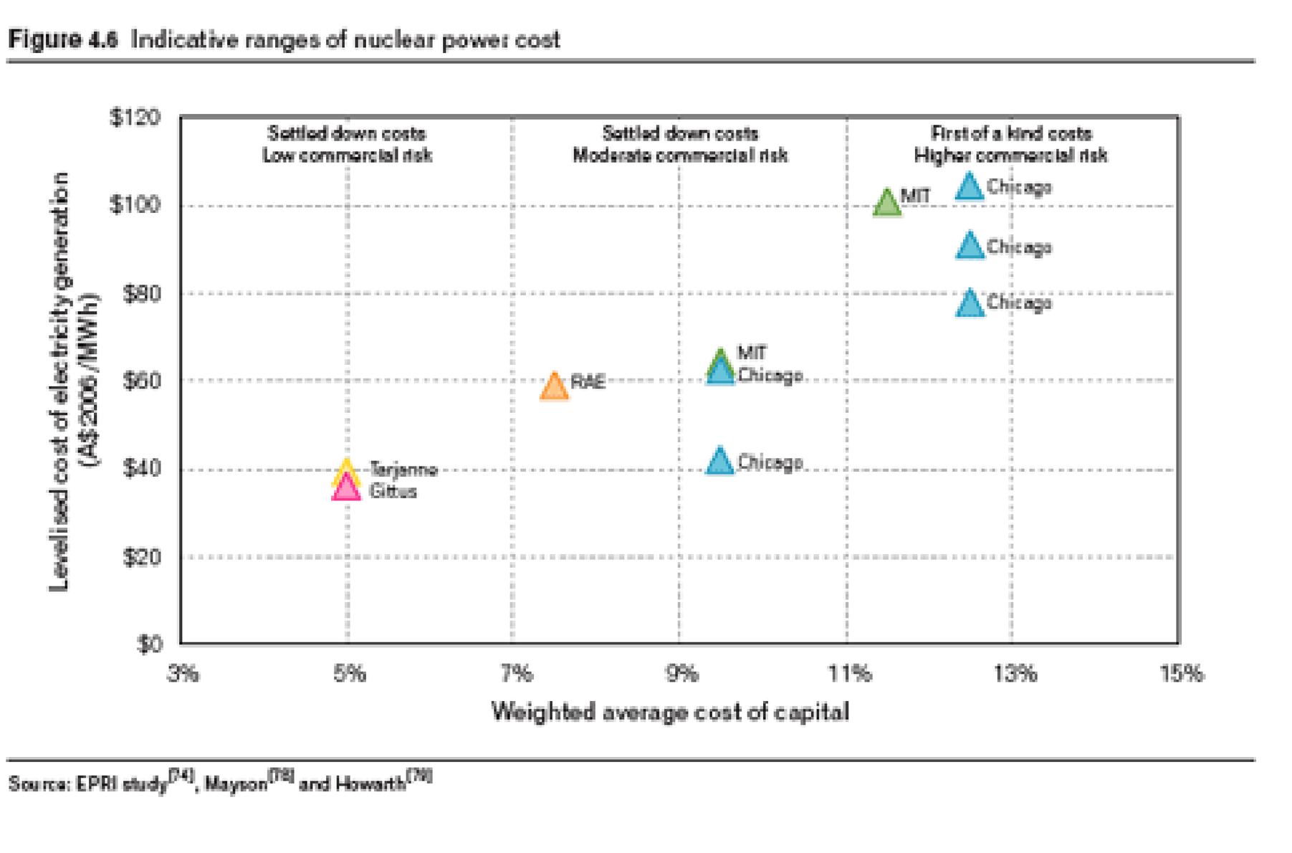
If industry estimates are to be believed, carbon capture and storage will cut greenhouse gas emissions by 80-90%. But that means .1-.2 tonnes of greenhouse gas emissions per megawatthour will still occur. To this must be added another .05 tonne for upstream emissions generated by digging up and transporting coal from coal mines to the power plant. Valued at $36 per tonne, these residual emissions of .15-.25 tonne per megawatthour of electricity generated will add significantly to the *already-higher* costs of carbon capture and storage when both are applied. Offsetting this, of course, is the declining cost of the technology. IPCC experts estimate carbon capture and storage will drop 2-3% per year in price over the next decade.

Nuclear

A 2006 study produced for the *Australian Nuclear Science and Technology Organisation* (ANSTO) concluded the costs of nuclear power using latest generation technology such as the AP1000 would fall with widespread deployment. Assuming an aggressive rollout of the AP1000 worldwide over the next 15 years, the study concluded the technology would fall to about 5c cents per kilowatt over the medium term. These estimates, however, assumed an artificially low cost of capital provided by lavish government subsidies and excluded insurance costs -- which would have to be borne by the public sector willingly or unwillingly.

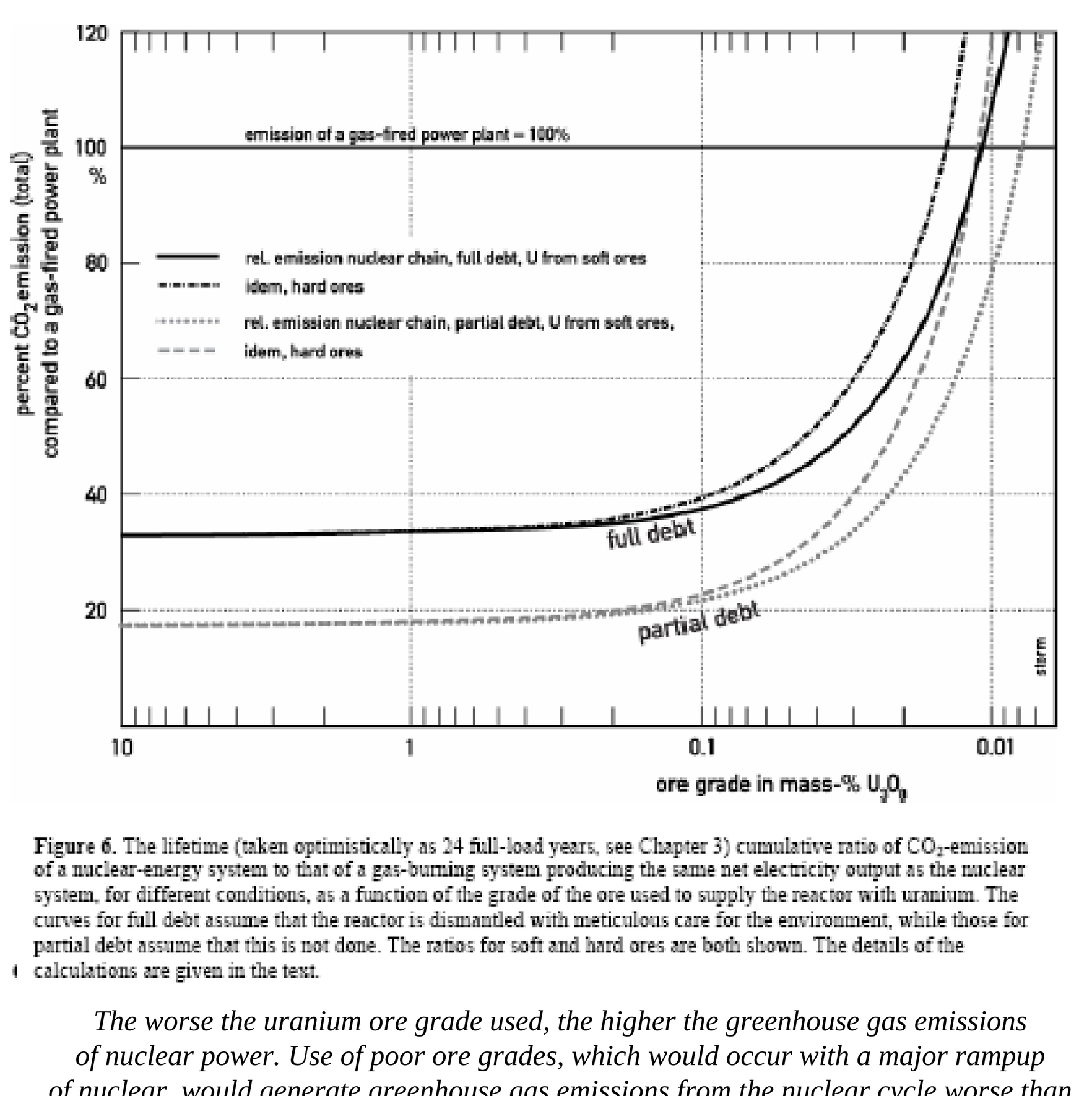


Source: "Introducing Nuclear Power To Australia,"
Australian Nuclear Science and Technology Organisation, 2006



"Uranium Mining, Processing and Nuclear Energy -- Opportunities for Australia?"
Office of Prime Minister and Cabinet, 2006

While nuclear plants emit little or no greenhouse gases in creating electricity, they do create greenhouse gases in the upstream process of blasting, digging, trucking, crushing and refining and enriching uranium ore. Furthermore, lesser and lesser grades of uranium will have to be mined if uranium demand rises. Lower grades require more processing. This in turn could push up the greenhouse gas footprint of nuclear to where it becomes little better than natural gas. When carbon costs are properly applied, this will significantly raise the cost of nuclear power above the selectively-presented prices above.



The worse the uranium ore grade used, the higher the greenhouse gas emissions of nuclear power. Use of poor ore grades, which would occur with a major rampup of nuclear, would generate greenhouse gas emissions from the nuclear cycle worse than natural gas
Source: "Nuclear Power, The Energy Balance," Van Leeuwen, Smith, 2005

Nuclear power also creates long-lived, open-ended waste problems. Naturally, nuclear industry experts insist such "back end" costs are negligible. Independent experts estimate back end costs at 2c per kilowatthour. Whom to believe?

The United States is instructive here. Its Yucca Mountain nuclear waste repository in Nevada was scheduled to open in 1997, but now isn't scheduled to open before 2017. During this time Yucca Mountain has cost the US government US $8 billion and is still 10 years away from opening. In Hanford, Washington, a nuclear waste preparation plant has tripled in cost in six years to US $11.55 billion. This suggests the back end costs of nuclear waste are considerable.

This isn't to say nuclear waste problems can't be overcome with greater competence than that shown by the United States. But it *does* indicate a burden of proof exists to convince the public that industry and government are up to handling such a responsibility *before* nuclear power plants are built.

Renewables

In 2005, the Australian Bureau of Agricultural and Resource Economics (ABARE) offered some forecasts of the future price course of renewables.

7 Current and projected costs for renewable electricity generation

	Investment costs				Generation costs			
	Low		High		Low		High	
	2002	2010	2002	2010	2002	2010	2002	2010
Power source	US$/kW	US$/kW	US$/kW	US$/kW	USc/kWh	USc/kWh	USc/kWh	USc/kWh
Small hydro (capacity <10 MW)	1 000	950	5 000	4 500	2–3	2	9–15	8–13
Solar photovoltaic	4 500	3 000	7 000	4 500	18–20	10–15	25–80	18–40
Concentrating solar	3 000	2 000	6 000	4 000	10–15	6–8	20–25	10–12
Biomass	500	400	4 000	3 000	2–3	2	10–15	8–12
Geothermal	1 200	1 000	5 000	3 500	2–5	2–3	6–12	5–10
Wind	850	700	1 700	1 300	3–5	2–4	10–12	6–9

Note: Discount rate is 6 per cent for all technologies; the amortisation period is 15–25 years. For each renewable technology a range of investment and generation costs (low and high) is shown. This reflects the variety of technical specifications available for each of the technologies, the large number of applications and differences in the factor endowment of natural resources that affect the cost characteristics of renewable technologies.
Source: NET Ltd Switzerland in IEA (2003).

Source: *Near Zero Emissions Technologies*, ABARE eReport 05.1, 2005, page 29/43

From this information some trends can be derived, most importantly the expected downward annual rate of price change in the various technologies.

Annual Price Fall

	2002	Average 2010	Rate Of Change	2002	Best Case 2010	Rate Of Change	2002	Worst Case 2010	Rate Of Change
Solar PV	$0.340	$0.213	**-5.71%**	$0.190	$0.125	**-5.10%**	$0.490	$0.300	**-5.95%**
CSP	$0.175	$0.090	**-7.98%**	$0.125	$0.070	**-6.99%**	$0.225	$0.110	**-8.56%**
Biomass	$0.075	$0.060	**2.00%**	$0.025	$0.020	**-2.75%**	$0.125	$0.100	**-2.75%**
Geothermal	$0.063	$0.050	**2.50%**	$0.035	$0.025	**-4.12%**	$0.090	$0.075	**-2.25%**
Wind	$0.083	$0.055	**-4.94%**	$0.040	$0.030	**-3.53%**	$0.125	$0.080	**-5.43%**

Solar technologies are falling the most rapidly in price, compounding the speed at which they reach competitiveness with fossil fuels and other technologies

As can be seen, the costs of renewables such as concentrating solar power, solar PV and wind and geothermal are expected to fall 5-8% per year in coming years. That's *double* the rate of nuclear and carbon capture as estimated by the Intergovernmental Panel on Climate Change.

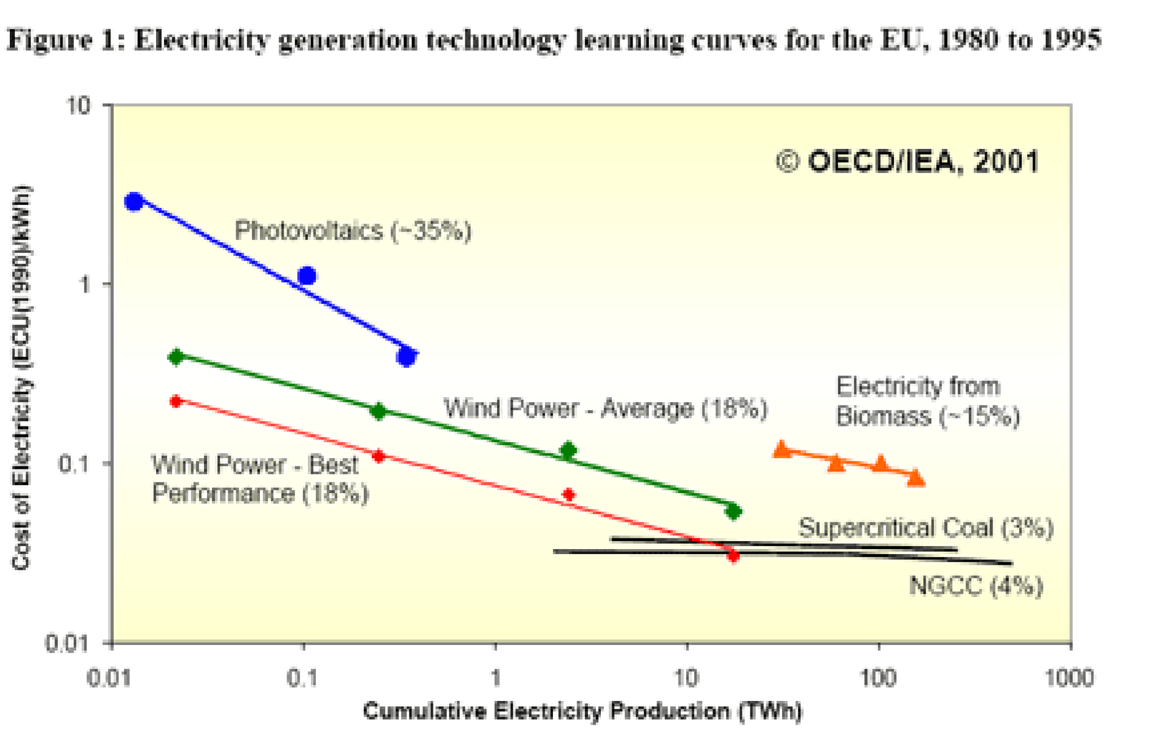
Why?

Three reasons:

--Renewables are in a period of rapid price decline as capacity expands and innovation becomes entrenched.
--Renewables must *try harder* and *be better* than traditional fossil fuel energy sources in order to overcome government complacency and bias.
--Traditional energy industries like coal see little value in innovation. They view lobbying as their core competency, not clean energy generation.

The difference in the rate of annual price reduction in sunrise renewable energy and mature fossil fuel is evident in the graph below. Note the steep downward price slopes of renewables and the flat lines of coal. After decades of cozy and protected commercial lethargy, can the coal industry's clubby culture *really* be transformed into a lean and mean innovation machine? The past is instructive. While renewables spent the 1980s and 1990s innovating, the coal industry spent *its* time denying climate change existed and fighting against carbon taxes. The OECD doesn't believe the coal industry.Why should we?

Figure 1: Electricity generation technology learning curves for the EU, 1980 to 1995



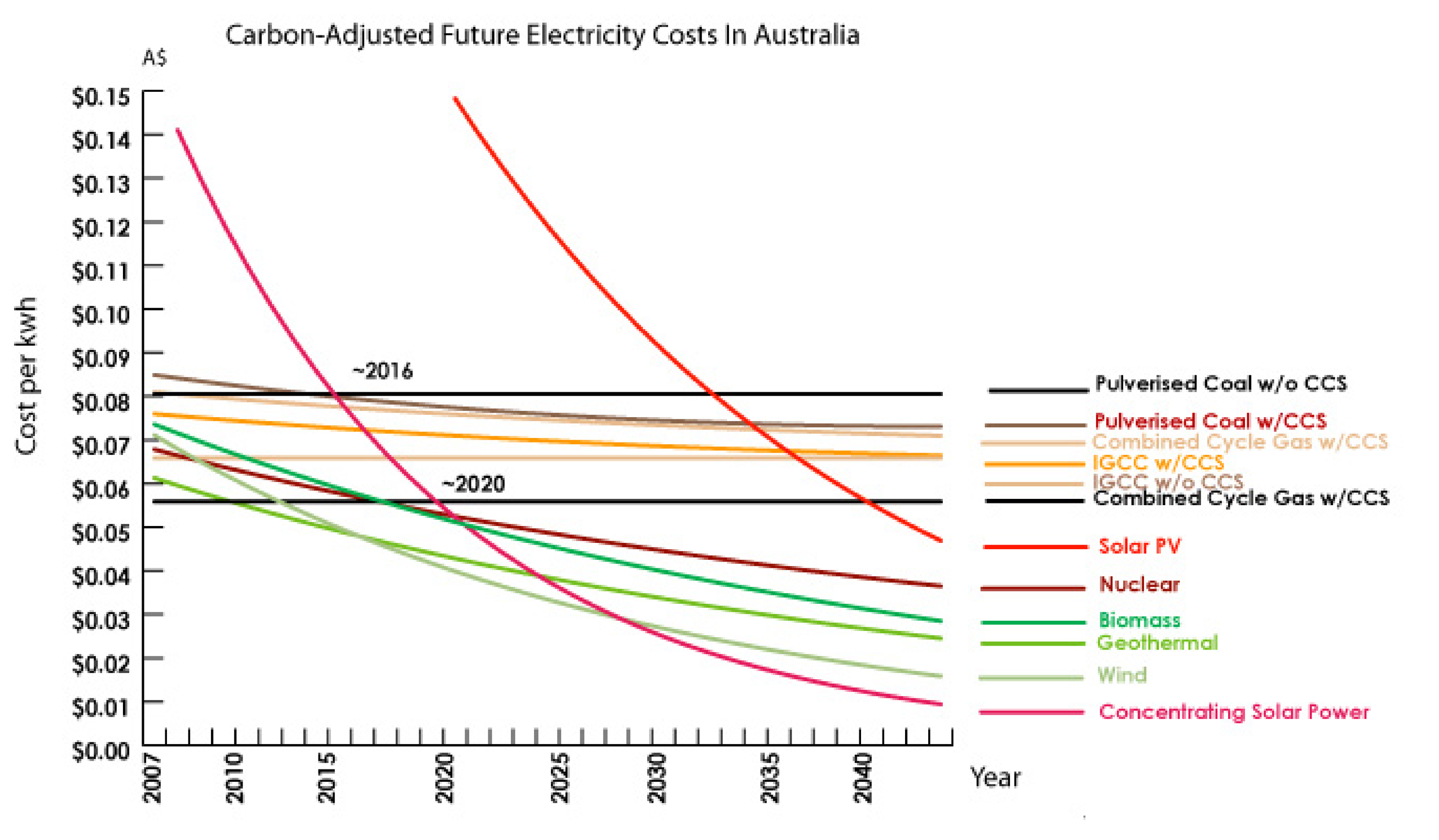
Source: *Technology Innovation, Development and Diffusion*, OECD/IEA, 2003

The Big Picture

Given the information above, it's possible to project future price paths based upon historical downward rates of price change in a carbon-adjusted marketplace. This probably results in an underestimate of cost trends in renewable energy since the pace of innovation is picking up and thus can be expected to result in *faster* annual price drops in the future.

Nonetheless, the picture obtained is *very* instructive. Using inflation-adjusted 2006 Australian dollars, and assuming flat real carbon prices of A$36 per tonne over the next 25 years (a big assumption), the per kilowatthour prices of each technology for electricity generation are projected into the future at their historical annual rate of price decline.

The top horizontal black line represents current pulverised coal-fired power, costing 8c/kilowatt hour according to ANSTO's estimates. This could be called the *business as usual* scenario. The bottom black line is the price of natural gas power equipped with carbon capture and storage, to the extent the costs of drawing board technology can be accurately estimated. This represents the *best-case* scenario for fossil fuels. In between those lines lie the various costs of carbon capture and storage, initially raising fossil fuel prices above business as usual, but gradually falling. The maroon line represents nuclear power, which starts out costing more than certain fossil fuel solutions, but eventually falls below their prices. The two steeply-sloped redlines represent concentrating solar power and solar photovoltaics, the two renewable energy technologies with the steepest learning curves. The various green lines represent other renewable energy technologies.



Conclusions:

1. ***Carbon capture and storage locks in the highest prices over the long term***. It combines high costs, unproven technology and unknown mitigation ability compared to renewables, and even nuclear. In fact, carbon capture could have the perverse outcome of raising prices *above* the worst case scenario that already exists if Australia rushed headlong into building this kind of capacity (ie the Howard government policy setting).
2. ***In a properly-priced carbon market, biomass, wind and geothermal are already competitive with coal and nuclear***.
3. ***Renewables are dropping in cost so quickly that*** *between 2010 and 2020 when the bulk of Australia's new investment in electricity generating capacity must be made,* ***renewables will be cheaper than coal or nuclear.***
4. *Given that electricity capacity planned today may not come on line until 2011, this indicates that for* ***most forward planning of new capacity -- renewables are the way to go.*** *In other words, fossil fuel and nuclear risk being White Elephants from the day they open. Is that smart?*

Naturally, future forecasts are provided in ranges, and the above chart uses the averages of the ranges. But even recalculating the figures using the highest costs and slowest rates of price decline for renewables, and the lowest costs and fastest rates of price decline for nuclear and coal -- the picture remains the same. Crossover points shift by just a year or two. Clearly, the experts have spoken. We should listen.

---

*"**Australia has a huge opportunity to be a global leader in energy reform.** Governments can't pick winners. However, they can and must ensure a level playing field to let the market prosper."*
John Ellice-Flint,
managing director,
Santos Ltd.

*"While **renewable energies** still account for a small percentage of the global energy mix, they **are growing rapidly as governments mandate targets and benchmarks for their widespread introduction into the market and their falling costs make them increasingly competitive.**"*
Jeremy Rifkin, president,
Foundation on Economic Trends

*"**The solar thermal energy to meet Australia's entire current power demand would require 35x35 km square area in a high irradiance, low cloud cover location.**"*
Synergies with Renewables: Concentrating Solar Thermal, Cooperative Research Centre for Coal in Sustainable Development

*"**Deserts receive about 700 times more energy from the sun than humankind consumes by burning fossil fuels.**"*
His Royal Highness Prince Hassan bin Talal of Jordan,
TREC White paper

***The scale of the (geothermal) resource is such that we need to think about getting the power to Adelaide, Sydney and Brisbane, or even Melbourne.** Using high voltage direct current lines, where the transmission losses are quite low, the cost of links is estimated to be about $700 million to $800 million -- and the CIE estimates that the value to Australia through extra NEM competition that the lines would enable would be worth some $1.4 billion.*
Adrian Williams,
CEO, Geodynamics

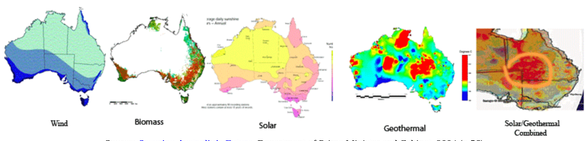
*"**Renewables have up until recently been a green side salad, but now we need to make them the main meal.**"*
John White, California Center for Energy Efficiency and Renewable Energy.

*"The focus today on clean energy is not a bubble or passing phenomenon. **Unconventional clean energy is now poised to cross the divide and move from the fringes of the energy sector to the mainstream.**"*
Cambridge Energy Research Associates

*"**We can't solve problems by using the same kind of thinking we used when we created them.**"*
Albert Einstein

The Big Picture
If Renewables Are Cheaper, Where Will They Come From?

If renewables are a better deal, where are they located? The federal government's 2004 paper "Securing Australia's Energy Future," provides some clues.



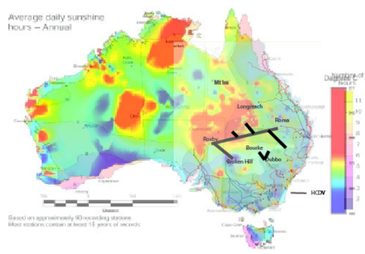
Source: *Securing Australia's Future*, Department of Prime Minister and Cabinet, 2004 (p.56)

For **biomass**, it looks to be the western interior areas of Victoria, New South Wales and Queensland.
For **wind**, it's the southern coasts.
For **geothermal**, it's southwestern Queensland and Northeastern South Australia.
For **solar**, it's the entire interior of the country.

Solar and geothermal resources exist together in northeastern South Australia and southwestern Queensland. As for wind, an isolated portion of the Nullarbor Plain region is the only part of Australia's windy southern coast without sizeable settlements and outside national parks. It's also an area of very high wave energy.

How might that energy could be gotten to market? Given that Australia's eastern electricity grid ends at Olympic Dam, connecting Olympic Dam to the Queensland and New South Wales grid would allow new solar, geothermal, wind and wave resources to get to market. Later, building a power line from the Nullarbor to Olympic Dam could do the same thing for wind and waves. We'll be concentrating here on Olympic Dam as a potential nexus of Australia's new energy system.

Connecting the western and eastern ends of Australia's electricity grid would allow power to flow more freely, lowering prices.
Source: Electricity Supply Association of Australia

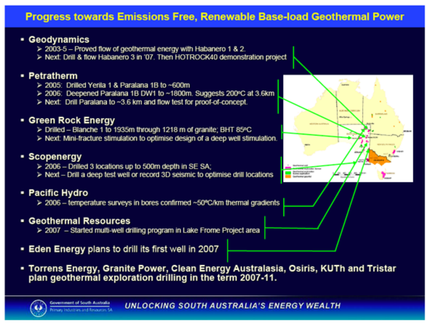


This could be achieved by stringing high capacity direct current power lines from South Australia to Queensland and/or western or northern New South Wales, potentially all three.

Source: ABARE (energy maps), ASFEE (power line graphics)

The Outback clearly provides the best location for a whole host of renewables. Roxby Downs represents the ideal location to bundle them for transmission to the populated east coast. Roxby Downs is the location of BHP's massive Olympic Dam mine, which BHP plans to massively expand. If BHP expands the mine, it will quadruple energy demand at Roxby Downs. At present, BHP gets electricity from two aging dirty Port Augusta brown coal-fired power plants, the Northern and Playford. Meanwhile, another major miner, Oxiana, plans to build a huge uranium mine at Prominent Hill, northwest of Roxby Downs. At present, BHP and Oxiana are discussing joint energy initiatives. These could include building new gas fired power plants, buying more dirty brown coal power or purchasing large amounts of renewable power generated in the region.

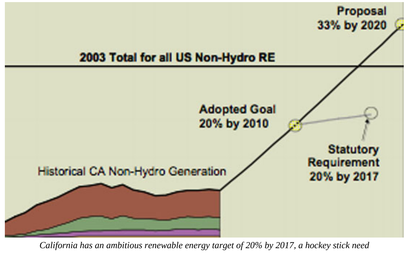
A host of geothermal companies are exploring for hot dry rock resources in the area. Should one or more of these companies hit pay dirt, they'll have two ways of getting their energy to market. They can sell the clean power to BHP and Oxiana, or they can deliver the electricity to urban consumption markets situated to the south and east.



The northeastern SA Outback is thick with geothermal explorers
Source: South Australian Department of Primary Industries and Resources

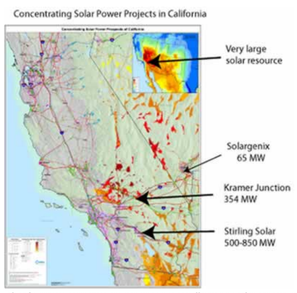
Why not build new transmission infrastructure for renewables with a nexus at Olympic Dam? The mine lies exactly where huge solar and geothermal resources are. Given that both mines need power, why not arrange a marriage of convenience? Extending eastern Australia's power line infrastructure into the northern South Australian Outback has already been suggested by geothermal energy companies such as Petratherm and Geodynamics.

Building such transmission infrastructure to eastern markets would close the eastern electricity grid by connecting South Australia to Queensland using power lines passing through the rich seam of low emission energy sources (solar, geothermal and coal seam methane) that lie between Olympic Dam, South Australia, and Roma, Queensland. This would allow a major ramping up of renewable energy. These kinds of things are already happening elsewhere. California, which has a statutory goal of raising renewable energy to 20% by 2017, is instructive here. It has huge needs for renewable energy over the next decade.



California has an ambitious renewable energy target of 20% by 2017, a hockey stick need

Like Australia, California has an arid, very sunny hinterland with a vast solar resource. Already, California has in place 350MW of parabolic trough concentrating solar power capacity that has been operating since 1980s. To this has been added (just across the border in Nevada) another 64MW, with more than 1,000MW of additional concentrating solar power capacity planned in just the next few years. The impact could be huge. The graphic on the right shows much California land would be needed for concentrating solar power plants to replace the entire United States' coal-fired power industry. The land is there, the sun is there. What's needed is the will to harness it. In California, they have it.



Already, private companies are stepping up to install vast new solar capacity in California.

US National Renewable Energy Laboratory

The power generating capability of concentrating solar power is so huge it could supplant the nation's coal industry.

Source: Vinod Khosla, Khosla Ventures

The state has also drawn up plans to build new high capacity power lines to the state's southeastern desert areas. A far more ambitious plan is afoot to build a 1,000 kilometer power line to bring Canadian-generated electricity to California. Therefore, the template is clearly there for Australia to follow.

In Australia's case, installing new power line capacity to connect Olympic Dam to eastern electricity markets leads to some interesting follow on thinking in creating a future proof, competitive, low emission, low cost, high technology electricity generation industry for the nation.

***"We need to start moving now to start building the infrastructure** to meet the deadlines that nature will impose on us."*
Tim Flannery,
Author

***"I don't think energy markets or mineral markets perform best if there's a monopolisation or cartel activity.** I think they perform best when there's open development, open trade and free pricing."*
Peter Costello,
Treasurer, Australia (1996-2007)

"Using High Voltage Direct Current (HVDC) transmission lines, loss of power during transmission can be limited to only about 3% per 1000 km."
TREC -- Clean Power From Deserts

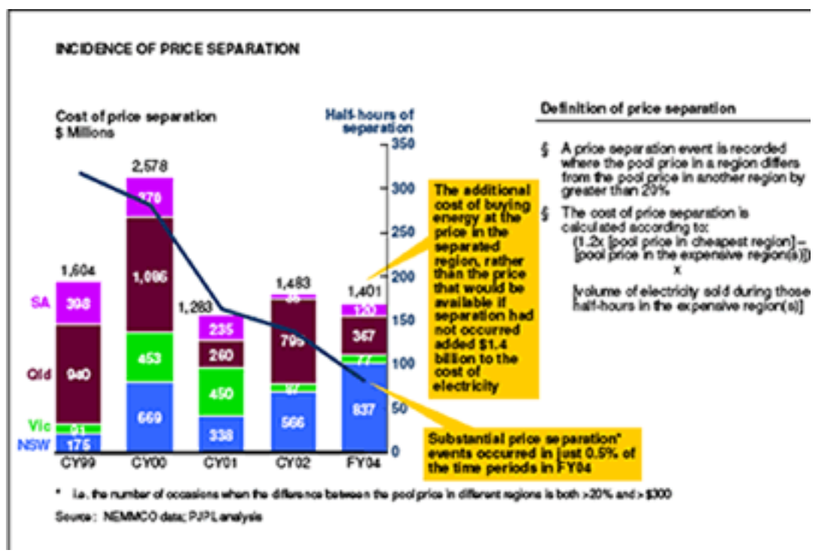
If the (South Australia renewable energy, particularly geothermal) sector grows to the significant levels that are being discussed within the timeframes proposed there will need to be major additional investment in transmission infrastructure. ***High voltage DC links to strong points in interstate transmission networks, such as into the 500 kV network in NSW, could minimise losses, easement space and costs.***
2007 Annual Planning Report, ESIPC, 68/44

Getting the Power To Market

Clearly, an energy generation and transmission nexus in the middle of the country will involve a near total reorientation of the energy industry. But what better time than now to do this than when the entire energy industry needs a facelift, both on the generation and transmission side?

Eastern Australia's electricity grid is a one-way street. This creates huge inefficiencies in electricity costs. The aging system was built to carry coastally-generated coal-fired power from Queensland to New South Wales, from the Snowy to Melbourne and from Victoria to South Australia.

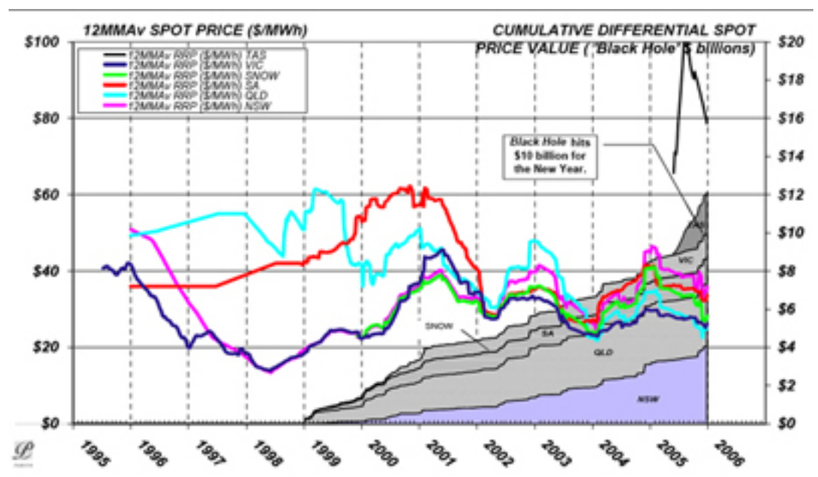
This arrangement may have made sense when coal was the main fuel, no one cared about the environment and cheap coastal real estate was readily available. But these days coal isn't the only fuel, people care about the environment and coastal real estate is expensive. Times have changed.



Lack of national transmission market and pricing costs the nation $1.4-2.6 billion a year, enough to pay back construction of a HVDC power line in one year

Source: *Business Council of Australia*

Click to Enlarge



Each year, Australians pay more for electricity than they need to due to an inefficient electricity grid
Click to Enlarge

'Black Hole' in the NEM Passes $10Billion, Electricity Users Association of Australia, 2006

Click to Enlarge

The existing grid is old. It needs modernisation. The opportunity should now be taken to connect the northwestern end of the eastern electricity grid to the eastern cities in order to carry renewable energy. In addition to bringing huge, clean new energy supplies to market, such an upgrade will have a huge impact on electricity trading. A better transmission would flatten eastern energy prices by reducing technical and administrative bottlenecks that now cost consumers up to $1.7 billion per year, and to date have imposed deadweight costs of $12 billion and counting on the Australian economy. This is not a technology issue. This is an economic reform issue.

For instance, Australia already enjoys two world firsts in high capacity cables in trans-Bass Strait undersea Basslink cable and the MurrayLink cable between Victoria and South Australia, the world's longest underground power line. Using a rough estimate of $1 million per kilometer (actual costs could be as low as $600,000 per kilometer) a 1,000-kilometer high-capacity direct current buried power line similar to Murray link stretching the 1,000 kilometers from Olympic Dam to the Southeastern Queensland grid would cost about $1 billion. A 500-kilometer line from Olympic Dam to Broken Hill would cost about $500 million. Given that "price separation" (ie prices in different state markets that vary by more than 20%) impose $1.5 billion of deadweight losses on the national economy annually, eliminating these losses by unifying the grid would pay for itself in one year. A very good deal, indeed.

Since taking office, the Rudd government in Australia has announced plans to build a $4.7 billion national broadband network in an effort to modernise the nation's communications system. An interconnected eastern electricity grid similarly would modernise the nation's electricity system at less than one-fifth the cost of a national broadband network. Both will enhance economic growth. Both are good investments. Both will pay themselves back quickly and generate immense economic gains for the nation.

The 180-kilometer Murraylink is the world's longest underground power link

The cable and its trench are no more than a few meters wide

Once laid, the cable is visually unobtrusive and hard to sabotage

Source: ABB Group

ABB's HCDV Projects in Australia

DC power lines also exist in Brazil to carry hydro power from Itaipu to Sao Paolo, in the Philippines to carry Leyte's geothermal power to Manila and in India to carry coal-fired power from Uttar Pradesh to New Delhi. China plans to build a DC power line to bring Three Gorges Dam hydropower to coastal cities. In the United States, DC power lines may soon carry Wyoming wind power to Phoenix and Las Vegas. In Europe, DC power lines may be built to bring Saharan solar energy to northern Europe. And industry groups even claim that high capacity direct current power lines have become cheap enough they could span the world like the Internet, becoming a force for world peace by spreading adequate energy supplies for all rather than sparking wars out of concerns about disruption.

For its part, European researchers have estimated that high capacity power cables strung between North Africa and Europe would add only about A2c/kwh to the cost of electricity. That's *less* than the still hypothetical cost of carbon capture and storage.

TRANS-CSP-Executive Summary_Final

Year		2020	2030	2040	2050
Transfer Capacity GW		2 x 5	8 x 5	14 x 5	20 x 5
Electricity Transfer TWh/y		60	230	470	700
Capacity Factor		0.60	0.67	0.75	0.80
Turnover Billion €/y		3.8	12.5	24	35
Land Area km x km	CSP	15 x 15	30 x 30	40 x 40	50 x 50
	HVDC	3100 x 0.1	3600 x 0.4	3600 x 0.7	3600 x 1.0
Investment Billion €	CSP	42	143	245	350
	HVDC	5	20	31	45
Elec. Cost €/kWh	CSP	0.050	0.045	0.040	0.040
	HVDC	0.014	0.010	0.010	0.010

Table 1: Main indicators of the total EUMENA High Voltage Direct Current (HVDC) interconnection and Concentrating Solar Power (CSP) plants from 2020 – 2050 according to the TRANS-CSP scenario. In the final stage in 2050, lines with a capacity of 5 GW each will transmit about 700 TWh/y of electricity from 20 different locations in the Middle East and North Africa (MENA) to the main centres of demand in Europe.

Large scale solar electricity generated in North Africa could be brought to Europe for as little as A2c/kwh.

Source: Trans-European Energy Cooperation

What's particularly intriguing about this idea is that the same route, laid with power lines, can be used to transport hydrogen and potentially backhaul carbon for carbon capture and store, but we're getting ahead of ourselves. Please read on.

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Nullarbor Wind
Other Technologies
Australia 2020

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"While we take full advantage of the mining boom, ***we must also build long-term competitive strengths in the global industries of tomorrow - industries that will provide the high-paying jobs of the future****."*
Kevin Rudd,
Prime Minister, Australia

"BHP Billiton has recognised that our company, as well as society generally, must make real behavioural changes and accelerate technological progress if we are to achieve a meaningful reduction in energy use and greenhouse gas emissions."
Chip Goodyear,
BHP Chief Executive

"We will continue with our policies to improve solar, wind and other renewable resources of energy. ***We don't need to go down the path of nuclear energy."***
Senator Penny Wong, Federal Climate Change Minister.

"Australia has a clear responsibility to develop its uranium resources in a sustainable way - irrespective of whether or not we end up using nuclear power."
John Howard

"In the 2020s, nuclear energy will be the most cost effective and cleanest form of base-load electricity that Australia has on option to consider."
Dr Ziggy Switkowski

"Nobody really has effectively sorted out the long-term tailing costs of holding redundant
Paul Anthony, AGL chief executive

I have very great concerns about the current fragile safety regimes (regarding nuclear power) and the porous nature of (nuclear) safeguards *because of the International Atomic Energy Agency's inadequate monitoring of safety*
Peter Garrett,
Environment Minister, Australia

"The current Australian Government came to office with a new commitment to seek to be much more active... as a nation on nuclear non-proliferation and disarmament matters."
Stephen Smith,
Foreign Minister, Australia

"In the latter part of this century, the environmental benefits of nuclear energy can expand and even extend to other energy products besides electricity. For example, nuclear energy can be used to generate hydrogen for use in petroleum refinement and as a transportation fuel to reduce the dependence upon oil, and to desalinate water in areas where fresh water is in short supply."
A Technology Roadmap for Generation IV Nuclear Energy Systems,
U.S. DOE Nuclear Energy Research Advisory Committee, 2002

"If nuclear power is unavailable here, then clean coal is going to be a necessity."
John Boshier, National Generator Forum executive director

"It'll be years before we have any nuclear reactors, probably 10 years, and where they will go will be determined by commercial decisions and they'll be governed by the normal processes of environment *and other approval, but*
John Howard,
Prime Minister, Australia 1996-2007

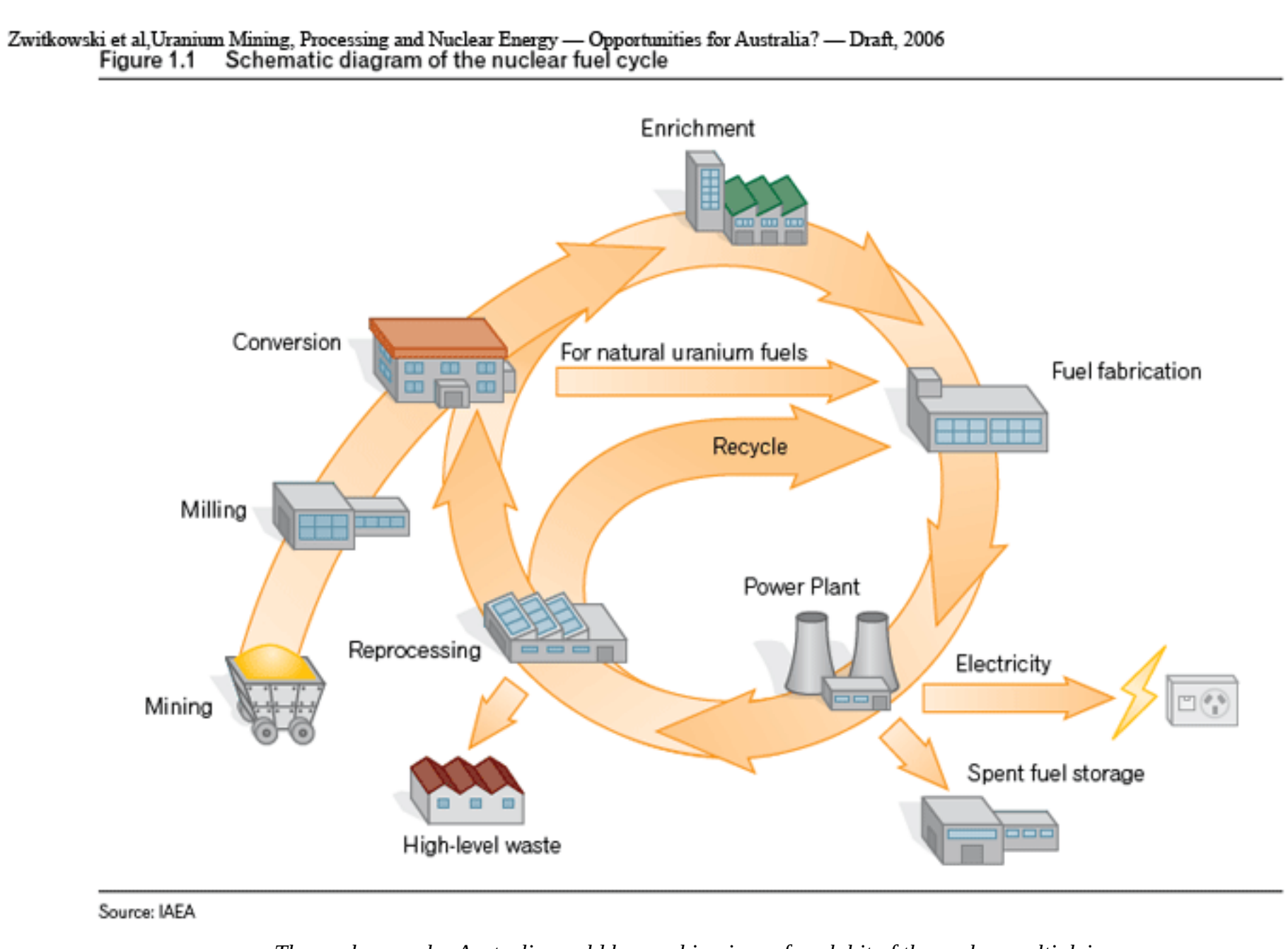
Continuing permitting challenges, supply-chain bottlenecks, and issues with construction assurance suggest the nuclear development cycle will be 9-11 years from conception to reactor start up. *A further delay could be caused by some investors waiting for a demonstration from the first wave of new reactors that expanded nuclear power is profitable.*
*Reducing US Greenhouse Gas Emissions: How Much and At What Costs?*McKinsey and Co, Dec. 2007

Why Not Put The Nukes At Roxby

Locating Australia's nuclear industry at Roxby Downs makes a of lot of sense. Why?

1. Olympic Dam has 40% of world uranium supplies.
2. A nuclear enrichment industry would make money while maintaining control.
3. The Australian Nuclear Science & Technology Organisation says Australia needs around 6,000 MWs of nuclear power capacity to ensure viability
4. Woomera has been named as a good location for both a nuclear power station and a national nuclear waste repository
5. Locating the industry at Roxby Downs would lower insurance costs because environmental damage to major population centres would be eliminated in case of major mishap

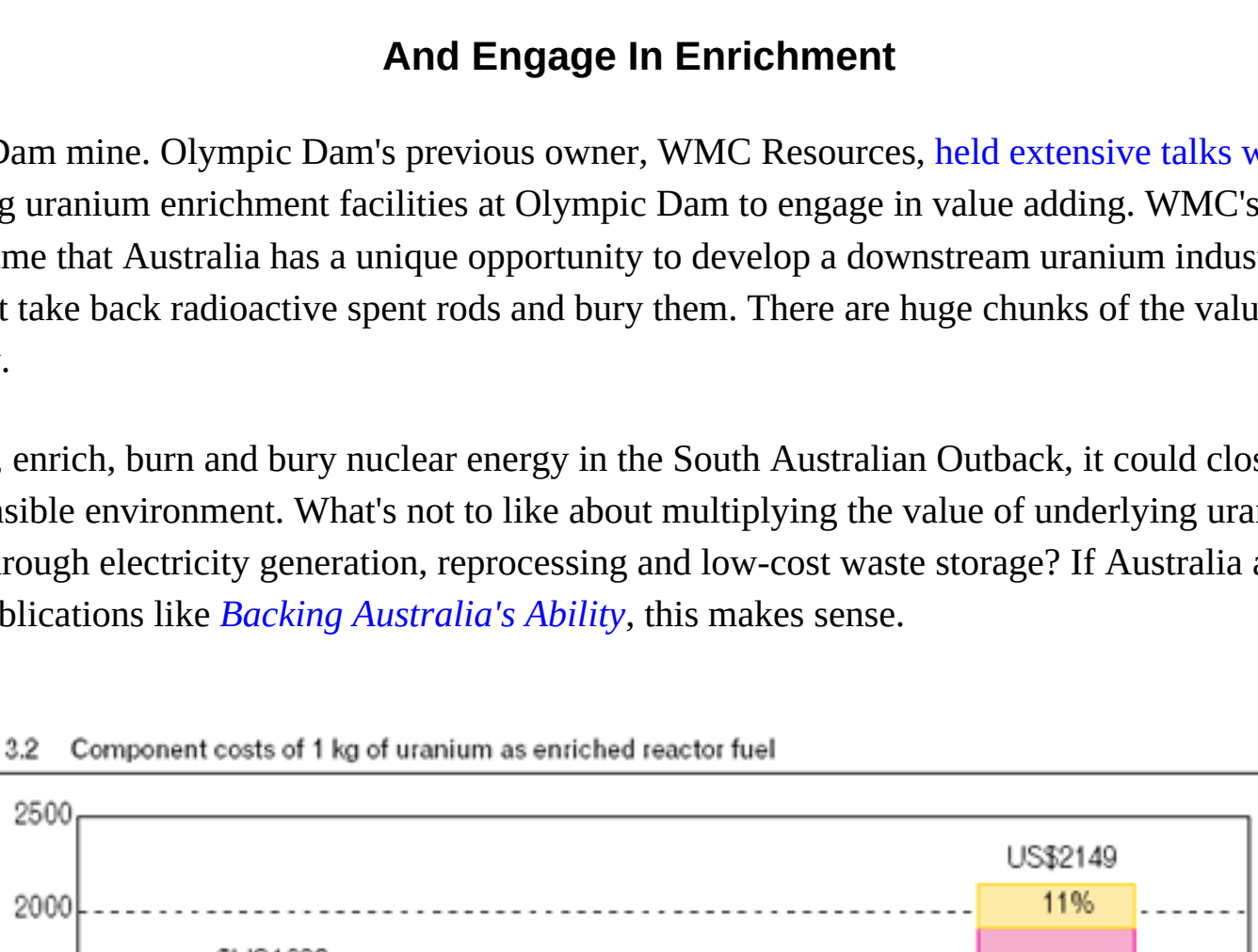
A geographically-concentrated national nuclear industry would reap huge operational and safety efficiencies. It would “close the nuclear cycle” through mining, enriching, burning and burying nuclear material all in the same place. Furthermore, given that public opinion opposes nuclear power and the Labor states are competing with each other to say "no" nuclear power plants within their borders, the Commonwealth can build out a nuclear industry on federal land in the Woomera Prohibited Area, which already has played host to nuclear tests at Maralinga.



The nuclear cycle: Australia could have a big piece of each bit of the cycle --multiplying the value of the industry many times over

Source: *Uranium Mining, Processing and Nuclear Energy – Opportunities for Australia?*
Office of Prime Minister and Cabinet, 2006

Consider this: why are Australia's coal-fired power plants located in in the Hunter Valley, the La Trobe Valley, the Upper Spencer Gulf and coastal Queensland? They were built there to be close to their coal supplies. Should nuclear be different? Why not put the nukes where the uranium is, and Roxby Downs is world class. The Switkowski nuclear study group estimated a nuclear generation industry providing one-third of Australia's electricity by 2050 could do so in in a land area as little as 20 square kilometers. The area around Olympic Dam has multiples of that amount of land available. It could easily house not just a nuclear electricity generating industry, but also upstream (mining and enrichment) operations as well as downstream radioactive waste burial operations. And it would all be located in one highly-controlled, highly-secure spot.

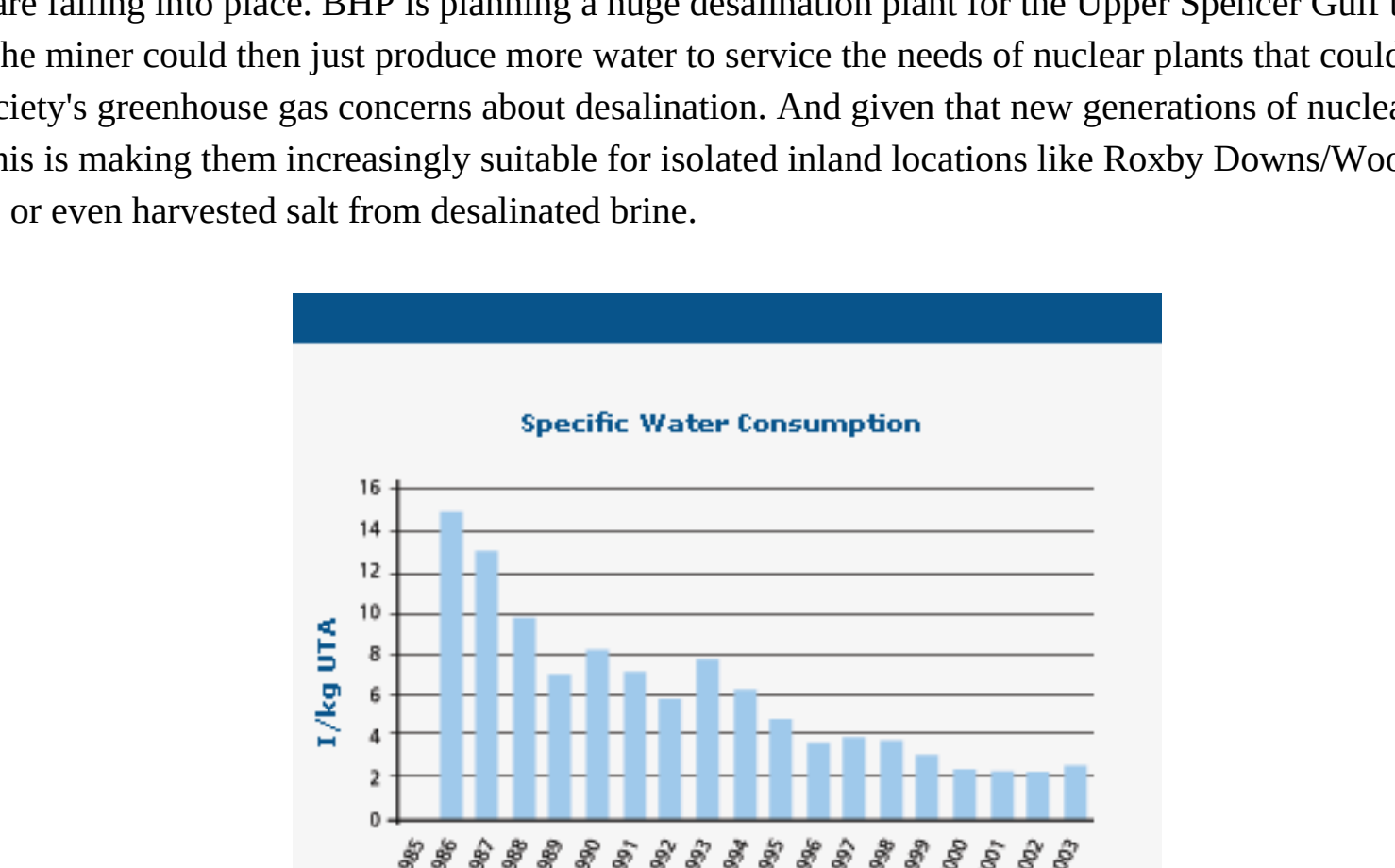


Australia's ***entire*** *nuclear industry could be contained within the Woomera Prohibited Area, enhancing security and avoiding negative public opinion problems*

And Engage In Enrichment

BHP owns the Olympic Dam mine. Olympic Dam's previous owner, WMC Resources, held extensive talks with French nuclear fuel giant Areva on developing uranium enrichment facilities at Olympic Dam to engage in value adding. WMC's chief executive, Andrew Michelmore, said at the time that Australia has a unique opportunity to develop a downstream uranium industry. Michelmore even suggested Australia might take back radioactive spent rods and bury them. There are huge chunks of the value chain to be exploited here safely and profitably.

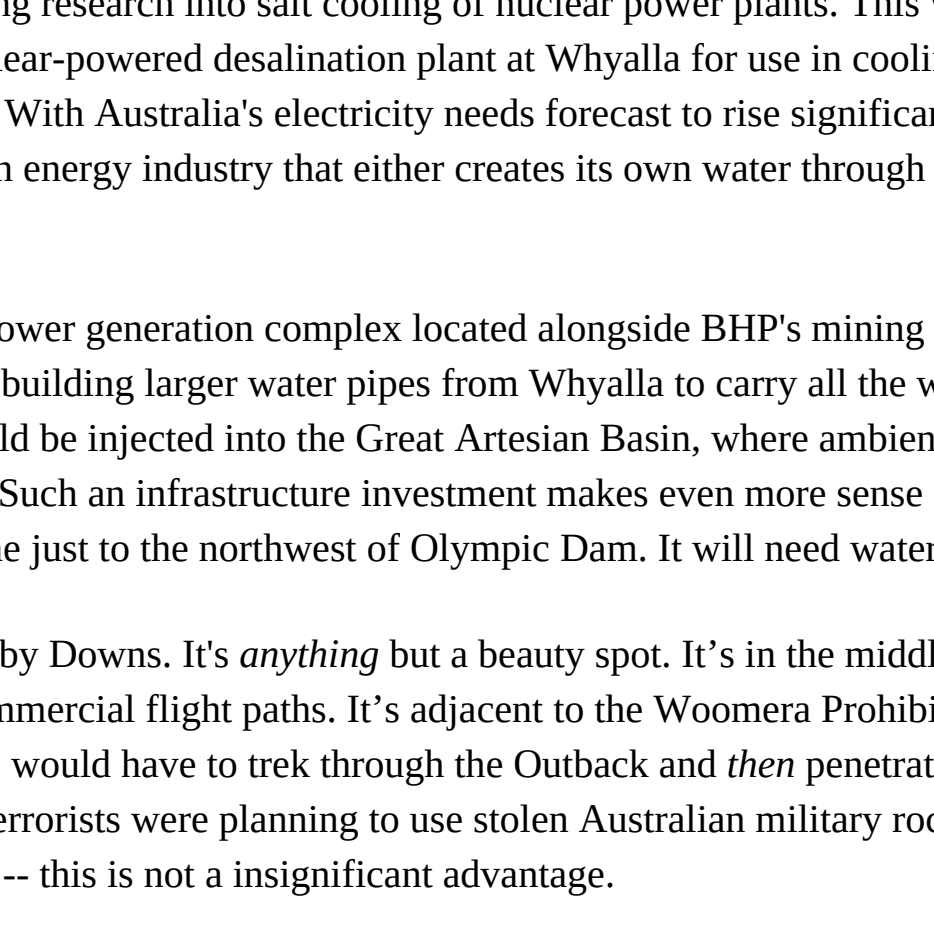
If Australia were to mine, enrich, burn and bury nuclear energy in the South Australian Outback, it could close the nuclear cycle in a safe, stable, smart, responsible environment. What's not to like about multiplying the value of underlying uranium through enrichment and then adding profits through electricity generation, reprocessing and low-cost waste storage? If Australia aspires to be a Smart Country as outlined in publications like *Backing Australia's Ability*, this makes sense.



By engaging in value-added processing of uranium, Australia can garner huge amount of additional wealth in the uranium/nuclear industry, moving itself toward John Howard's goal of being an "energy superpower"

Source: *Uranium Mining, Processing and Nuclear Energy – Opportunities for Australia?* Office of Prime Minister and Cabinet, 2006

Already the pieces are falling into place. BHP is planning a huge desalination plant for the Upper Spencer Gulf to service Olympic Dam's expansion. The miner could then just produce more water to service the needs of nuclear plants that could power desalination, eliminating civil society's greenhouse gas concerns about desalination. And given that new generations of nuclear plants require less water for cooling, this is making them increasingly suitable for isolated inland locations like Roxby Downs/Woomera. Seawater could be used for cooling, or even harvested salt from desalinated brine.



Water requirements for enrichment are falling

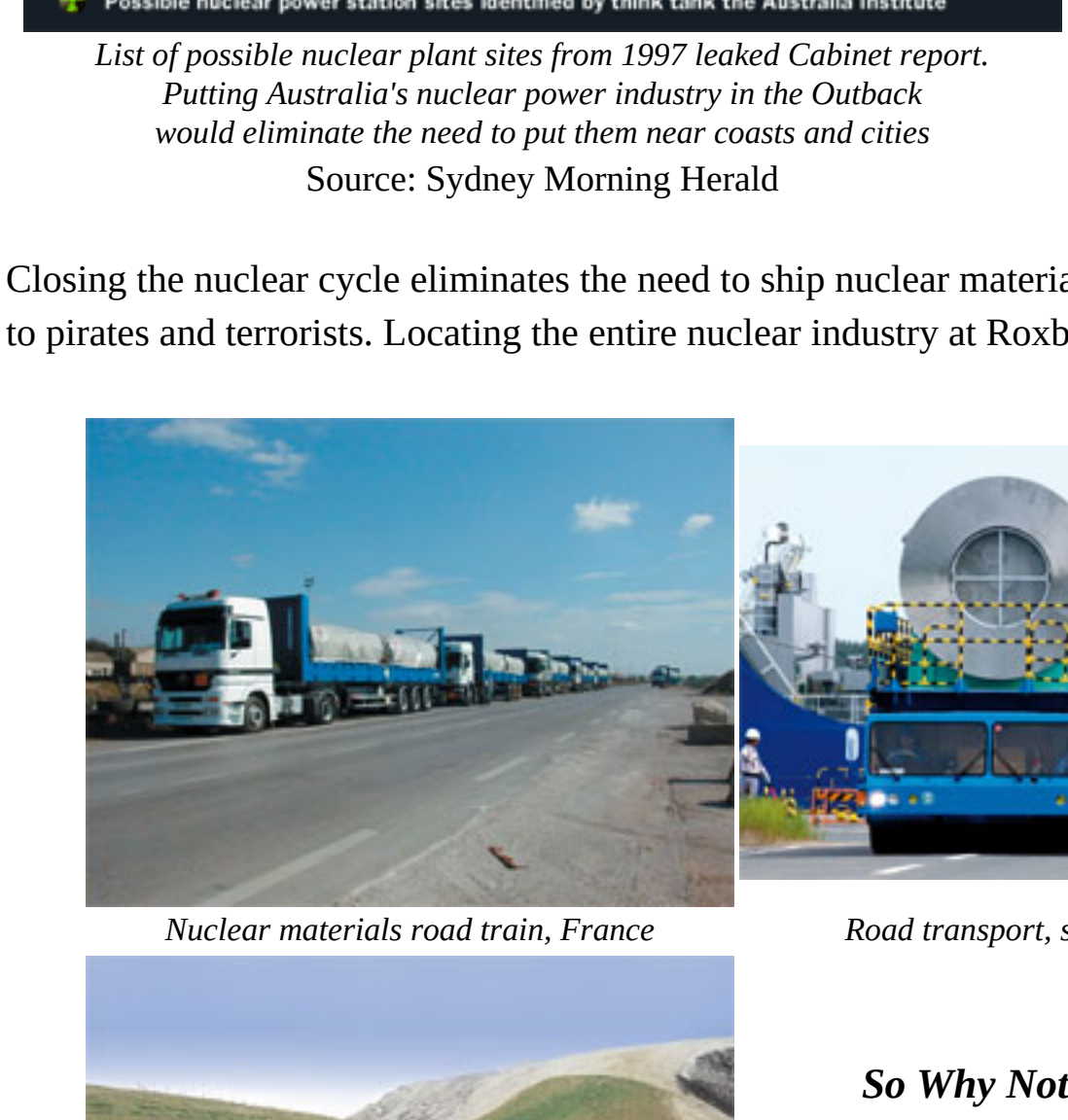
In Queensland, the Millmerran and Kogan Creek coal-fired power stations used low-water consumption cooling systems. Furthermore, the US Department of Energy is funding research into salt cooling of nuclear power plants. This would provide BHP an opportunity to reprocess brine from a large-scale nuclear-powered desalination plant at Whyalla for use in cooling nuclear plants at Roxby Downs, further closing the nuclear/water loop. With Australia's electricity needs forecast to rise significantly in coming years, and the nation increasingly short of water -- having an energy industry that either creates its own water through desalination or uses less to start with is a very attractive proposition.

With a large nuclear enrichment and power generation complex located alongside BHP's mining operations at Olympic Dam, huge economies of scale could be reaped in building larger water pipes from Whyalla to carry all the water needed for both mining and energy production. Leftover water could be injected into the Great Artesian Basin, where ambient water temperatures are already elevated due to geothermal processes. Such an infrastructure investment makes even more sense given that another mining company, Oxiana, will be developing a huge mine just to the northwest of Olympic Dam. It will need water and power as well.

As ‘ground zero,’ few places beat Roxby Downs. It's *anything* but a beauty spot. It’s in the middle of nowhere. There’s one sealed road to it. It lies outside traditional commercial flight paths. It’s adjacent to the Woomera Prohibited Area. To attack a nuclear power installation at Roxby Downs, terrorists would have to trek through the Outback and *then* penetrate the Woomera Prohibited Area. Given recent headlines that potential terrorists were planning to use stolen Australian military rockets to attack nuclear installations in Australia's cities -- like Lucas Heights -- this is not a insignificant advantage.

Should nuclear power prove itself safe at Roxby Downs, a *subsequent generation* of nuclear plants could be built near Australia's cities around 2070. But as long as the new generation of nuclear power plants is untried and untested, and the nuclear industry has atrophied skills, it would be imprudent to put any nuclear plants anywhere near where they can hurt people until they regain their spurs.

Given that BHP is mining uranium at Olympic Dam, it should have little hesitation playing host to downstream industries. There's abundant worldwide precedent. In France and Japan, enrichment facilities have commonly been adjacent to nuclear power plants.



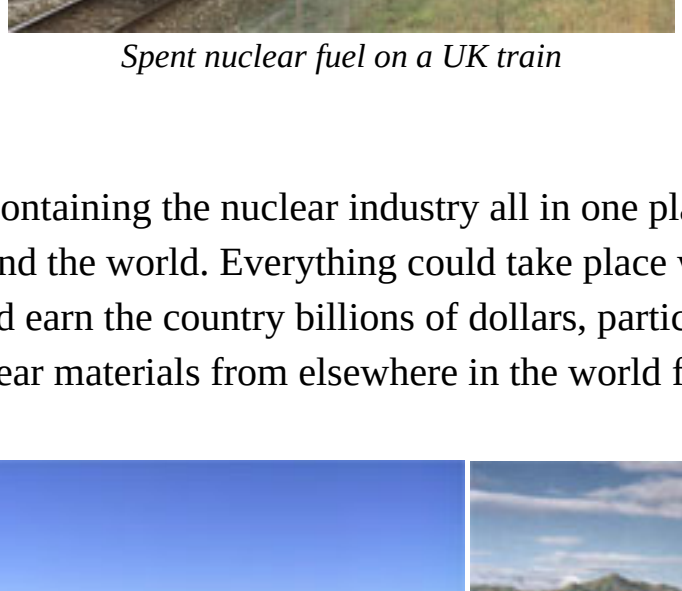
List of possible nuclear plant sites from 1997 leaked Cabinet report. Putting Australia's nuclear power industry in the Outback would eliminate the need to put them near coasts and cities

Source: Sydney Morning Herald

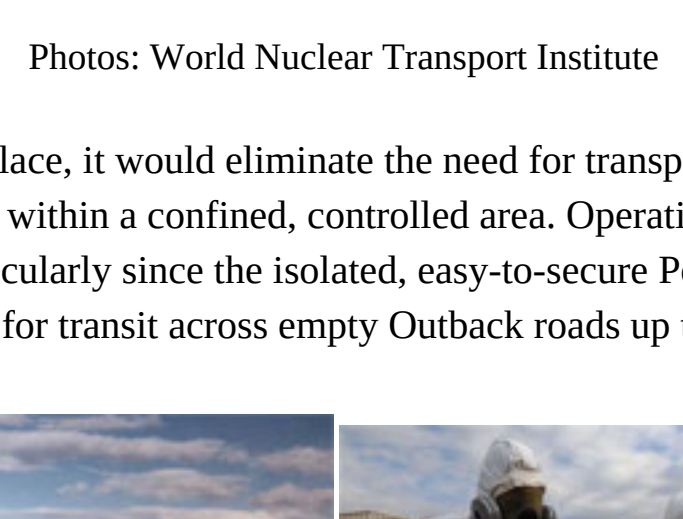
A newer list of possible nuclear sites from the Australia Institute in which most would be located near cities

Source: Australia Institute

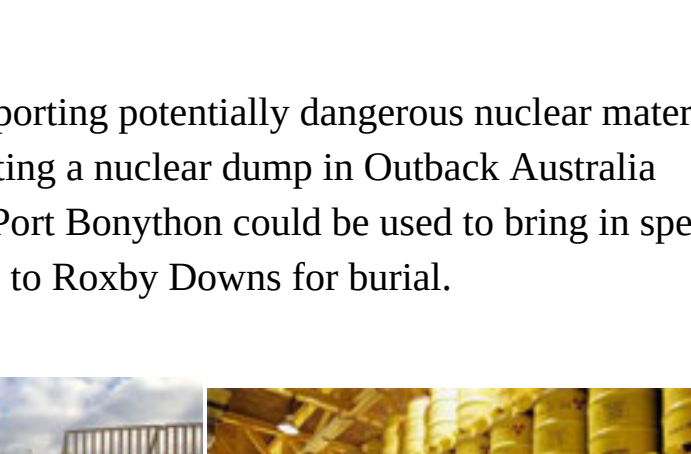
Closing the nuclear cycle eliminates the need to ship nuclear materials over an increasing crowded global transport system vulnerable to pirates and terrorists. Locating the entire nuclear industry at Roxby Downs would eliminate this as an industry problem.



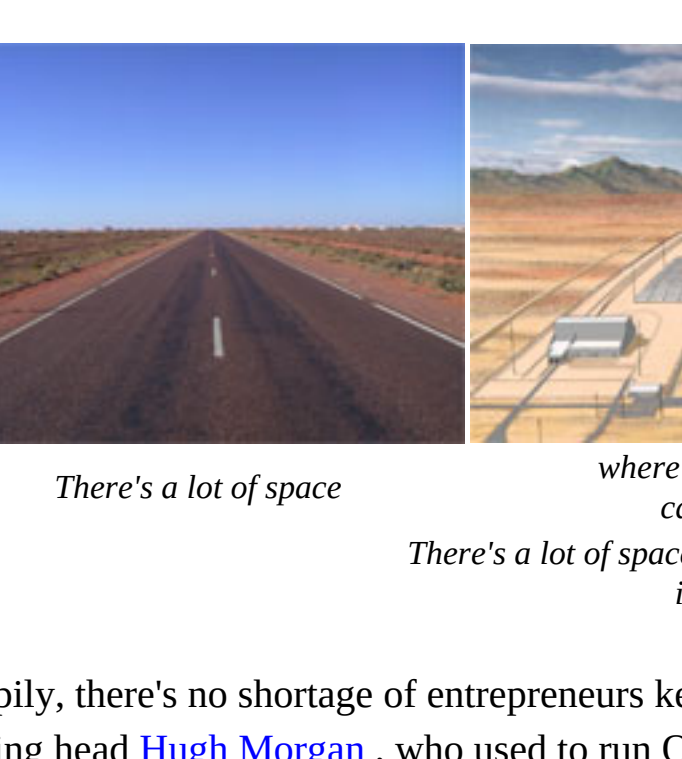
Nuclear materials road train, France



Road transport, spent fuel, Japan



Nuclear materials on the high seas



Spent nuclear fuel on a UK train

So Why Not Keep It All

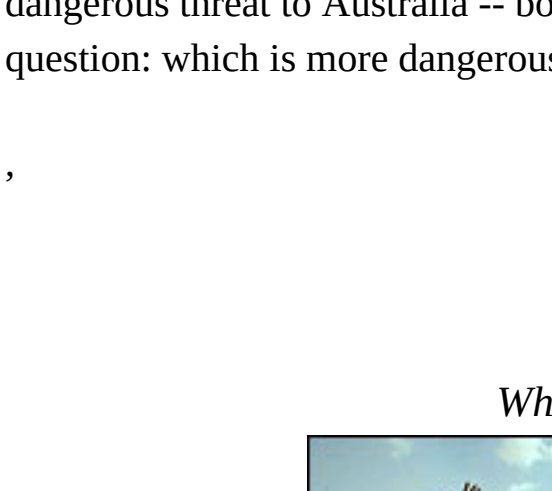
At Roxby Downs

And Save The Trouble?

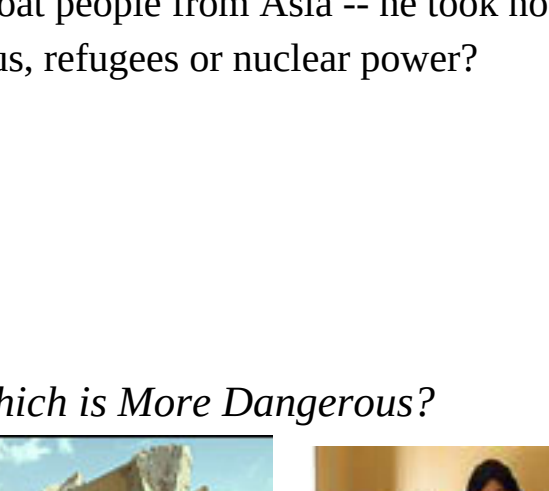
Spent nuclear fuel transport cask

Photos: World Nuclear Transport Institute

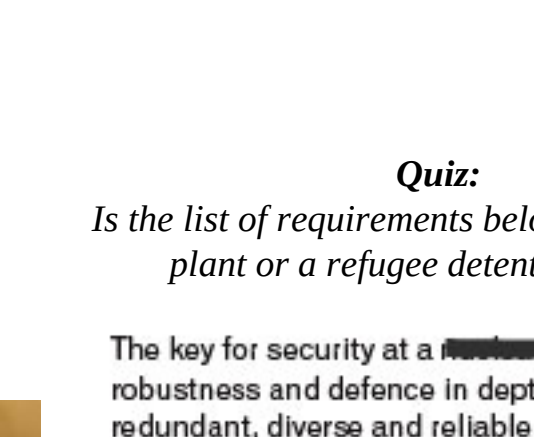
By containing the nuclear industry all in one place, it would eliminate the need for transporting potentially dangerous nuclear materials around the world. Everything could take place within a confined, controlled area. Operating a nuclear dump in Outback Australia could earn the country billions of dollars, particularly since the isolated, easy-to-secure Port Bonython could be used to bring in spent nuclear materials from elsewhere in the world for transit across empty Outback roads up to Roxby Downs for burial.



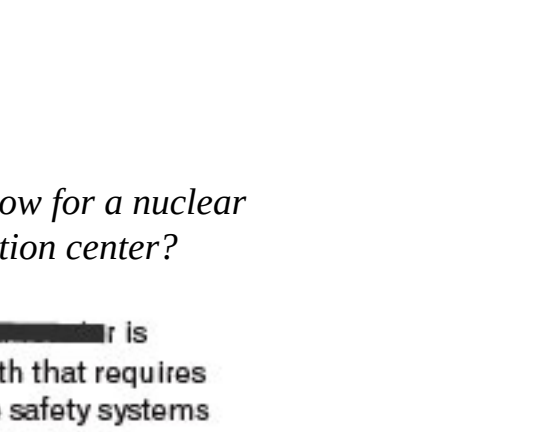
There's a lot of space



where nuclear waste can be kept



under watchful eyes



in safe surroundings

There's a lot of space in Outback South Australia waste could be kept under watchful eyes in safe surroundings AWAY from Australia's cities

Happily, there's no shortage of entrepreneurs keen to get involved in the nuclear waste dump business, including former Western Mining head Hugh Morgan , who used to run Olympic Dam and therefore knows all about the geology out there. It's not too much of a stretch to think he may know of good places around Roxby Downs, which already has been canvassed in the past as a potential nuclear dump site.

Locating Australia's nuclear industry at Olympic Dam protects and serves the interests of society at large. It also dovetails nicely with current government policies. For instance, when the Howard government sought to quarantine Australia from the previous most dangerous threat to Australia -- boat people from Asia -- he took no chances. He quarantined them at Woomera. This begs the question: which is more dangerous, refugees or nuclear power?

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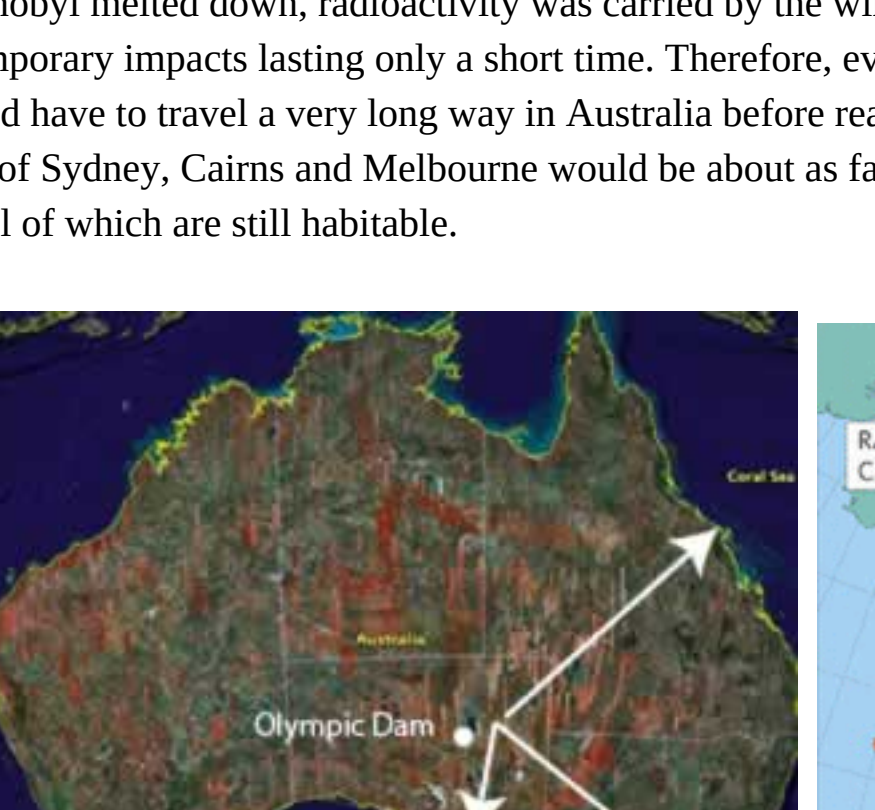
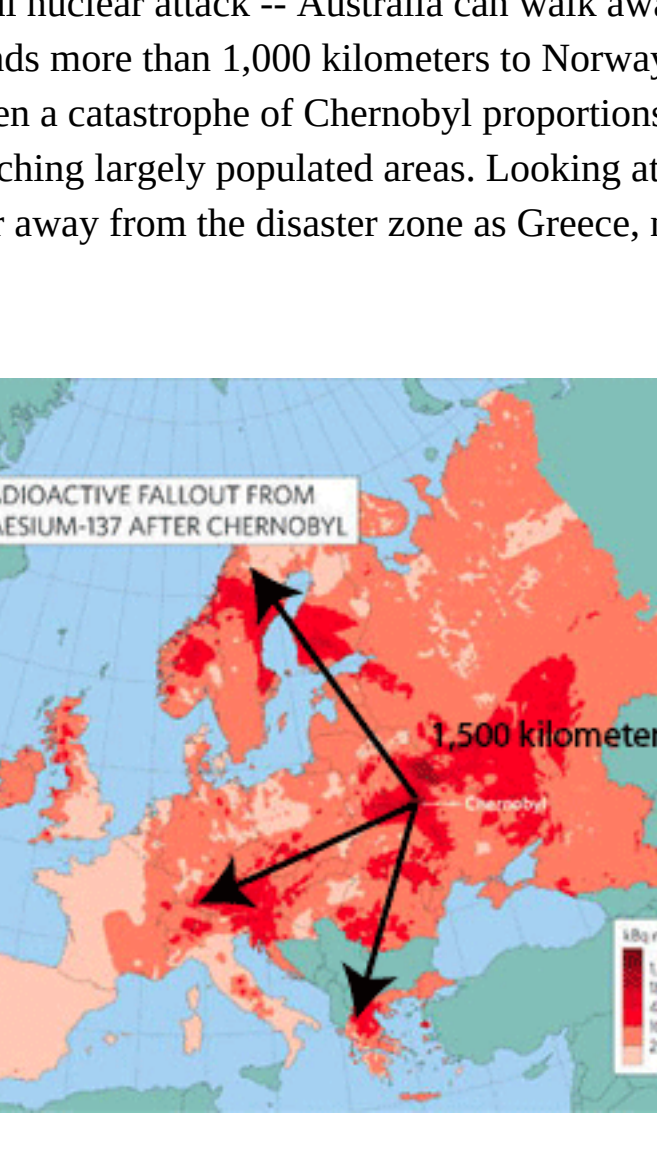
Which is More Dangerous?



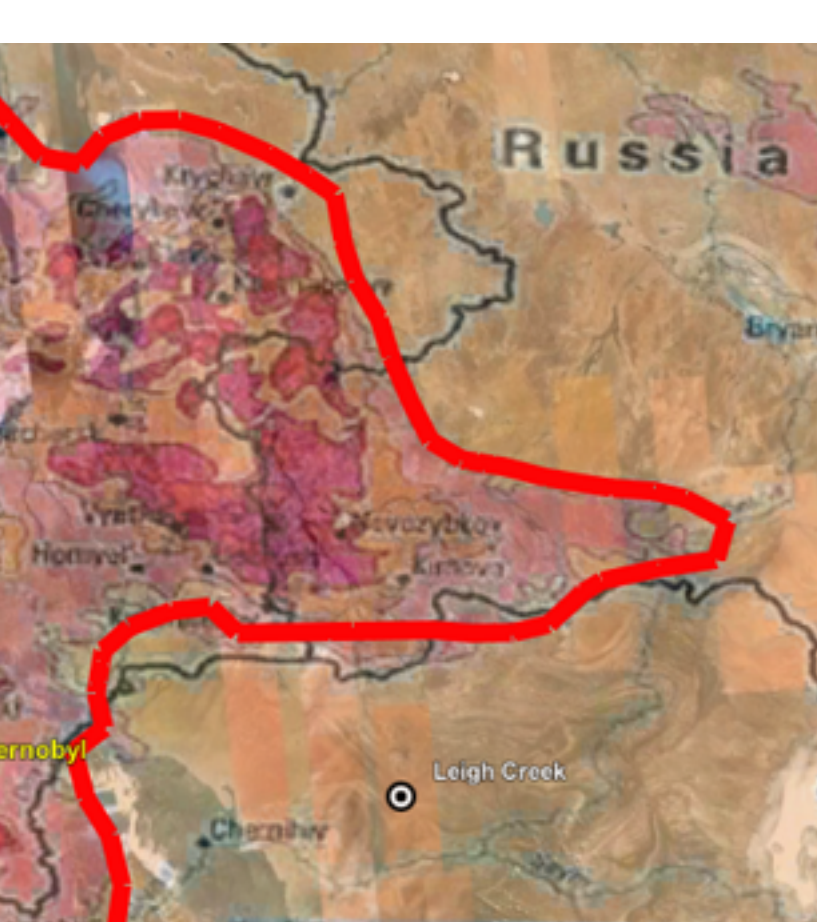
Quiz:
Is the list of requirements below for a nuclear plant or a refugee detention center?


The key for security at a [redacted]r is robustness and defence in depth that requires redundant, diverse and reliable safety systems (Figure 8.3). Security measures include:

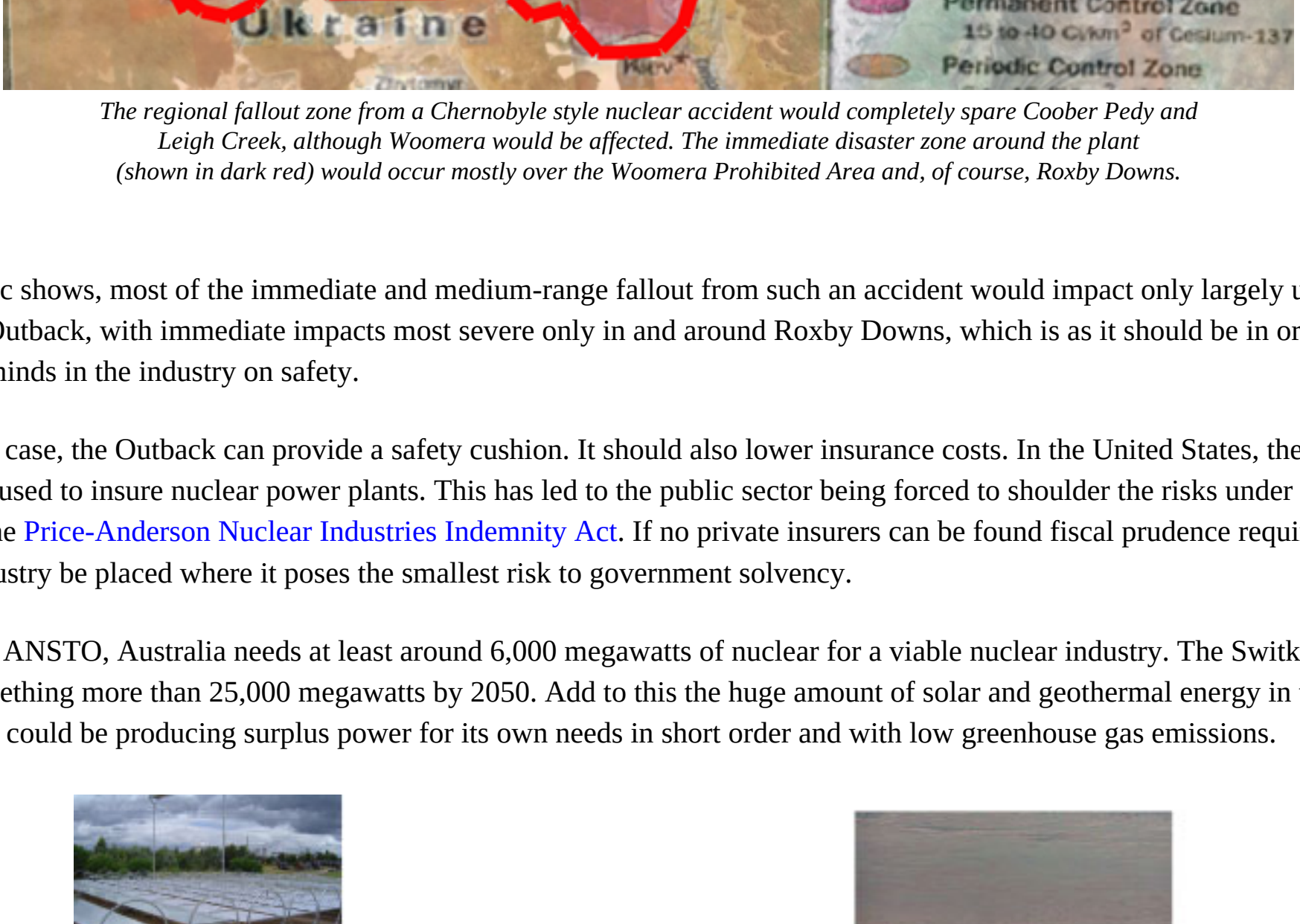
- physical barriers and isolation zones
- well-trained and well-equipped guards
- surveillance and patrols of the perimeter fence
- search of all entering vehicles and persons
- intrusion detection aids, such as closed-circuit television and alarm devices
- bullet-resisting barriers to critical areas
- coordinated emergency plans with police, fire, and emergency management organisations
- regular drills
- staff security clearances.[201]

Answer at bottom of page

Should the worst happen -- something like a nuclear accident or successful nuclear attack -- Australia can walk away from Olympic Dam. When Chernobyl melted down, radioactivity was carried by the winds more than 1,000 kilometers to Norway and the Balkans, but these were temporary impacts lasting only a short time. Therefore, even a catastrophe of Chernobyl proportions would mean that radioactivity would have to travel a very long way in Australia before reaching largely populated areas. Looking at it from the scale of Europe, the cities of Sydney, Cairns and Melbourne would be about as far away from the disaster zone as Greece, northern Sweden and Budapest -- all of which are still habitable.



Naturally, however, the localised effects would be much more severe. Below is an scaled overlay of the Chernobyl disaster zone placed over Roxby Downs.

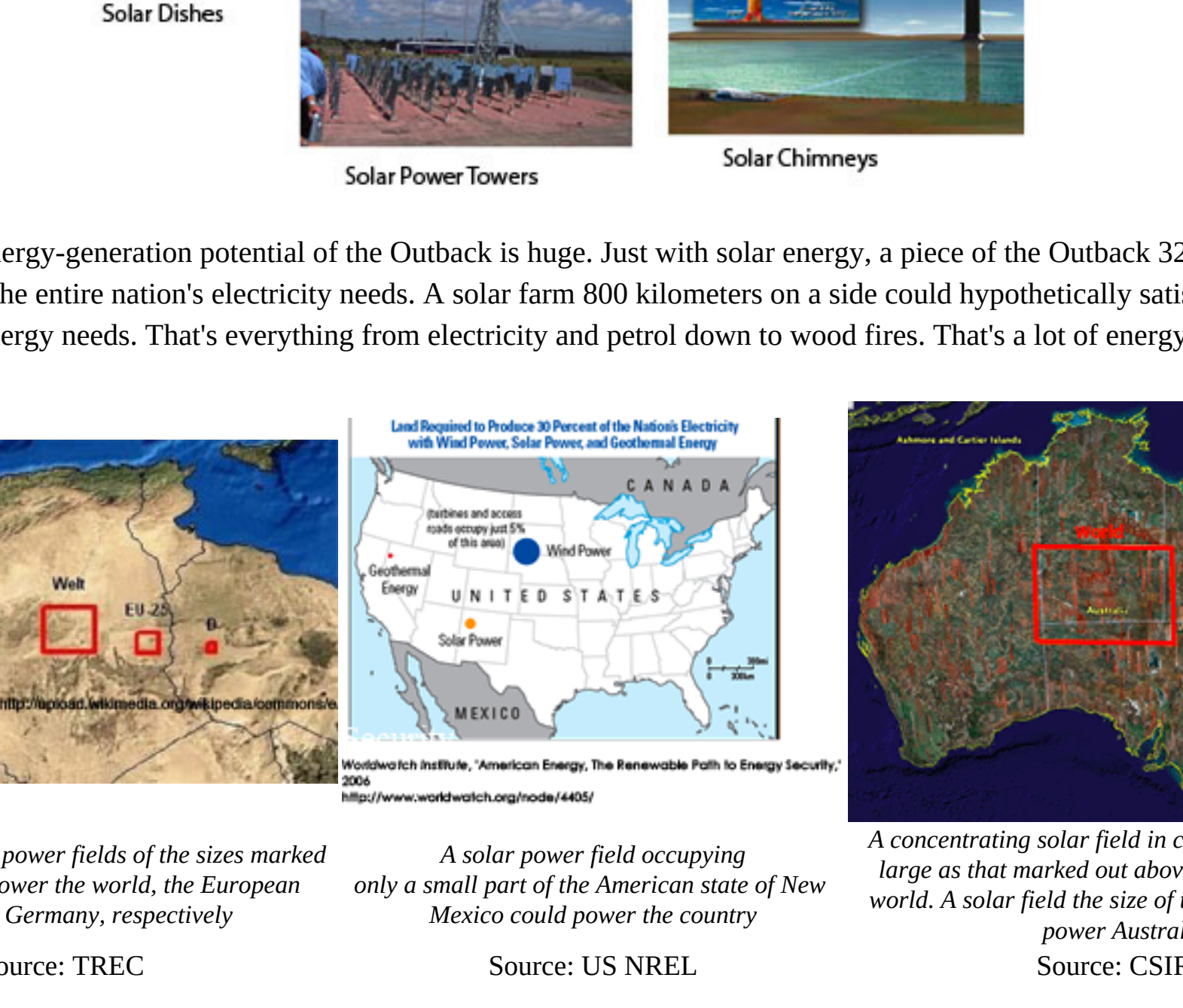


The regional fallout zone from a Chernobyle style nuclear accident would completely spare Coober Pedy and Leigh Creek, although Woomera would be affected. The immediate disaster zone around the plant (shown in dark red) would occur mostly over the Woomera Prohibited Area and, of course, Roxby Downs.

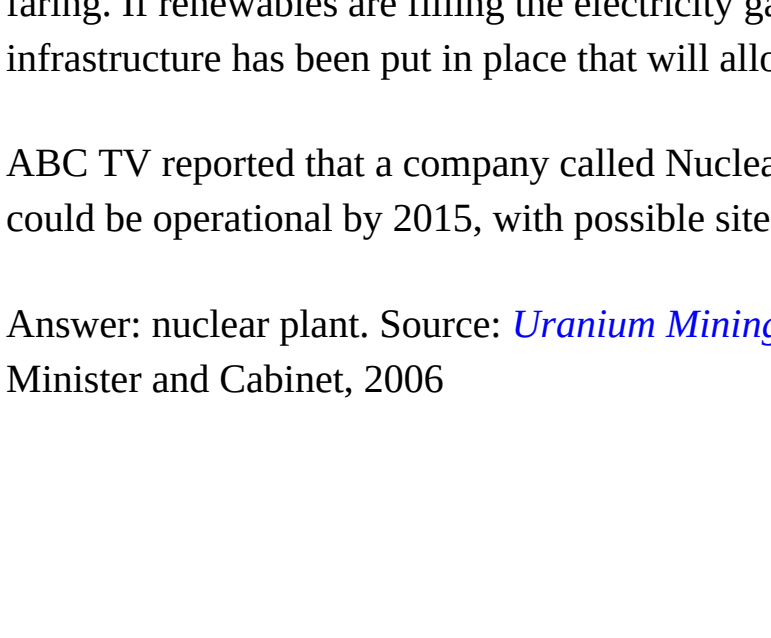
As the graphic shows, most of the immediate and medium-range fallout from such an accident would impact only largely uninhabited areas of the Outback, with immediate impacts most severe only in and around Roxby Downs, which is as it should be in order to concentrate minds in the industry on safety.

In Australia's case, the Outback can provide a safety cushion. It should also lower insurance costs. In the United States, the private sector has refused to insure nuclear power plants. This has led to the public sector being forced to shoulder the risks under such schemes as the Price-Anderson Nuclear Industries Indemnity Act. If no private insurers can be found fiscal prudence requires such a high-risk industry be placed where it poses the smallest risk to government solvency.

According to ANSTO, Australia needs at least around 6,000 megawatts of nuclear for a viable nuclear industry. The Switkowski report hinted at something more than 25,000 megawatts by 2050. Add to this the huge amount of solar and geothermal energy in the region, and Australia could be producing surplus power for its own needs in short order and with low greenhouse gas emissions.

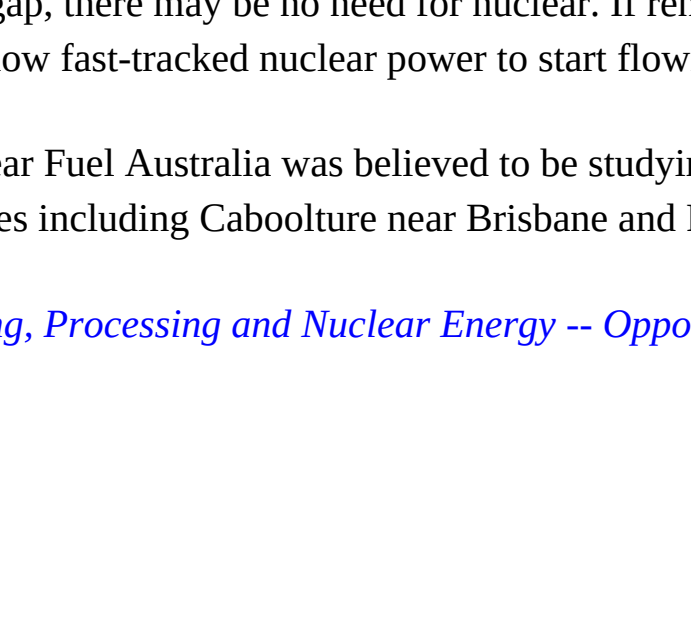


The scale of the energy-generation potential of the Outback is huge. Just with solar energy, a piece of the Outback 32-kilometers on a side could satisfy the entire nation's electricity needs. A solar farm 800 kilometers on a side could hypothetically satisfy the entire world's primary energy needs. That's everything from electricity and petrol down to wood fires. That's a lot of energy.



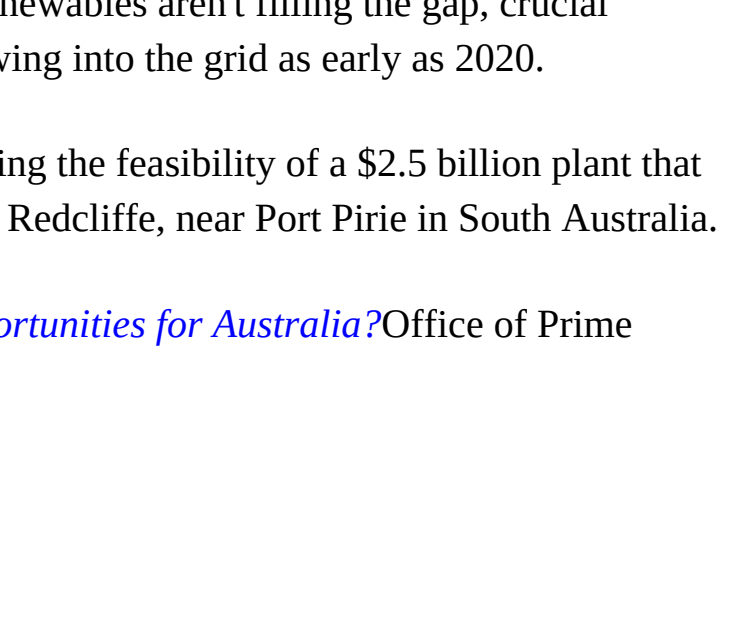
Concentrating solar power fields of the sizes marked out above could power the world, the European Union and Germany, respectively

Source: TREC



A solar power field occupying only a small part of the American state of New Mexico could power the country

Source: US NREL



A concentrating solar field in central Australia as large as that marked out above could power the world. A solar field the size of the small dot could power Australia

Source: CSIRO

By building an electricity transmission infrastructure to Roxby Downs now, and using it to carry renewables, Australia gains the best of both worlds. It has an electricity infrastructure ready to go now, and an electricity infrastructure in place for a 2017 referendum on nuclear power. By that year, the country should have a pretty good idea how the large-scale, Outback-based renewables industry is faring. If renewables are filling the electricity gap, there may be no need for nuclear. If renewables aren't filling the gap, crucial infrastructure has been put in place that will allow fast-tracked nuclear power to start flowing into the grid as early as 2020.

ABC TV reported that a company called Nuclear Fuel Australia was believed to be studying the feasibility of a $2.5 billion plant that could be operational by 2015, with possible sites including Caboolture near Brisbane and Redcliffe, near Port Pirie in South Australia.

Answer: nuclear plant. Source: *Uranium Mining, Processing and Nuclear Energy -- Opportunities for Australia?*Office of Prime Minister and Cabinet, 2006

The Blended Solution

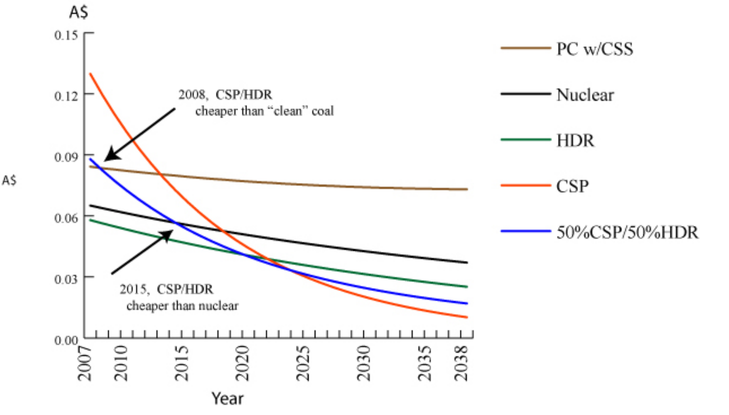
If high capacity power lines are built to Roxby Downs, the best way to get power flowing down them would be through, among other things, offering transitory premium feed in tariffs. This would reward early movers in building new electricity generation capacity. 'Power parks,' or state-sponsored energy generation experimentation areas could also be created, a concept developed by 2006 *Adelaide Thinker in Residence* Stephen Schneider, a climatologist from California's Stanford University.

Regarding *feed in tariffs*, consider some of the economics. If the current carbon-adjusted cost of power in Australia (according to ANSTO) is about 8-9c per kilowatthour, another 3-10 cents of incentives could be added to that price to provide incentives for investment in new electricity generation. The premium would then be cut annually by fixed increments over 10-15 years. To give an idea of how much subsidy this would entail, 6,000MWs of clean energy produced from a power park with a 6c/kwh subsidy would amount to $315 million a year, and this amount would fall year by year.

The construction costs of the new electricity power line infrastructure to isolated areas could be paid down through non-discriminatory, common carrier transit fees. This would help eliminate a major source of unfair competitive advantage enjoyed by current energy producers with existing power lines, many of which were originally subsidized with state and federal money.

With the long-term certainty gained from such policies as guaranteed feed in tariffs and guaranteed delivery to market, investment will follow. Efficient new power producers will expand. Poor performers will be eliminated. The best technology will win.

How might this work? Consider the future price curves already outlined. Given that concentrating solar power and geothermal are ideally suited to colocation in the Outback, a bundled energy price comprised of equal amounts of each would be cheaper than coal-fired power with hypothetical carbon capture and storage. In addition, new concentrating solar power and geothermal power supplies could be online as early as 2011. Carbon capture and storage won't be ready until 2015. By that year, a CSP/hot dry rock combination would be cheaper than nuclear, which itself couldn't come on line until 2020. Therefore, stringing power lines to Roxby Downs to encourage renewables with transitory premium feed-in tariffs would yield near term gains, and it wouldn't require subsidisation for long.



Combinations of concentrating solar power, geothermal and even solar PV from the Outback hold the promise of very attractive blended energy prices

Concentrating solar power and geothermal can provide huge amounts of Outback-generated electricity cleanly and cost effectively and much earlier than carbon capture and storage or nuclear. That isn't to say carbon capture and storage and nuclear shouldn't be considered, but with proven, cheaper technology available now -- does it make sense to wait? Why not developed the proven technologies now, and the speculative technologies later?

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*If Australia is serious about this, **we could build a major new city out there (in the Cooper Basin)**, link it up with the north-south railway line, **make it the centre of our electricity grid, and use that resource. It will provide enough electricity to run the entire Australian economy for 100 years**.*
Tim Flannery

*"**If we develop the technologies for converting solar energy into electricity, if we learn how to store solar heat from day to night and how to transmit power over a few thousand kilometres with small losses, then fossil fuels could be replaced by solar energy** from deserts (except for some fraction of the transportation sector), and by the other forms as wind, biomass, and hydropower."*
says Mark Diesendorf from the University of NSW.

***"The solar thermal energy to meet Australia's entire current power demand would require 35x35 km square area** in a high irradiance, low cloud cover location."*
Synergies with Renewables: Concentrating Solar Thermal, Cooperative Research Centre for Coal in Sustainable Development

*"**We could have 100 per cent of our electricity coming from renewable energy in coming decades if we really wanted to**, assuming solar and geothermal sources play a significant role," says Mark Diesendorf from the University of NSW.*

"We believe that geothermal energy will play an increasing role in securing the world's future needs for clean energy."
Grant King,
Origin Energy

***We make money in geothermal.** We're the largest geothermal producer in the world. **We're continuing to expand and invest in that business.** That has now moved along the maturity curve to where it is a good moneymaking business.*
Chevron CEO David O'Reilly

***"We know we can count on concentrating solar power.** It's extremely producting in the peak power parks of the day. So it's worth a lot to us."*
Barbara Lockwood, Arizona Public Service

*"**Australia should be and will be the leader in solar technologies in the world**."*
Australian Federal Environment Minister (2001-2004) Ian Campbell

Contact ASFEE
at info@asfee.org

Hydrogen Creation

Creating a robust, high volume electricity generation plex in the South Australian Outback has intrinsic efficiencies.

--it offers the ability for renewables to have a role in energy generation
--It closes the nuclear cycle
--It jump starts a hybrid car industry by allowing nighttime nuclear power to recharge vehicles
--It gives Australia a headstart in adapting to the Hydrogen Age because nighttime Outback-generated power over and above that needed for off-peak and vehicle recharging needs can be used to generate hydrogen.

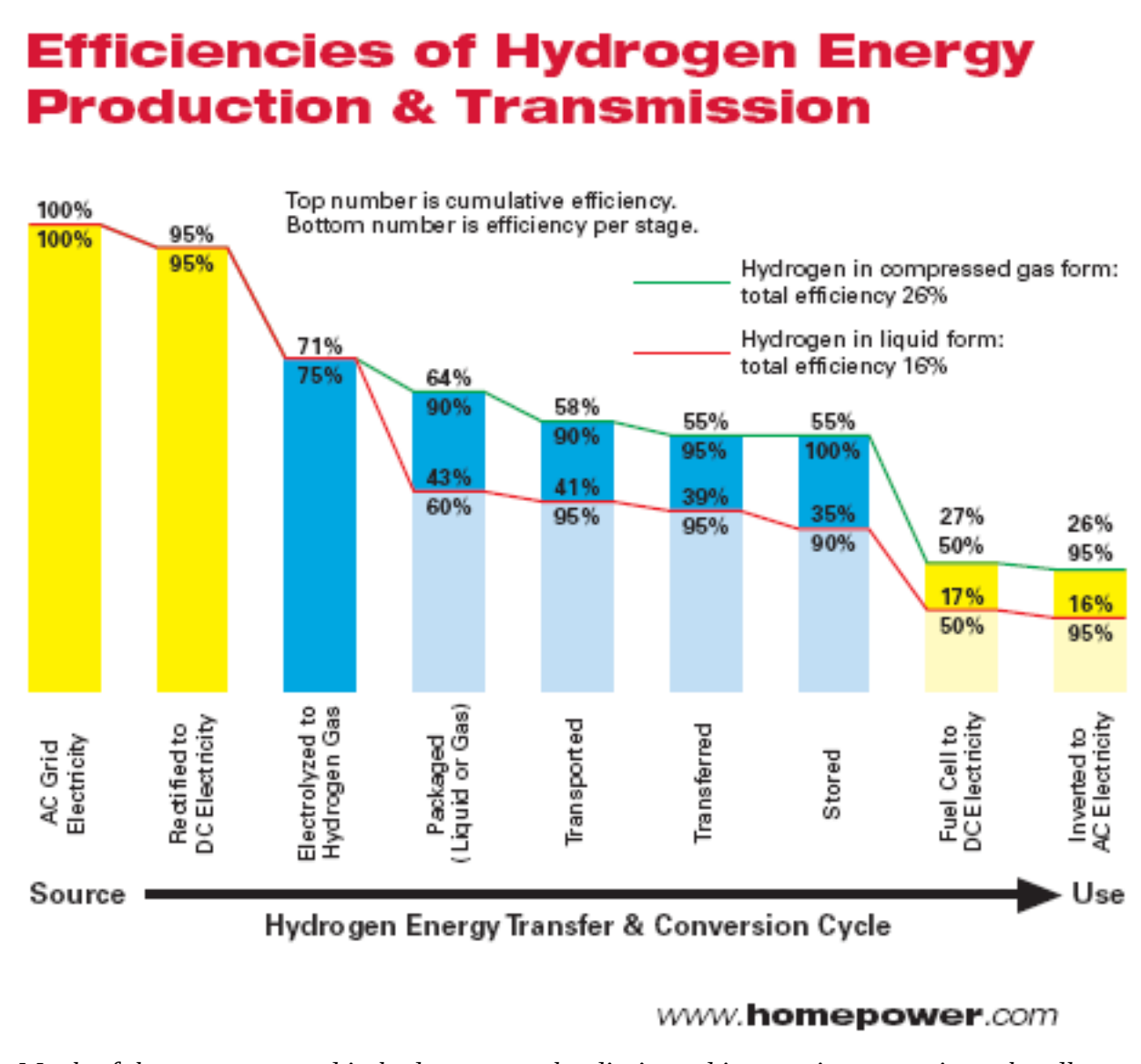
Making hydrogen is a relatively well-known process. The question now is cost. Making hydrogen with renewables is the Holy Grail. Making hydrogen with nuclear could be a step along the way.

The United States is already engaged in researching hydrogen-producing nuclear plants. As a result, there's a terrific opportunity for Australia, with the world's most abundant uranium supplies, to team up with America, the world's research powerhouse. Together they can work toward an era of clean energy production based upon nuclear hydrogen. The Americans are taking the potential so seriously they may spend US$1.25 billion on it. That's as much as the US had planned to spend on the ill-fated Futuregen "clean coal" effort.

America is considering spending big on research to develop hydrogen from nuclear power
Source: *A Means To The Hydrogen Age: The U.S. Power Industry*, Senate Hydrogen & Fuel Cell Caucus Briefing, February 22, 2006

In the US state of Nevada, researchers believe they can solar hydrogen cost effectively in as little as three years from now, all in a climate very similar to Outback Australia. Meanwhile, researchers at the Australian National University are busily working on ways to store solar energy by splitting ammonia into hydrogen and nitrogen.

In Australia's "National Hydrogen Study," researchers concluded hydrogen production in Australia is most cost efficient if initially it's produced on a distributed basis. The is because of difficulties in transporting hydrogen compared to transporting electricity. The chart below compares the rate of losses of electrons and hydrogen between the power plant and the consumer. While advances in technology will reduce this over time, for now transporting power as electricity rather than hydrogen makes alot more sense. But that may change as time goes on. So why not get a bet either way? Australia can.



Much of the energy stored in hydrogen can be dissipated in transit, presenting a hurdle to overcome
Source: Home Power

As the Hydrogen Economy becomes a reality, South Australia's massive energy generation resources centered around Olympic Dam and Moomba can serve over time as both a means of distributed and centralised means of hydrogen production -- first one, then the other. In the early days, a huge nuclear/renewable electricity generation complex centered at Roxby Downs could send electricity down high-capacity direct current wires to urban markets to enable recharging of plug-in hybrid vehicles and small-scale off peak production of hydrogen during nighttime hours in order to soak up all the excess nighttime power generated by the nuclear power industry.

Michael Strizki's home near New York City uses hydrogen made from solar power to run his home
Source: *CNET*

By creating downstream infrastructure for hydrogen progressively followed by an upstream infrastructure, Australia ensures it gets the lowest cost hydrogen creation over time. As technological advances make centralised production of hydrogen more cost efficient, Australia's flexible distribution system will be able to accommodate a shift of hydrogen production upstream to Roxby Downs.

During the intermediate period between distributed and centralised hydrogen production, Australia's flexible power line system between Roxby Downs, New South Wales and Queensland can be used to carry both electricity and hydrogen (dubbed "hydricity") with only minor tweaks to the system. Natural gas could also be used as a hydrogen feedstock. As it happens, Australia's natural gas pipeline network converges at Moomba, just to the northeast of Roxby Downs.

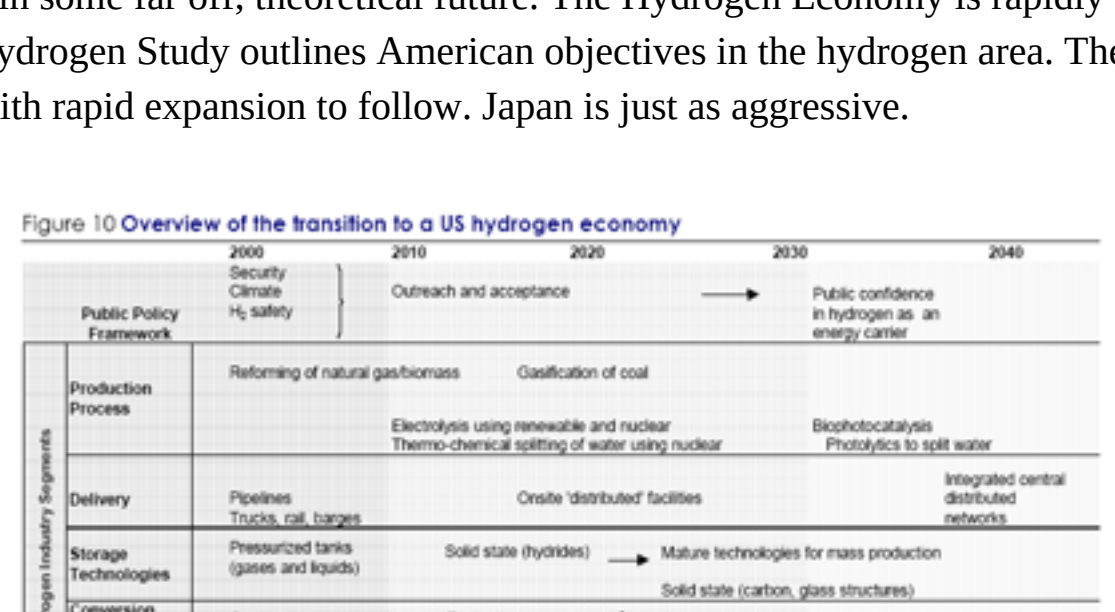
This raises the possibility large scale, centralised hydrogen production could be undertaken in the Outback using, variously, renewable energy, nuclear power and/or natural gas as inputs. The resulting hydrogen supplies could then be delivered to urban consumers through existing natural gas pipelines or through parallel pipelines laid along existing rights of way.

Australia's natural gas pipeline infrastructure converges at Moomba

With such a secure supply of domestic hydrogen, Australia could then move on to generating an exportable surplus. This would put Australia in the happy position of exporting higher-value, safe hydrogen instead of low-value uranium and coal. By moving up the value chain to hydrogen, Australia would benefit many times over by gaining more of the value added at in each link in the energy value chain. Australia needs to think about its global energy responsibilities. Does Australia want to be a sultan of clean energy, or a salesman of uranium raw materials for dirty bombs?

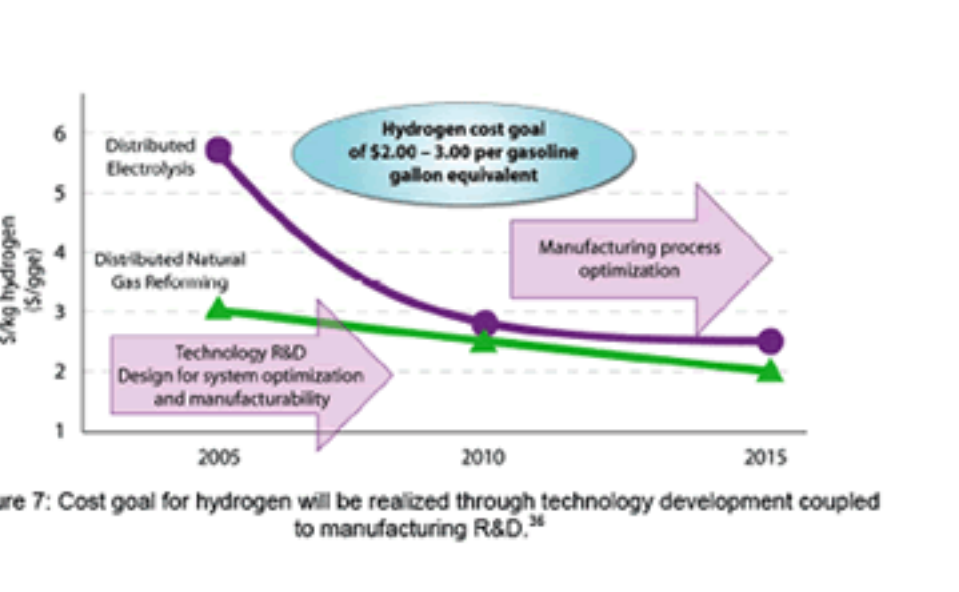
The Hydrogen Economy

The Hydrogen Economy doesn't lie in some far off, theoretical future. The Hydrogen Economy is rapidly approaching. To get an idea of how fast it's getting here, the National Hydrogen Study outlines American objectives in the hydrogen area. The US anticipates introducing hydrogen vehicles around 2010 -- with rapid expansion to follow. Japan is just as aggressive.

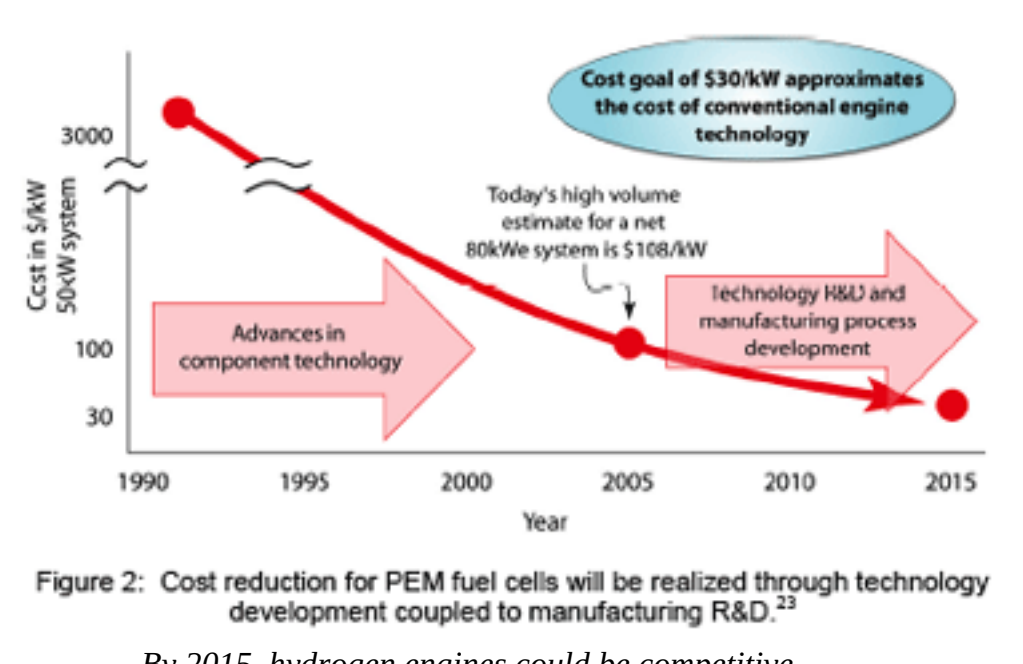


The United States foresees a rapid shift toward a hydrogen economy, and already the timeline above is proving overly conservative

What's more, rapid falls are expected in the prices of both hydrogen engines and hydrogen as a fuel. Incredibly, US Department of Energy researchers believe hydrogen could fall in price to as little as US$2-3/kg by 2015. Used in transport, that would equate to roughly A73cents per litre for petrol.



By 2015, hydrogen could cost the same as regular fuels



By 2015, hydrogen engines could be competitive

Source: "Roadmap on Manufacturing R&D for the Hydrogen Economy," US Department of Energy, 2005

If large scale, reliable, cost-effective hydrogen supplies are reliably introduced into the transport fuel mix, particularly from renewables and nuclear power, it would reduce Australia's largest single source of greenhouse gas emissions: transport. The only problem is adjusting the vehicle-refueling infrastructure (ie petrol stations) to handle and sell it. If Australia grasps the opportunities presented by hydrogen economy, it can help create global intellectual property of incalculable value.

Already, the United States is moving down this path. California has its 'Hydrogen Highway,' a network of hydrogen-equipped filling stations along the major north-south freeway, thus enabling hydrogen cars to traverse the state. The city of Las Vegas has gone one better. It's opened a filling station that sells hydrogen generated exclusively from solar power.

The hydrogen economy will have hugely positive macroeconomic effects as well. One of the most volatile inputs to the Australian economy is energy. Once the nation's energy supply is produced from highly-predictable, *flat price*, stable domestic sources, fuel price volatility will disappear. This will create more stable prices across the economy. Constant wasteful hedging of energy costs will become a thing of the past. With a wild card taken out of the inflation equation, monetary policy will be easier to conduct, in turn allowing the economy to operate at a higher 'speed limit' without worries about spurring inflation.

In blazing a path toward the hydrogen economy, Australia need only exploit her natural factor endowments. In the "National Hydrogen Study," Australian researchers estimated hydrogen could emerge as both a major vehicle fleet transportation and industrial power fuel in Australia by 2010, followed by passenger cars in the following years. Given that Perth is already running a hydrogen-powered bus, these forecasts are already looking conservative.

By using Outback-generated nuclear power and renewables to create both electricity and hydrogen, Australia gains flexibility and profit at every link in the energy value chain. In the "National Hydrogen Study," Australian researchers envisaged a combination of nuclear, fossil fuels and renewable energy sources for creating hydrogen during a transitional retooling of the global economy away from dirty fuels and toward cleaner energy supplies. The most aggressive Hydrogen Economy strategy would entail the need for 54,000 gwhs of electricity by 2030, or the equivalent of about 7,000 megawatts of generating capacity. As it happens, that's nearly exactly the amount of nuclear power plant capacity ANSTO says is necessary to ensure a viable domestic nuclear industry.

Table 1 Calculated Australian hydrogen demand by scenario and conventional energy equivalents

	2030			2050		
	Scenario			Scenario		
Possible demand	1	2	3	1	2	3
Million m³ H_2	18,002	10,800	6,611	42,050	25,206	11,797
Energy equivalents						
• Million m³ natural gas	5,254	3,152	1,929	12,272	7,356	3,443
• kilo tonnes black coal	6,943	4,165	2,550	16,217	9,721	4,550
• kilo tonnes brown coal	13,500	8,099	4,958	31,533	18,902	8,847
• GWh of electricity	54,004	32,398	19,832	126,143	75,614	35,389

Source: ACIL Tasman estimates

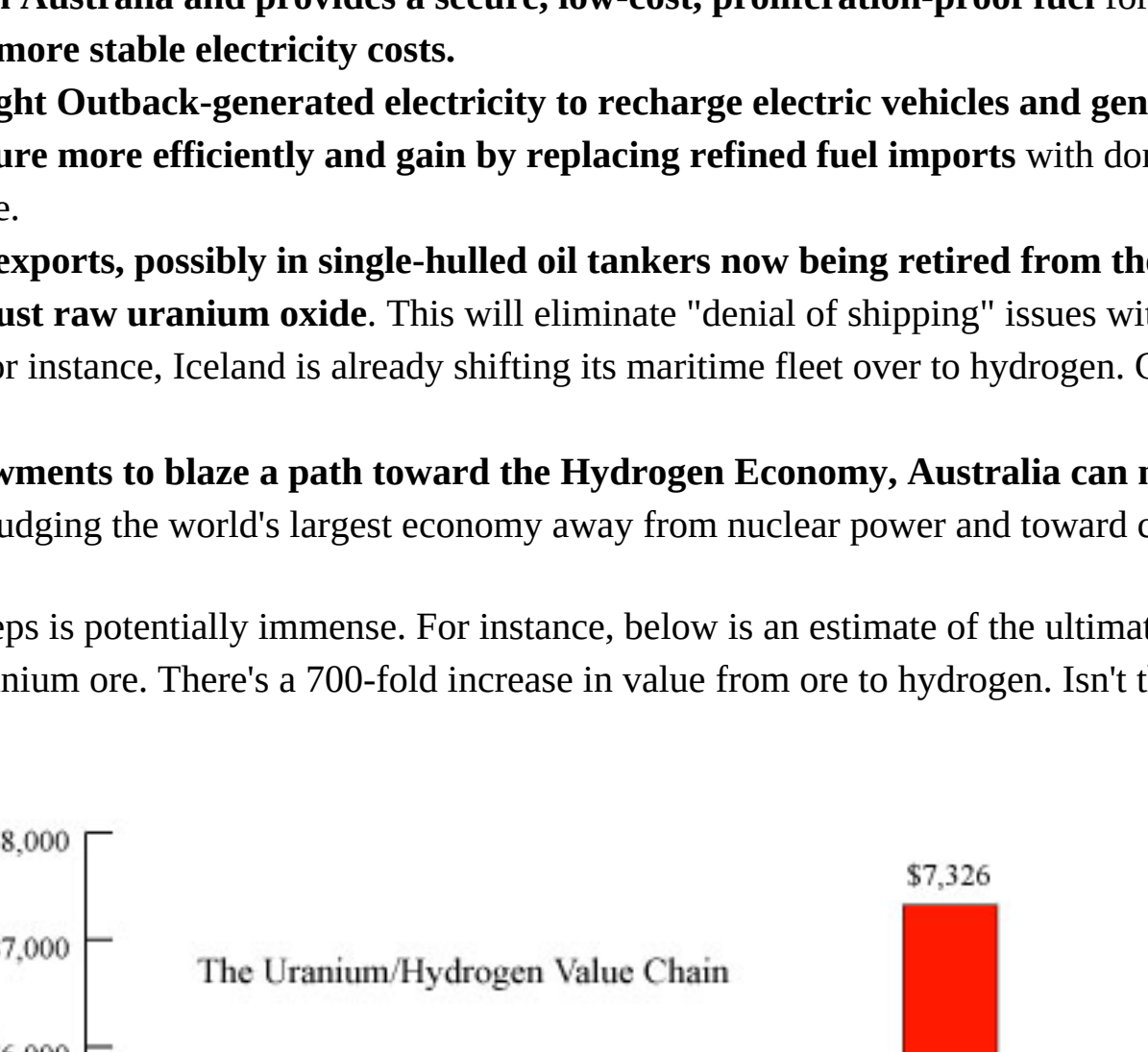
By using its own enriched uranium to generate power for urban consumption during the day and hydrogen creation at night, and in large volume, Australia can set itself up as a low-cost global producer of hydrogen. This will be due both to its unique factor endowments but due to its creativity in linking them altogether to create the highest-value output for sale on international markets. The possibilities are huge.

Consider this: supertankers routinely arrive in Australia's east coast ports laden with oil and oil derivatives from Singapore. Instead of *buying* refined oil products from other nations, why not *sell* them hydrogen? Reliable low-cost hydrogen from Australia could, by itself, spur de carbonization of the Chinese and Indian economies. Hydrogen could replace coal as Australia's greatest value energy exports -- putting it at the pinnacle of the global energy chain.

Here, once again, is the value chain:

--**If Australia engages in uranium enrichment, Australia pockets the profits.**
--**If that enriched uranium stays in Australia and provides a secure, low-cost, proliferation-proof fuel** for a domestic nuclear electricity generation, **Australia gains lower, more stable electricity costs.**
-- **If Australia uses surplus overnight Outback-generated electricity to recharge electric vehicles and generate hydrogen, Australia will operate its energy infrastructure more efficiently and gain by replacing refined fuel imports** with domestically-produced energy sources, improving her trade balance.
-- **If Australia pioneers hydrogen exports, possibly in single-hulled oil tankers now being retired from the global oil trade, Australia gains a higher value export than just raw uranium oxide**. This will eliminate "denial of shipping" issues with uranium. There are already templates for Australia to follow. For instance, Iceland is already shifting its maritime fleet over to hydrogen. Canada has experimented with hydrogen barges.
--**By using its natural factor endowments to blaze a path toward the Hydrogen Economy, Australia can match its resources and skills with the United State,** while also nudging the world's largest economy away from nuclear power and toward cleaner renewables.

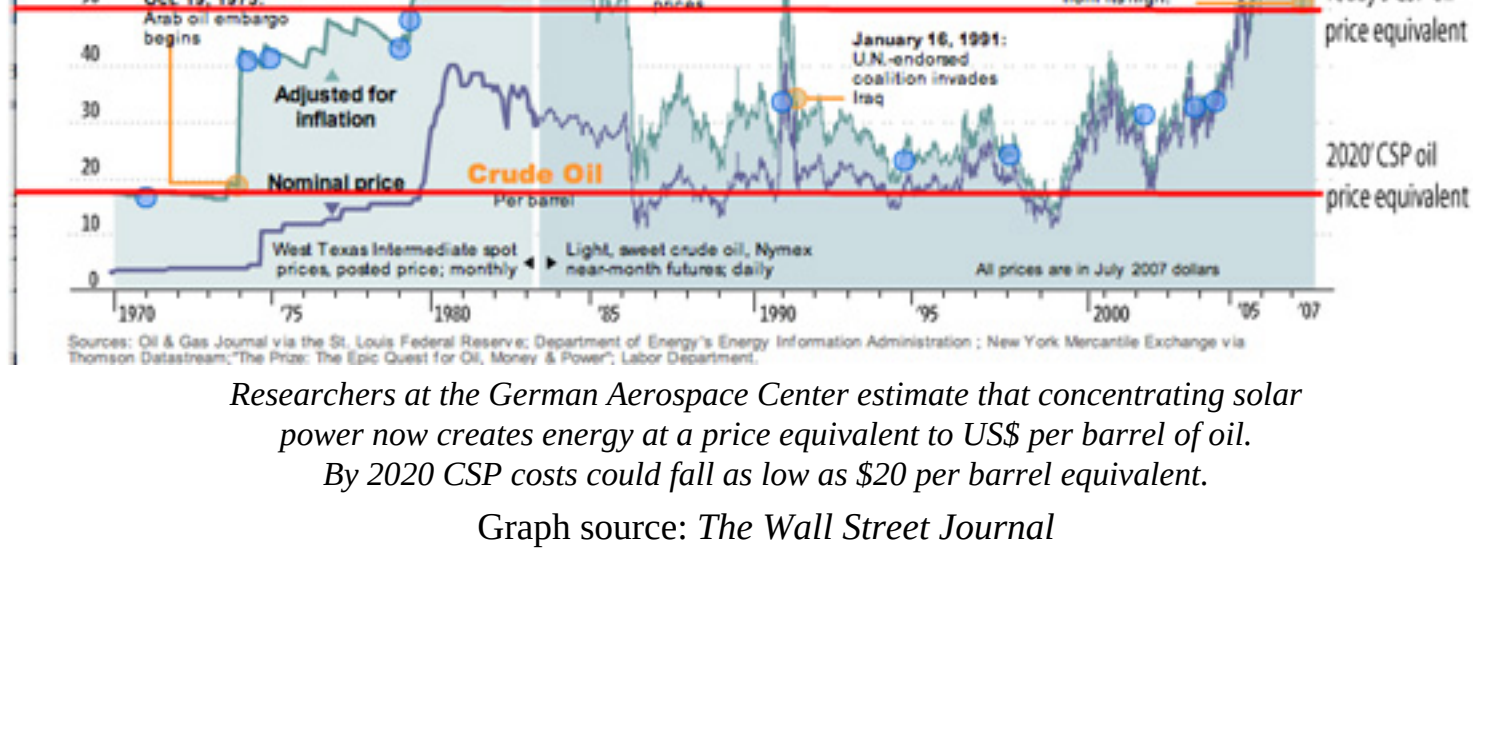
The extra value captured in these steps is potentially immense. For instance, below is an estimate of the ultimate value of hydrogen exported from Australia versus low-grade uranium ore. There's a 700-fold increase in value from ore to hydrogen. Isn't that value worth reaping at home?



Prices quoted are values derived from a single kilogram of uranium ore throughout the value-adding chain to hydrogen
Source: ASFEE

There's not just money involved, but geopolitical stability as well. Consider this: the United States is the world's largest importer of uranium. As an 'energy superpower' Australia could -- by channeling it's own efforts into closed-cycle nuclear power and hydrogen creation -- limit the globally aggressive tendencies of its big brother by selling it only value-added hydrogen, not uranium. This would greatly improve geopolitical stability by providing the US one less reason to start regional wars.

Over time, solar could replace nuclear as the prime hydrogen creation energy input. In fact, solar could prove cheaper than nuclear before 2017, the year of Australia's nuclear referendum. But whether it does or doesn't won't really matter if the infrastructure is in place to exploit whichever energy source is most efficient, cleanest and safest. The key is *flexibility*.



Researchers at the German Aerospace Center estimate that concentrating solar power now creates energy at a price equivalent to US$ per barrel of oil. By 2020 CSP costs could fall as low as $20 per barrel equivalent.
Graph source: *The Wall Street Journal*

"If renewable energy can be used to extract hydrogen from water, which can then be stored for later use, society will have a continuous supply of power. *The technology may appear expensive now, but so were the first cars and computers."*
Jeremy Rifkin, UK economist

"Use of existing natural gas pipelines for the delivery of pure hydrogen or mixtures up to 20-30% hydrogen is a possibility, particularly in the transitive stages of a hydrogen economy"
National Hydrogen Study, Australia

"As for hydrogen, we've demonstrated the efficiency of producing it at service stations. You take natural gas, convert it into hydrogen, and pump it into the car. The problem is that we're using natural gas, so you're back to hydrocarbons again, and that doesn't seem as good a long-term solution as, say, ethanol from nonfood crops."
Chevron CEO David O'Reilly

"Imagine how the hydrogen economy will change geopolitics. OPEC will no longer be a factor in foreign policy. *Relations with oil-producing nations will be based on common interests. The US will be free to promote democracy in countries like Nigeria, Saudi Arabia, and Iran. Bases in Saudi Arabia, Kuwait, and Qatar will be dismantled and naval forces in the Mediterranean and Persian Gulf sent home."*
Peter Schwartz, chairman, Global Business Network

"The software and communication revolutions have begun to increase productivity in every industry, their true potential is yet to be fully realised. That potential lies in their convergence with renewable energy, *partially stored in the form of hydrogen, to create the first distributed energy regimes."*
Jeremy Rifkin, president, Foundation on Economic Trends

Hydrogen pipelines exist in Europe and the USA. *These generally have a larger diameter than a natural gas pipeline and have to hold higher pressures. Therefore the cost of transporting hydrogen in pipelines is higher than that of natural gas.* ***However, in the transition to a hydrogen economy, some hydrogen can be mixed with natural gas and transported through natural gas pipelines.*** *As the fraction of hydrogen in a pipeline is increased, it may be possible to contain it by putting liners within existing natural gas pipelines.* ***For transporting 100% hydrogen, special hydrogen pipelines are required. The existing natural gas infrastructure is useful for this transition,*** *even if the pipes themselves cannot be used, because it already has established easements andaccess points, making up a significant part of the cost of the pipeline.*
WWF Australia, A Clean Energy Future For Australia

"No scientific breakthroughs are needed to achieve the reality of the Energy SuperGrid, *yet major technological innovations will be required to minimize environmental effects and maximize economic and societal benefits. DC, high power superconducting power transmission should become a viable technology that can be integrated with the existing AC power grid."*
National Energy Supergrid Workshop Report (US), 2002

"The Energy Supergrid proposal calls for supplementing the existing high voltage electric grid using superconducting DC cables for power transmission with liquid hydrogen used as the core coolant. The electric power and hydrogen would be supplied from nuclear and other source power plants spaced along the grid. *Electricity would exit the system at various taps, connecting into the existing ac power grid directly in the urban load centers. The hydrogen would also exit the grid, providing a readily available, alternative fuel, for fuel-cell based automobiles. Hydrogen could also be generated locally by electrolysis using the electricity supplied by the superconducting cables."*
National Energy Supergrid Workshop Report (US), 2002

"If deliberate sabotage and terrorism remains a significant risk, many of the major elements of the SuperGrid could be placed underground or subsurface, easing the problem of protection and increasing security. *Certainly such underground siting would be required in many urban areas. At the same time, the distributed energy components also add to the robustness and reliability of the Energy SuperGrid."*
National Energy Supergrid Workshop Report (US), 2002

Natural Gas

Natural gas is a wonder fuel. Nuclear and coal-fired power plants need to be run constantly to run efficiently. By contrast, natural gas can be switched on and off quickly. It's an attribute that few other energy sources enjoy with the exception of hydro. As a result, it should be used primarily as a load-balancing energy source in a future electricity grid increasingly marked by fluctuating renewables.

To waste natural gas on providing base load power is a bit like squandering the talents of an gifted orchestra conductor by having him play the French horn, and nothing else. Encouraging the use of natural gas (and coal seam methane) as a primarily a load-balancing energy source rather than a base-load energy source is another economic reform that's needed in the Australian energy market.

The benefits will be many. First, Australia will gain a more robust energy system during the transition period away from dirty fossil fuels by having abundant natural gas as a backup fuel spread widely across the system and ready to be switched on at short notice. Second, by properly economically valuing this critical load-balancing characteristic of this fuel, it eliminates the current undervaluation of gas, and thus increases economic transparency of prices. Third, natural gas producers and generators stand to make *more* money from *less* gas by progressively targeting their energy resource toward peak power markets, which are less frequent but much more lucrative than base load markets. Fourth, by exploiting renewables and concentrating gas on load-balancing, increased supplies of natural gas (and coal seam methane derivatives) can be exported, offering a double benefit in the fight against global warming. That's because Australia itself will use less fossil fuel, while the countries that in turn import the additional internationally-traded gas supplies will similarly lower their greenhouse gas emissions since natural gas can supplant coal in countries without Australia's abundant wind, solar, geothermal and other renewable resources.

9 Gas fired electricity generation, by state

	Generation			Annual growth	
	2001-02	2008-09	2019-20	2001-02 to 2008-09	2001-02 to 2019-20
	TWh	TWh	TWh	%	%
New South Wales a	2.1	3.1	5.7	5.9	5.8
Victoria	2.1	3.6	6.8	7.9	6.8
Queensland	3.1	9.4	12.4	17.2	8.1
Western Australia	13.6	17.9	27.2	3.9	3.9
South Australia	7.5	9.2	12.4	3.0	2.8
Tasmania	0.0	0.6	0.9	–	–
Northern Territory	2.1	2.8	3.8	3.8	3.3
Total	30.5	46.5	69.3	6.2	4.7

a Includes the Australian Capital Territory.

Australia should find ways to reduce gas use going forward...

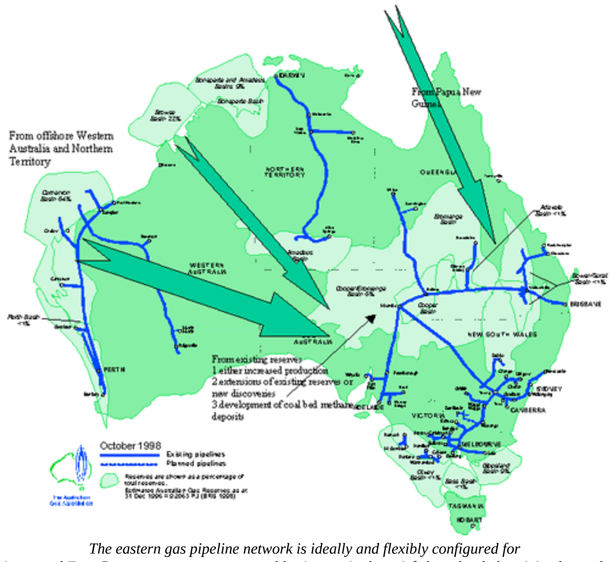
Source: ABARE

..and direct it to exports

Source: ABARE

What's doubly intriguing here is that increased export receipts from gas could help underwrite domestic investment in renewables. This would create a double-benefit for Australia. First, it would get a discounted renewable energy infrastructure built through the proceeds of foreign trade today. Then, in 30 years time, it would get a second export opportunity through advising other nations how to build out *their* eventual shift to renewables.

At present, most of Australia's gas from the northwest shelf is already exported. Future exports of gas, assuming the fuel doesn't emerge as the low-cost input to hydrogen creation, could come via the existing eastern gas pipeline infrastructure as renewables satisfy an increasing amount of Australia's energy needs, leaving the gas to be exported through the pipeline terminus ports of Brisbane, Sydney and Melbourne to huge markets like China.



The eastern gas pipeline network is ideally and flexibly configured for increased East Coast gas exports as renewables increasingly satisfy base load electricity demand.

Exports: Global Grid

Once again, dream a little. Australia is smart. Australia catches on to the global tide of post-industrial economic reconstruction centered around clean energy. Thanks to Outback power from solar, geothermal, nuclear and wind, waves and other technologies, Australia is an "energy superpower." It's creating more power than it needs and in many transmutable forms: electricity, hydrogen, heat. Being in this situation, Adam Smith's theory of comparative advantage argues Australia would be smart to export this surplus. If it does, there'll be plenty of takers. Energy runs the global economy. That's not about to change.

Just as fiber optic cables connected the world with ubiquitous communications and dropped the cost of a phone call from expensive to negligible, the same thing can and will happen with power. Remember domestic electricity "price separation?" Energy price separation also happens globally because domestic markets are largely disconnected. Low cost power can't flow to high-priced markets. For the true flowering of the clean energy age to occur, , the world needs an interconnected energy market to levelise prices. This is already happening. Supertankers and gas pipelines are examples of it. What's needed is something more ambitious: a global electricity/energy grid.

This idea has been pushed for years by an outfit called GENI -- the Global Energy Network Institute. Consider the impacts at the Australian level of connecting its clean energy supplies to the world, just as Tasmania is linked to Victoria through the Basslink cable and the eastern Australian electricity market could be unified through building power lines from Olympic Dam to Brisbane.

The first port of call for such an energy export pipe would be to Australia's north, to Indonesia, just as the Overland Telegraph connected Australia to the world in the 19th Century. Indonesia needs the power. Indonesia is now considering building nuclear plants along geologici fault lines directly north of Australia. It wants Australian expertise to build them. Is this smart? Rather than sell low-profit uranium and one-off nuclear expertise to a country with sloppy safeguards and a militant Muslim fringe, wouldn't it make more sense to export a lucrative perpetual annuity of higher priced electricity? This would make Indonesians safer and Australians richer. It would also enable Indonesia to concentrate on geothermal. This is an area where Indonesia has a distinctive comparative advantage, instead of nuclear, where Indoneisa has comparative disadvantages too numerous to mention.

Just as global telegraph cables gave rise to global telephony which in turn gave rise to global waves in interchanged data, and just as dirt tracks gave rise to country roads which in turn became freeways, so global energy cables can similarly revolutionise production and consumption of global electricity.

How to start? Through building a Basslink-style underwater electricity cable to Indonesia. Over time, other markets can be connected. This will drive economies of scale. The replacement cycles of fiber optic cables and energy cables will eventually coalesce, allowing both sets of infrastructure to be replaced on the same cycle, saving money.

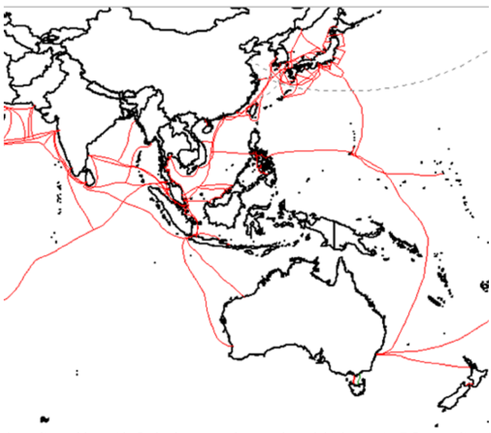
"A global energy network makes enormous sense if we are to meet global energy needs with a minimal impact on the world's environment."
Al Gore,
environmental activist.

***"I want to see an energy freeway between Australia and East-Asia where we are supplying needs that a growing East-Asia will have. This is an enormous opportunity for Australia** but it is important for these countries. They are going through with China, massive industrialisation, they need to be assured that they are going to get energy. "*
Peter Costello,
Treasurer of Australia, 1996-2007

"The current Australian Government came to office with a new commitment to seek to be much more active... as a nation on nuclear non-proliferation and disarmament matters."
Stephen Smith,
Foreign Minister, Australia

"The nation faces serious long term challenges which go well beyond the normal electoral cycle. We want to make sure that in rising to those challenges that we bring forth and summon forth the best ideas available across our country."
Kevin Rudd,
Prime Minister, Australia

"If you expand Australia's uranium exports, then you not only give the world greater flexibility and options to deal with climate change, but you also help offset the cost of the structural adjustment that Australia would face."
Michael Angwin, executive director,
Australian Uranium Association



Australia could provide Outback generated power through high capacity DC power lines laid along fiber optic subsea pathways, pictured above

Consider the hypothetical energy reserves that could be unleashed. A concentrating solar power farm in central Australia 800 kilometers on a side would be enough to satisfy the entire world's primary energy demand. Yes, primary energy demand. That's everything from electricity to all transport fuels and on down to firewood -- for the whole world.

The amount of sunshine falling on Central Australia could power the entire world's energy demand. A far smaller area could satisfy all Australia's power needs.

Source: German Aerospace Laboratory

Parabolic trough concentrating solar power

Dish concentrating solar power

Concentrating solar power towers

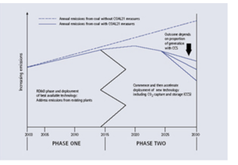
About ASFEE
Contact ASFEE
at info@asfee.org

What About Coal?

In any future energy market characterised by carbon prices, innovation and a competitive playing field, coal is a loser. This explains why the coal industry fights energy market reform and carbon taxes with such ferocity.

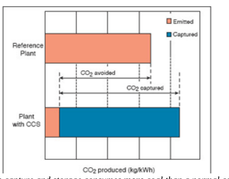
In an energy marketplace dominated by cheaper, cleaner renewables, $100 billion of existing coal industry assets has highly questionable value. Maintaining that value is the coal industry's sole concern. But should it be society's? Since the Industrial Revolution, the coal industry has shifted hundreds of billions of dollars in climate liabilities to the public sector. Should it be given another half-century sinecure to continue 'business as usual?' Economics argues no.

In addition to safeguarding its balance sheet, the coal industry has another reason to love carbon capture and storage. Carbon capture and storage coal-fired power plants consume 25-35% more coal to get the same electricity output as non-carbon capture plants. For the coal industry, what could be better? For society, what could be worse? Carbon capture and storage means *more* greenhouse gases emitted at the coal face. Carbon capture means *more* greenhouse gases emitted in transit. That's a perverse outcome.



Carbon capture and storage won't even be ready until 2015, if then

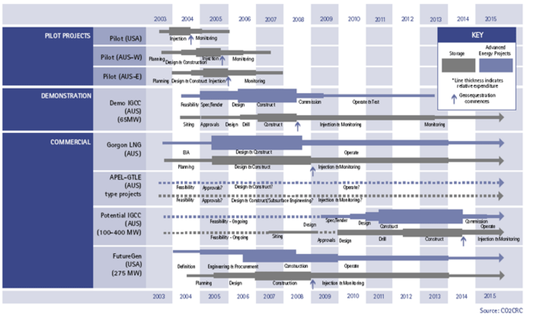
Source: "Coal 21 National Action Plan" *Coal 21*



*Carbon capture and storage consumes **more** coal than a normal coal power station*

Source: "Special Report Carbon Dioxide Capture and Storage," *Intergovernmental Panel on Climate Change*, 2005

The coal industry's climate change action plan is known as "Coal 21." It suggests that by 2015 the industry ***might*** be ready for a carbon capture and storage technology roll out. That's practically 10 years from now *if* the timetable is met, and there's no assurance it will. For instance, America's US$1 billion Futuregen carbon capture project was supposed to be operational in 2009. That date was later pushed back to 2013. It's now been cancelled. And Futuregen was just a *test* plant.



Most carbon capture and storage projects are lagging badly on the optimistic projections given for their deployment

Source: Coal21

***"The value of coal-fired power stations is dropping now by the day**. It's possible some people will be prepared to pay nothing for some of them in 10 years' time."*
John Boshier, National Generators Forum director

"(Clean coal) It is a furphy, a pork pie to cover up the fact that there is no such thing as clean coal."
Karl Kruszelnicki, ABC commentator

"The sequestration has its limitations; the capture of the CO2 has limitations, and it's never totally clean anyway."
Professor Kurt Lambeck, geophysicist, Australian National University; president, Australian Academy of Science

"They couldn't get the project (Zerogen -- a clean coal proposal) to stack up - it was too expensive."
Ian Macfarlane, Australian Industry Minister, 1996-2007

"Flinders Power is cautious as to the implementation of an emissions trading scheme given its potential to detrimentally impact the asset value of our "
Flinders Power, Submission, Prime Ministerial Task Group on Emissions Trading

*"I don't think you can sustain shareholder value unless you take climate change as part of the jigsaw. **Customers will not buy from, and staff will not join "***
Rod Eddington, Former Chief executive officer, British Airways

"There is no clean coal. There's cleaner coal but there is no clean coal."
Harry Reid, US Senate Majority Leader

***"There is no tradition in Australia for compensating capital for losses associated with economic reforms of general application.** The business community has been aware of the risks of carbon pricing for many years. **There is, however, both Australian precedent and a rationale for structural adjustment assistance to workers**, communities and firms whose established incomes, employment and patterns of life are disrupted by reforms.*
Garnaut Report

Even if carbon capture and storage were credibly on schedule and potentially cost competitive, there's a third problem with it. Australia's major coal-fired power centres like the Upper Spencer Gulf and New South Wales' Hunter Valley are unsuited to carbon capture and storage. These two regions account for 40% of the nation's coal-fired power. Carbon capture plants in those two locations could capture CO2, but they couldn't store it. As a result, Huge pipelines would have to be built to ship the carbon to geologic storage sites in Victoria or the Bass Strait. But that would add as much as 25% to the already-high cost of carbon capture. The diseconomies multiply.

Dark areas represent carbon sinks of which few exist in eastern Australia outside Victoria

Source: "Special Report Carbon Dioxide Capture and Storage," *Intergovernmental Panel on Climate Change*, 2005

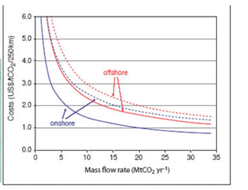
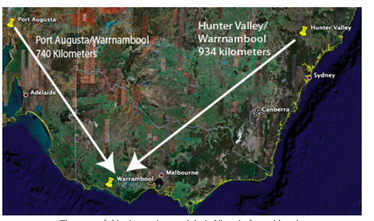


Figure TS.5. Transport costs for onshore pipelines and offshore pipelines, in US$ per tCO_2 per 250 km as a function of the CO_2 mass flow rate. The graph shows high estimates (dotted lines) and low estimates (solid lines).

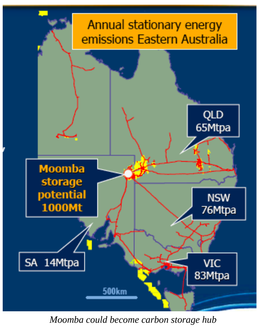
Shipping CO2 from Queensland, NSW or South Australia to Victoria would be prohibitively expensive

Source: "Special Report Carbon Dioxide Capture and Storage," *Intergovernmental Panel on Climate Change*, 2005



The costs of shipping carbon to sinks in Victoria from either the Hunter Valley of New South Wales or the Upper Spencer Gulf of South Australia will be prohibitive

This problem is already looming in Western Australia. There, efforts to build a so-called clean coal plant near Perth look to be foundering on the absence of suitable carbon storage sites. One possibility, of course, is to sequester the carbon around Moomba, for which electricity, hydrogen and natural gas power line and pipeline infrastructure could then be exploited to backhaul carbon from clean coal plants in Victoria and New South Wales if carbon capture proves safe and economic.



Moomba could become carbon storage hub

Source: Santos

Another problem haunts carbon capture and storage: where will the plants be located? There's near universal agreement among experts that carbon capture and storage is best suited to new coal-fired capacity, and retrofitting it to existing capacity is uneconomic. Should old coal-fired power plants be torn down and new ones put up in their place? That would create a several-year capacity gap as old coal-fired capacity is taken offline and torn down and new capacity built in its place at a time when Australia's annual energy needs are rising. Given this, a carbon capture and storage rollout based upon replacing existing coal-fired capacity on a brownfield basis could actually worsen Australia's electricity shortage in the short- to medium term. Conversely, if new carbon capture and storage plants are built on greenfield sites, that will create negative environmental effects through *doubling* the deleterious land footprint of coal-fired power plants in Australia. It would also require costly new investment in power line infrastructure to serve the new plants. And if the Australian government is going to subsidise this cost of hookup of new coal-fired capacity, why shouldn't it do the same for cleaner, cheaper, more rapidly-available solar and geothermal capacity in the Outback.

Elsewhere in the world, the compelling negative economics of coal-fired are leading to cancellations of planned new capacity. In late January, the United States announced it would not be funding the largest clean coal effort of them all, Futuregen. Given this, the whole future of CSS looks to be in something of a state of limbo.

Contact ASFEE
at info@asfee.org

Carbon taxes

	Emissions Mt CO_2-e[a]		Per cent change in emissions
	1990	2004	1990 - 04
Australia's Net Emissions	**551.9**	**564.7**	**2.3**
Energy	**287.5**	**387.2**	**34.7**
Stationary Energy	195.7	279.9	43.0
Transport	61.7	76.2	23.4
Fugitive Emissions	30.0	31.0	3.4
Industrial Processes	**25.3**	**29.8**	**18.0**
Agriculture	**91.1**	**93.1**	**2.2**
Land Use, Land Use Change and Forestry [b]	**128.9**	**35.5**	**-72.5**
Waste	**19.2**	**19.1**	**-0.7**

(a) Carbon dioxide equivalent, CO_2-e, provides the basis for comparing the warming effect of different greenhouse gases.
(b) 2004 estimate is interim only and will be revised with the next update of the inventory.

Given that Australia emits 565 million tonnes of greenhouse gases per year, a $40 per tonne carbon levy will raise roughly $24 billion dollars. This money could ease the friction of positive change. Dismantling another $8 billion of existing fossil fuel subsidies would bring the amount to $30 billion. In addition, Australia has been spending roughly $600 million per year in Iraq, a geopolitical morass caused at least in part by the need to secure oil supplies. Redirecting government expenditure away from seat-of-the-pants efforts to cope with effects (political instability in oil producing regions) rather than causes (excess consumption by importing countries) would help Australia move away from fossil fuels in to cleaner, more stable energy sources.

If the coal industry generates 175 terawatt hours a year at a wholesale price of 3.5 cents, a gross undercounting -- that means the revenues derived from this are on the order of A$6 billion. This is an intriguing figure for two reasons. First, that amount is roughly equal to the government subsidies the industry gets. Secondly, the figure is dwarfed by the $36 billion worth of market distortions a carbon tax, a more efficiency energy supply system and abolition of current coal subsidies would eliminate -- creating a massive net gain to the economy. In fact, the 'net' gains would be so large the nation could afford to 'buy out' the coal industry (ie *pay it to remain idle as reserve capacity*) several times over -- each year.

"Long-term ***business certainty can be improved through a long-term, stable carbon price signal.****"*
BHP Billiton, Submission, Prime Ministerial Task Group on Emissions Trading

"A (emissions trading) scheme should allow the flexibility to accommodate substantially increased Australian exports of low emission fuels to world markets*, which would have a net beneficial effect on the environment."*
BHP Billiton, Submission, Prime Ministerial Task Group on Emissions Trading

"The burden associated with ***carbon costs will not necessarily fall on those industries in which greenhouse gas emissions occur because associated costs can flow upstream and downstream*** *to suppliers and customers as pricing arrangements are revised."*
BHP Billiton, Submission, Prime Ministerial Task Group on Emissions Trading

"The more we are able to directly engage in trade on emissions reduction credits with countries like China and India, the lower the short term cost of reducing emissions may be in Australia. *The net outcome will be a better global environmental result."*
BHP Billiton, Submission, Prime Ministerial Task Group on Emissions Trading

"Suppression of export demand for coal and some other commodities is expected under any global approach based on binding national emission targets."
BHP Billiton, Submission, Prime Ministerial Task Group on Emissions Trading

"Achieving these (climate change) technological solutions *on a large scale, however,* ***will require an aggressive global technology policy****. First, there will have to be market incentives to avoid emissions, in the form of either* ***tradable permits or levies****. A reasonable levy might be US$25 per ton of emitted carbon dioxide, introduced gradually over the next 10 to 20 years.* ***Second, there will have to be ample government support for rapid technological change.*** *Patents can help spur private market research and development (R&D), but* ***public funding is required for basic science as well as for the public demonstration and the global diffusion of new technologies.*** *In sum, we need a strategy sometimes described as RDD&D.*
Jeffrey D. Sachs, Earth Institute, Columbia University, New York

"CCS still promotes a fossil-fuel economy. *We can't be giving public money to oil and coal companies to help them use more oil and coal."*
Rebecca Harms, vice-chair, Greens/European Free Alliance, European Parliament

"There is no point in simply having a high price for carbon without the technological capacity to respond *to the impact of that price."*
Mitch Hooke, chief executive, Mining Council of Australia

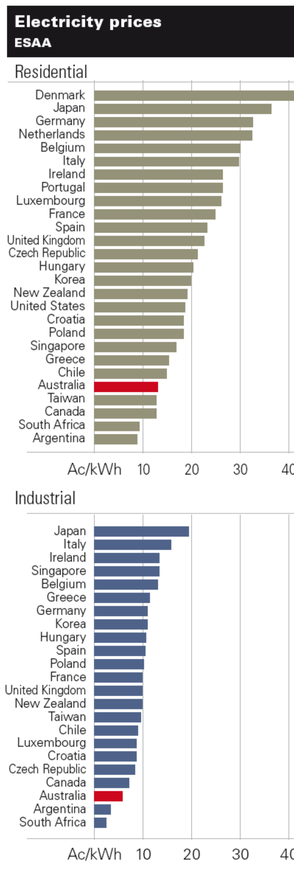
8 Electricity generation, by fuel

	Generation			Annual growth	
	2001-02	2008-09	2019-20	2001-02 to 2008-09	2001-02 to 2019-20
	TWh	TWh	TWh	%	%
Black coal	125.7	142.4	185.3	1.8	2.2
Brown coal	48.3	52.4	59.4	1.2	1.2
Oil	2.3	2.3	2.4	0.3	0.3
Natural gas	30.5	46.5	69.3	6.2	4.7
Renewables	17.2	25.3	27.5	5.7	2.6
– hydro	15.9	17.3	17.8	1.3	0.6
– biomass	0.7	4.1	4.1	28.1	10.1
– biogas	0.3	1.5	1.5	24.1	8.8
– wind	0.3	2.4	4.1	35.3	15.9
Total	224.1	269.0	343.9	2.6	2.4

Australia should encourage much more aggressive use of renewables to replace fossil fuel generation over the coming decades

Paying the coal industry not to produce power reduces greenhouse gases, shifts the power industry to renewables and *extends the life of Australia's current coal fired power plants*, thus making them available to meet future excess demand. In other words, idling current coal fired power capacity creates an insurance policy. These plants could be reintegrated to the grid on a as-needed basis to provide both base load and peaking power. It would also ease the way into retirement of the plant by stretching their lifespans until carbon capture plants can prove their worth, if they can.

The Howard government white paper "Securing Australia's Energy Future," claimed low energy costs were a source of economic strength for Australia. That's a bit like saying heroin makes a junkie healthy. When the junkie has his fix, he may temporarily *look* healthy -- but this is short short-lived and unsustainable. A far better strategy is to encourage efficiency (ie get off the junk) instead of rely on palliatives (ie more heroin). Efficiency in all respects makes the economy stronger. A $40 per tonne carbon tax would raise electricity prices by about 4c/kwh. But even a 4c/kwh rise in electricity prices in Australia would still leave the country with low power prices compared to elsewhere, and well more than 4c/kwh below countries such as the United States and UK. If, indeed, low cost energy are such a source of competitive advantage for Australia, then according to the chart below Australia's main economic competitors are Chile, Greece and Croatia. That's simply not the case.



In economics, there's a theory that says "protect the workers, not the industry." What this means is that, in order to grease the wheels of positive change, government should assist workers in obsolete industries adapt to change, and not help obsolete industries stay afloat artificially. With carbon taxes, the government could fund redundancy packages for coal industry workers nearing retirement, fund transitory income support and training programs for workers still in their prime, and also fund a smaller coal electricity-generation industry in which the goal is to produce peaking power to meet surplus summer demand, rather than operate to provide base load power.

How Might It Be Paid For

Everyone realises electricity will be more expensive in the future than it has been in the past. But consider this, with $18 billion in carbon taxes coming in, $8 billion in eliminated fossil fuel subsidies and an estimated $1.3 billion of deadweight electricity network losses eliminated through update infrastructure, the friction of positive change can be softened immensely. Want some numbers? Those three numbers add up to $28 billion per year. However, a better way to look at it is that $28 billion is the cost we now pay now for bad market policies. As a result, fixing this will *give* us $28 billion. In 2004-2005 Australia collected $162 billion in national income tax. By straightening out the nation's energy industry, the $28 billion in revenue achieved (through carbon taxes collected and existing subsidies ended) would be enough to fund a 17% across the board national income tax cut.

Contact ASFEE
at info@asfee.org

"South Australia is the new Kuwait of renewables."
Dr. Tim Flannery, Author

***"The eyes of the world are on geothermal exploration activity** now going on in SA."*
Joan Kuche, chief executive, South Australian Chamber of Mining

*"By ramping up its purchase of green power, **the Government will encourage demand for renewable energy,** which should lead to greater installation of sustainable energy generators."*
Mike Rann, SA Premier

South Australia

Most of South Australia's electricity generation capacity is based in the south of the state, near Adelaide. There, gas-fired power plants satisfy most demand and also help offset growing amounts of wind power, the highest percentage in the nation.

But at the northern tip of the Upper Spencer Gulf, just south of Port Augusta, two relic coal-fired power plants cling to life. They produce power the dirtiest way possible. The two culprits are the 520MW Northern and the 240MW Playford. Both of these plants brown coal, emitting roughly 1.5 tonnes of greenhouse gas per megawatthour. That ranks them among the dirtiest in the world, and the most expensive to operate on any carbon-adjusted basis. The Playford, built in 1960, is the oldest coal-fired power plant in Australia.

Station	State	Type	Marginal costs $/MWh	Including $30/tCO2 $/MWh	Emissions tCO2/ MWh
Loy Yang A	Vic	Brown coal	3	42	1.30
Yallourn W	Vic	Brown coal	4	45	1.37
Hazelwood	Vic	Brown coal	4	48	1.47
Loy Yang B	Vic	Brown coal	5	42	1.23
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Millmerran	Qld	Black coal, supercritical	10	37	0.90
Callide C	Qld	Black coal, supercritical	10	34	0.80
Tarong North	Qld	Black coal, supercritical	11	35	0.80
Callide B	Qld	Black coal	11	39	0.93
Stanwell	Qld	Black coal	11	38	0.90
Tarong	Qld	Black coal	12	40	0.93
Bayswater	NSW	Black coal	12	39	0.90
Mount Piper	NSW	Black coal	13	38	0.83
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Vales Point	NSW	Black coal	14	40	0.87
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Gladstone	Qld	Black coal	14	41	0.90
Callide A	Qld	Black coal	14	46	1.07
Wallerawang	NSW	Black coal	15	42	0.90
Munmorah	NSW	Black coal	15	43	0.93
Northern SA	SA	Brown coal	16	50	1.13
Anglesea	Vic	Brown coal	16	57	1.37
Collinsville	Qld	Black coal	17	51	1.13
Newport	Vic	Gas	31	49	0.60
Thomas Playford	SA	Brown coal	33	78	1.50
Smithfield	NSW	Combined cycle gas	34	48	0.47

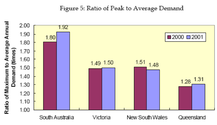
The Northern and Playford are two of the nation's dirtiest coal fired power plants
Source: "Greenhouse Gas Issues Within Australia's Electricity Industry," *Institute of Actuaries of Australia*, 2003

Both the Northern and the Playford must be retired, and the sooner the better. Apart from the punitive economics carbon pricing will place on them, their brown coal supplies from Leigh Creek are expected to dry up within 15 years.

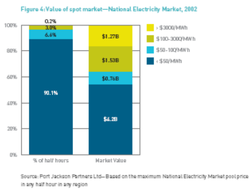
In mid July 2006, *Adelaide Thinker in Residence* Stephen Schneider, a Stanford University climatologist, suggested making a virtue of necessity. He suggested northern South Australia become a showcase of renewable energy: solar and geothermal. The high capacity power lines connecting Port Augusta to Olympic Dam and to Leigh Creek pass through some of the nation's most promising areas for generating concentrating solar power and geothermal. By adding large amounts of renewable solar and geothermal to its existing portfolio of wind power, South Australia could meet its ambitious greenhouse gas reduction targets.

And if such a conversion to renewable energy were made quickly in order to *conserve* and *extend* the Leigh Creek coal supplies, it would be even better for the state. The reason is that the Northern and Playford, instead of being taken completely offline, could be used to provide peaking power. Yes, it *would be* dirty peaking power. But it would be peaking power nonetheless. South Australia -- as well as the nation as a whole -- has a strong need for peaking power. The Northern, Playford and other "well-past-their-use-by dates" coal-fired power plants could provide this power as an insurance policy as they are progressively taken offline and replaced with cleaner capacity.

Intriguingly, this could even end up making more money for the coal-fired plants than they make now. The reason is that their costs would be cut (through more infrequent operation) at the same time as their revenue per kilowatthour produced skyrockets because peaking power prices are multiples of base load power. The chart below left shows that South Australia has the nation's highest ratio of peak to average electricity demand. A mere two percent of the annual half-hour spot market periods in the National Electricity Market yields 15% of the revenue. By using aging power plants for high-priced peaking, it would pay to keep them on line until the national electricity generation system can completely switch over to cleaner sources of energy.



South Australia has the nation's most volatile electricity prices as measured by the ratio of peak to average demand
Source: "A Transmission Network to Power South Australia," *ElectraNet SA*, 2002



The very high electricity prices than can be reached during peak power represent a disproportionate amount of market value. Reducing these peaks would reduce power costs across the board.
Source: "Securing Australia's Energy Future," *Office of Prime Minister and Cabinet*,2004

South Australia has huge amounts of wind, solar and geothermal waiting to be exploited. If Australia has to the potential to be an energy superpower, South Australia has the potential become its premier energy sultanate. And it can do this merely by following the advice of its own one-time *Adelaide Thinker in Residence*, Stephen Schneider. In his 2006 report to Mike Rann, Prof. Schneider recommended the below.

Over the next generation South Australia will be faced with a number of important decisions around energy supply. Leigh Creek, your only coal mine and the fuel source of the Port Augusta power station, is due to run out; the expansion of the Olympic Dam mining operation at Roxby Downs will greatly increase the energy demand in the State, as will the underlying growth implicit in your population target.

The important principle here is that in meeting these changing demands we do not repeat the mistakes of the past. We now know the sustainability implication of carbon-intensive dependence. As a consequence, when there is significant new, long-lived energy infrastructure to be built we must ensure that it is low-emission and sustainable.

Hubs of renewable energy and low-emission technologies

To help supply the State's future energy demand I am proposing that the State investigate the idea of Power Parks, or hubs of renewable and low-emission technologies. These Parks would potentially be established in regional areas where they could, to the extent feasible, combine solar, wind, geothermal, and carbon capture and storage (CCS) technologies.

The benefit of combining these renewable and low-emitting sources in a single geographical location would be that an economy-of-scale would be created, ensuring that the often-prohibitive cost of infrastructure, particularly transmission lines, could be shared between the proponents. Proponents could also share their cost of connection to the grid.

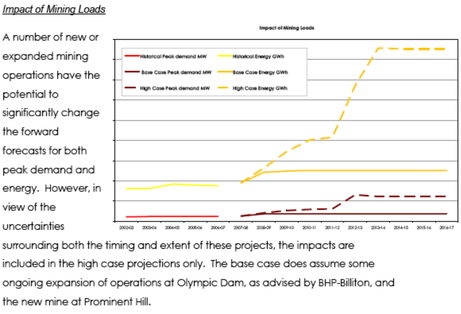
Not only would the Parks provide a significant reduction in the greenhouse intensity of your State's energy supply, but they would help showcase the State as a centre for innovation and renewable energy development.

Regional communities would benefit from the increased opportunities and investment that would result. And for successful participants – those who have made these Power Parks work through a learning-by-doing approach – significant business opportunities would result. These people would then hold the intellectual capital on this idea, not to mention the technological capacity. If successful, this could be a model program that the State could export. The learning-by-doing so gained is marketable, particularly as increasingly stringent standards are implemented on carbon emissions all over the world and shadow prices on carbon escalate. Early learners will have many later customers for their skills!

The South Australian Government could bring participants to the table, coordinating efforts to find the least-cost infrastructure solutions for Power Parks.

Power parks could create a second life for regional areas with declining fossil fuel industries
Source: Climate Change and Opportunities, Stephen Schneider

For its part, the electricity needs of Olympic Dam represents the perfect test case of Premier Rann's seriousness about greenery. That's because the Olympic Dam mine already consumes a sizeable portion of the state's electricity, and Olympic Dam's electricity needs are expected to quadruple due to its expansion. As has been outlined earlier in this report, this represents an ideal opportunity to make Olympic Dam and nearby Moomba the center of a national energy network.



Impact of Mining Loads

A number of new or expanded mining operations have the potential to significantly change the forward forecasts for both peak demand and energy. However, in view of the uncertainties surrounding both the timing and extent of these projects, the impacts are included in the high case projections only. The base case does assume some ongoing expansion of operations at Olympic Dam, as advised by BHP-Billiton, and the new mine at Prominent Hill.

The power needs of Olympic Dam are huge

Source: "Annual Planning Report 2006," ETSA

This network could include solar from the Outback, wind from the Nullarbor, nuclear from the Woomera Prohibited Area and hydrogen made from nuclear energy, renewables and natural gas in a fully flexible fashion that ensures that the market picks the long-term winner.

This kind of strategy also ensures that South Australia benefits from more capture of the value-creation process, now subject of a verbal tussle between Mike Rann and BHP.

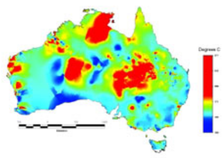
If South Australia presses its advantage in wind, solar, nuclear energy and gas -- it could become rich indeed.

Queensland

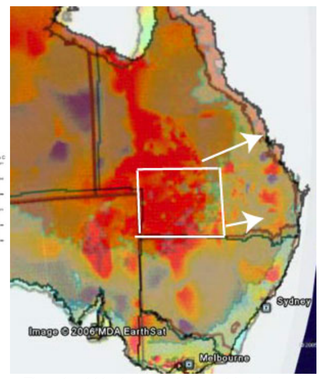
Queensland has large coastal urban consumption centers and a sunny, geothermally active western hinterland. It also has a relatively young set of coal-fired power plants for which replacement is not as pressing as elsewhere. It also has an electricity grid that stretches far inland in the south and is ideal for hooking up to South Australia.

The first step would to be work toward progressive sidelining of the 500MW Swanbank B power plant, followed by the 1,665 MW Gladstone plant and replacing them with replacement energy sources. These are not hard to find. In addition to hydro and biomass in the north, Queensland also has massive geothermal and solar energy potential. Geothermal prospecting is currently underway in the west of the state in areas suitable for solar power. Colocation opportunities for solar energy abound. The situation is particularly attractive since many of these colocation opportunities are located right along a desirable route for power lines between Moomba/Olympic Dam and Brisbane.

Western Queensland has lots of sun

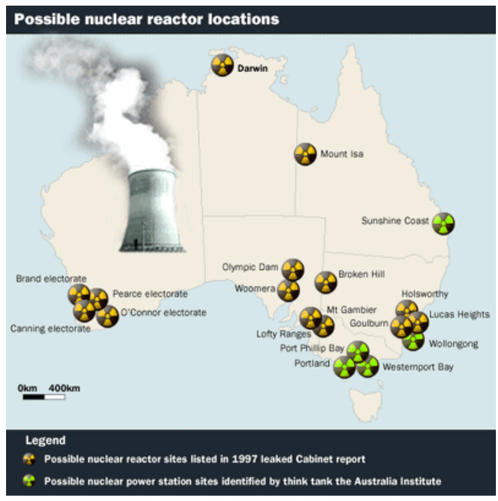


Southwestern Queensland has abundant geothermal



They should be harvested in combination and shipped to the state's east coast population centres

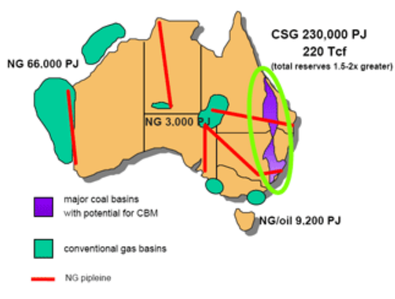
Mining town Mt Isa has been suggested as another location where nuclear power could be generated. Given this, Australia could split its bets with nuclear, building a second set of nuclear plants at Mt Isa to provide electricity for northern Queensland and hydrogen for transport and export and burying nuclear waste in the abundant Outback surrounding the town. Scarce nuclear expertise could be shuttled between the two locations.



Mt Isa in the past has been considered as a suitably "out the way" place for nuclear power

Source: Sydney Morning Herald

Lastly, Queensland has large supplies of coal seam methane gas, a "free lunch" energy source there for the taking. Existing pipeline infrastructure connects many of the potential coal seam methane production areas in the state to large urban centres such as Gladstone and Brisbane.



Queensland has sunshine, geothermal, gas and coal seam methane energy resources

Source: *Techno-Economic Assessment of Power Generation Options for Australia,* Cooperative Research Centre for Coal in Sustainable Development, 2006

Many of these resource lie along pathways that could be used in conjunction with solar and geothermal renewables

Coal Seam Gas In Queensland, Queensland Department of Natural Resources

Taking this logic a bit further, the huge amount of renewable energy and coal seam methane power that could be harvested from the state's western hinterlands could conceivably power large pipelines that could bring fresh water supplies from the Wet Tropics to the parched southeastern cities of the state. This would solve both the state's energy and water problems in one fell swoop while encouraging inland regional development.

"Existing coal-fired power stations should remain in public hands *while they are old and polluting until we complete dealing with the problem they are creating."*
Hugh Outhred, University of NSW

New South Wales

In terms of the energy industry, the Hunter Valley of New South Wales has it all: sun, geothermal, brains and proximity to the nation's largest electricity consumption market: the Newcastle-Sydney-Wollongong urban corridor.

What it also has is an obsolete coal industry deadset on its own interests, and a state-controlled generation industry that's long-past its 'use by' date and that has become a millstone to progress.

The good news here is that there's an excellent solution all around: keep existing generation capacity in state hands during the transition to cleaner energy sources. Everyone comes out ahead.

First, consider the Hunter's positives. It's home to the largest grid-connected solar photovoltaic farm in the southern hemisphere. Prospecting for hot dry rock geothermal resources is actively underway. The CSIRO's renewable energy laboratory is based in Newcastle, and is developing exciting new uses for concentrating solar power. Meanwhile, Sydney University is using concentrating solar power to increase energy efficiency at the Liddell coal-fired power plant.

All this is promising enough. But perhaps most intriguing of all is the large percentage of state ownership of energy generation assets for the state. Traditionally, state ownership has been a millstone to innovation. But with foresight, it can become a catalyst.

That's because state-owned energy assets can be politically-directed in ways beneficial to the state. For instance, investments in renewable energy could be incorporated into the future investment planning of state-owned corporations without the financial market strictures that bind private companies. This would open up particularly attractive opportunities for concentrating solar power, which is already being used in the Hunter to provide supplemental power for the region's coal-fired power stations.

At the Liddell coal fired power plant, concentrating solar power preheats water to reduce coal usage

Aerial view of the Liddell solar field

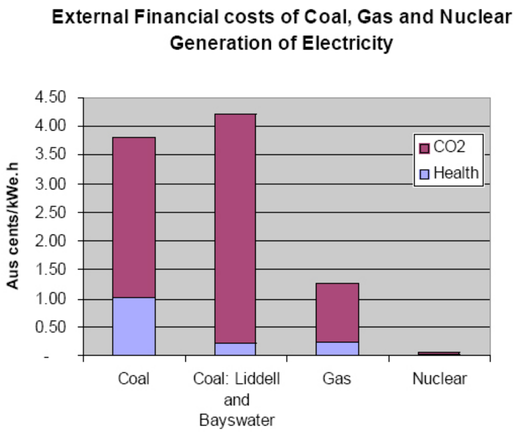
The way it would work is like this. Instead of taking a moribund, fully depreciated, obsolete industry and attempt to flog it off to private buyers (which is what NSW is trying to do, even though no one in their right mind would be interested), the state could keep existing electricity generation capacity in the state portfolio as a hedge against future demand while encouraging greenfield development of renewable energy to progressively supplant the Hunter's huge coal-fired power capacity.

The beauty of this is that it can occur in a measured, with only small disruption to end users and no worker layoffs. The Liddell plant is the perfect example. Concentrating solar power now preheats boiler water at the plant, reducing the coal that must be burned to turn that water into steam to drive turbines. Thus, concentrating solar power provides immediate efficiency gains to existing coal fired power stations. As more concentrating solar power stations are built in and around existing coal-fired power capacity to take advantage of existing power lines, concentrating solar power can supplant coal-fired power altogether. This provides an elegant, measured path toward retirement of dirty coal-fired capacity and its replacement with cleaner renewables.

Best of all, the progressively idled coal-fired power plants could serve as reserve capacity and be brought back on line in summer to handle increasing peak loads caused by air conditioner usage. This strategy will both reduce greenhouse gas emissions and extend the life of aging coal fired power plants such as Munmorah, Liddell and Wallerang.

The alternative plan would be to rip these old plants down and replace them on the same sites with new, unproven carbon capture and storage. At best, that strategy would result in a zero sum. At worst, that would reduce the amount of power available to New South Wales energy consumers if carbon capture doesn't work. An alternative plan would be to build new carbon capture and storage electricity generating capacity on greenfield sites, but that would DOUBLE the footprint of coal-fired power in the state -- which is precisely what we're trying to get away from. How much sense is there in that?

Economically, the case stacks up quite nicely. If we assume coal-fired power generation in the Hunter Valley costs 3.5c/kwh, to that needs to be added 3.75-4.25c/kwh of associated environmental and health costs. That's 7.25-8.7c/kwh, roughly the same price as concentrating solar power will achieve in 2015 or so, and well above the costs of geothermal and biomass. When lead times of infrastructure planning are taken into account, 2015 may as well be today. So, why not roll out competitive, proven renewables instead of unproven, overly expensive coal? What would the economic rationalists say? Go with renewables.



As the nation's largest, most populous state and economic powerhouse, blackouts are simply not an option. By holding on to the state's coal-fired assets, NSW places a carpet of confidence over future investment in the state. Businesses can be sure the lights will stay on. Of course, using coal for peaking power is very greenhouse-gas intensive. It's a third-best solution. But given that blackouts will always been a worst-case solution, having an expensive, transitory insurance policy in the form of progressively-mothballed coal-fired power capacity makes economic, environmental and long-term planning sense for the state. This would then in turn be reflected in economic risk premia of investment in the state. New South Wales will gain. It will also provide an medium-ground to overcome opposition to a selloff. Under this plan, the state could keep the electricity generation in state hands, and constructively fund the ongoing presence of the coal electricity-generation industry's workforce during the long and potentially fruitless wait for carbon capture and storage sometime in the 2015-2020 period, if then.

Victoria

Given Victoria's southern latitude, weak sun and "500 years of brown coal supplies," the state should become Australia's carbon capture and storage research and development center. If carbon capture and storage proves viable, it can be rolled out elsewhere.

Victoria is already moving ahead in this direction, investigating potential carbon sequestration locations in the Bass Strait. If these prove workable, existing coal-fired power plants could be confidently be replaced with clean coal technology, which would then have to compete with renewables on price. To date, however, carbon capture and storage has proven a technology marked by grandiose promises and missed deadlines.

If this technology were adopted without proof of viability, Australia could be saddled with three generations of coal industry subsidies.The first would fund construction, the second would fund 45 years of uncompetitive power generation and the third would fund the mess left over from backing the wrong horse. Given that proof of the viability of carbon capture and storage remains the better part of a decade away (see below), Australia should concentrate now on getting proven, cost effective renewables up and running to replace existing coal fired capacity *already due for retirement*. When 2015 and 2020 comes, the nation can take stock of carbon capture and storage and nuclear power. A referendum can then be held on nuclear power, perhaps followed by one on carbon capture and storage. Why not let the public decide?

SAMPLING OF LARGE-SCALE PROPOSED PROJECTS TO CAPTURE CO2

Company or consortium (location)	Fossil fuel	Fate of CO2	Possible opening
BP (Scotland)	Natural gas	Enhanced oil recovery	2009
BP (California)	Petroleum Coke	Enhanced oil recovery	2011
Statoil/Shell (Norway)	Natural gas	Enhanced oil recovery	2011
FutureGen (United States)	Coal	Sequestration	2012
RWE (U.K. and Germany)	Coal	Sequestration	2014 and 2016
Monash (Australia)	Coal	Enhanced oil recovery	2015
Vattenfall (Germany)	Coal	Sequestration	2015

Source: MIT Laboratory for Energy and the Environment

Carbon Capture and Storage is a technology that won't even be ready until 2012-2015.
Renewables are ready now

Clearly, anything that reduces the dirtiness of Victorian power should be applauded. Some of the world's dirtiest power plants are in Victoria. The state desperately needs solutions.

4.3. Marginal costs and emissions of selected power stations

Station	State	Type	Marginal costs $/MWh	Including $30/tCO2 $/MWh	Emissions tCO2/ MWh
Loy Yang A	Vic	Brown coal	3	42	1.30
Yallourn W	Vic	Brown coal	4	45	1.37
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Thomas Playford	SA	Brown coal	33	78	1.50
Smithfield	NSW	Combined cycle gas	34	48	0.47

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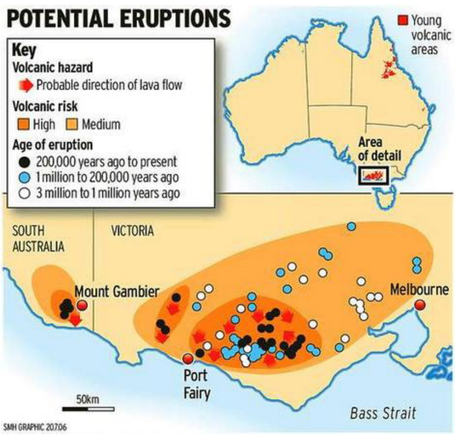
Victoria has the nation's dirtiest coal-fired power plants

Unfortunately, Victoria's choices are more limited than elsewhere for generating power in-state. To date, these choices have pretty much revolved around either clean coal or nuclear. Clean coal and carbon sequestration is controversial since no one is sure what geological hazards there are in long-term storage of carbon waste. For instance, the possibility of earthquakes in Victoria needs to be carefully monitored. To give an example, 13 people were killed in 1989 near Newcastle, New South Wales after pressures in a geologic fault were released by coal extraction and water pumping which changed the stress profile of the rock. These same hazards apply for nuclear. Given this, carbon capture and storage should be trialled in the state, but under highly controlled conditions.

Skeptics of carbon capture and storage are broadly spread. One of them is the former head of BHP, Paul Anderson, who remains on the company's board. He told the Sydney Morning Herald that if people are dubious about nuclear waste disposal underground, they'll be even more skeptical about the ability of gases to be stored there for long periods without escaping.



There is the potential for volcanic eruptions in Victoria
Source: Sydney Morning Herald

But that doesn't mean Victoria doesn't have options. In fact, it has several exciting ones.

Victoria has the the potential for geothermal power. A number of companies have signed up to prospect for the resource beneath Victoria. But at this point the resource has to be considered speculative. Better yet, northern Victoria is where Solar Systems is building a solar dish concentrating solar power plant. The company also is experimenting with hydrogen production using its technology, a path US researchers are also investigating. Potentially, new carbon capture-equipped brown coal power stations built inVictoria could pipe their carbon waste to places like Mildura where outfits like Solar Systems could transform it into transport fuel using concentrating solar power. These kinds of avenues are where the BHPs, Toyotas and Googles of the 21st Century will emerge.

If none of these work out, Victoria can always import power from New South Wales and South Australia, provided the infrastructure is in place for it to share in the solar, geothermal and, potentially, nuclear, power generated from in and around Roxby Downs.

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*"If we see climate change as a punishment, everyone will continue to fight and call names and not want to share the burden. **We have to turn this from an adversity to one of the – probably - greatest economic opportunities in history.***
Jeremy Rifkin, President, Foundation on Economic Trends

*"**In 100 per cent of circumstances, good environmental policy is good economic policy.**"*
Robert Kennedy Jr, US environmental activist

*"**The challenge is to end the linkage between economic growth and emissions of greenhouse gases**."*
Ross Garnaut, Australian government climate change researcher

*"To have a **90% reduction by 2050 would mean completely new technologies in terms of renewables.**"*
Richard McIndoe, managing director, TRU Energy

But Until Then...

Over the next 5-10 years, Australia should focus on expanding proven and price competitive renewable energy. During that time, increased intermittency of energy supplies should be offset by exploiting the load-balancing capacity of natural gas.

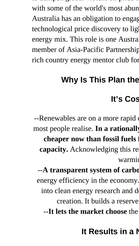
In 2015-2020, the first carbon capture plants can be built in Victoria, assuming they work, are cost competitive and a suitable safe place has been located and readied to receive the carbon. In 2017, following a national referendum in favour, Australia can start building out a national nuclear industry that includes mining, enrichment, power generation and waste storage around Roxby Downs, enabling Australia to generate its first radioactive kilowatt by 2020. From there, Australia can begin the migration to a an electric/hydrogen transport fleet and completely decarbonised economy based upon the most efficient energy conversion technologies available and that have been *chosen by the market*. The energy infrastructure to make this happen already will be in place.

Following this route, Australia will ride successive waves of positive energy industry innovation but remain hostage to no one technology. The market will provide the nation the best energy mix by 2040, ensuring continued competitiveness for the economy.

It all sounds ambitious. But bear in mind: things often happen faster than you think. 'The Internet' was considered an exotic word in 1993. It had become a household word by 1998. It's ubiquitous now. No one much knew or cared about climate change in 1997. Al Gore's "An Inconvenient Truth" changed all that. Now, the rush is on to develop the fastest and most effective means to lower emissions.

To provide just one example of how developments can outstrip forecasts, consider the International Energy Agency's 1998 forecasts for the future of wind energy and what really transpired in the industry in the subsequent years. And remember, those were *experts* making those predictions, not corner-shop bookies.

Wind energy capacity MW world wide



The wind industry's expansion has vastly outpaced estimates
"Ten steps to a sustainable energy future," *Energy Bulletin, 2004*

As Australia builds up a renewable energy industry between now and 2020, natural gas-fired power plants can take up the slack as the energy system becomes more dynamic through fluctuating supplies. More sophisticated grid management techniques must be developed to handle the grid load, particularly once a unified and circular four-state eastern grid connects Queensland, New South Wales, Victoria and South Australia. However, given that the entire system is creaking and needs and upgrade, now is the perfect time to install this kind of network functionality.

Under this model, Australia ensures itself abundant, reliable, low-cost renewable energy by backing a series of horses and allowing the market to pick the winner. Expanded coal and natural gas exports can largely pay for it, as will increased energy efficiency and carbon tax revenues.

Electricity generation and transport amount to more than 40% of global greenhouse gas emissions. Given this, a reorientation of domestic electricity and transport fuel production would be part of Australia's responsibilities as an energy superpower. Saudi Arabia takes its responsibility seriously to maintain spare oil production capacity in order to dampen global violent oil price fluctuations. As the country blessed with some of the world's most abundant and diverse energy resources, Australia has an obligation to engage -- on the world's behalf -- in technological price discovery to light the path toward the optimal global energy mix. This role is one Australia already has accepted as a founding member of Asia-Pacific Partnership for Clean Development and Climate, a rich country energy mentor club for developing nations.

Why Is This Plan the Best Course of Action?

It's Cost Effective:

--Renewables are on a more rapid descent into price competitiveness than most people realise. **In a rationally-priced market, renewables are now cheaper now than fossil fuels for most forward planning of new capacity.** Acknowledging this reality will speed solution of the global warming problem.
--A transparent system of carbon pricing will pay for itself. It raises energy efficiency in the economy. It yields revenue that can be recycled into clean energy research and development and intellectual property creation. It builds a reserve against future climate disasters.
--It lets the market choose the cheapest and cleanest energy source

It Results in a National Brain Gain

--Australia will become both an energy superpower and natural laboratory, and thus a magnet for brains.
--By developing renewables, **Australia will create new industries** to pursue when coal and nuclear become obsolete
--It puts Australia at the forefront of the emerging Hydrogen Economy

It Strengthens Australia's Economy

--It increases exports and reduces the trade deficit
--Australia benefits from exporting coal and gas now, and renewable energy expertise later, a two-for-one deal.
--Foreigners partially underwrite the decarbonization of the Australian economy, given Australia a free ride
--It will give Australia a role in emerging carbon trading markets, a rapidly growing part of the global economy

It Reduces Military Conflict Risk

--The US already has engaged in two gulf wars over oil. Do we really need more of those?
Using converse logic, if the two gulf wars weren't about oil,
...but were strictly humanitarian, why didn't the US intervene in Rwanda?
...but were only about stopping Iraqi dictator Saddam Hussein, why hasn't the US intervened in Zimbabwe?
...but were only about spreading democracy, why hasn't the US invaded Burma?
--Australia is currently spending about A$600 million a year on military operations in Iraq. This is money better spent elsewhere, specifically on energy alternatives that lessen the need for intervention in oil-rich countries to ensure supplies

It Reduces Global Risks of Nuclear Proliferation

--By keeping nuclear materials at home, closing the nuclear cycle, and exporting only value-added hydrogen
It speeds the shift to renewables by having Australia play its role as an energy superpower responsibly.
It reduces risks of out of control climate change and the economic, political and social costs of that

It Gives The Public A Stake InThe Decision-Making Process

-By giving the public the final say over over power through a national plebiscite

It Increases Australia's Standing in the World

--As a superpower, it will show Australia takes its role seriously as a force for good
--It will enhance the country's reputation
--Developing nations do have a point: **the developed work needs to take the lead in finding climate change solutions.**

Australia in 2029, the Bright View

Thanks to farsighted leadership shown between 2008-2015, Australia has low energy prices and huge solar farms in the Outback providing renewable energy through huge Direct Current (DC) power lines. Nuclear power plants at Roxby Downs keep the nation's lights on during the day and charge electric vehicles and create hydrogen at night. Expanding fleets of electric/hydrogen vehicles roam the nation's roadways, emitting nothing worse than water vapor. The cost of transport becomes remarkably stable since transport fuel can now be forecast in years advance. Oil prices are no longer even mentioned on the evening news. The Reserve Bank of Australia has to lay off economic researchers since inflation, without volatile energy components, has become much easier to forecast. Interest rates are lower since the economy has a higher 'speed limit.'

Atmospheric temperatures are stabilizing due to huge cuts in greenhouse gas emissions across the economy. Hydrogen exports are growing, particularly to European markets. Exports of coal and gas are stable. The trade deficit has fallen by half.

A huge new information technology industry has sprung up to manage the electricity grid and to bundle renewable energy into downstream retail packages for an increasingly choosy consumer sector, returning valuable price signals for investment. One late entrant -- wave and tidal power -- is gaining alot of attention to the surprise of everyone. Early prototypes tested in Wollongong in 2006 showed promise, and have flourished in a transparently priced energy market, thus sending correct economic signals to investors.

Billions of dollars of carbon taxes have funded infrastructure spending including direct current power lines linking Queensland, New South Wales, Victoria and South Australia. It's also funded a major expansion of energy research, creating a huge influx of highly-skilled labor to Australia. The benefits show in ever rising international patent applications.

Finally, early solar photovoltaic, concentrating solar power, geothermal and wind farms built between 2005-2015 have now paid down the bulk of their financing, meaning that most are now generating electricity for close to their operating costs of about 1.5¢ per kilowatthour, and are expected to do so indefinitely. These low prices are being bundled with newer-high cost power sources, enabling new bundles of competitively priced power to be brought to market.

In Victoria, carbon capture and storage has proven itself technologically feasible, but high cost. Geosequestration has cost much more than expected, and carbon emission reductions have been less than expected. The government has said the current fleet of experimental plants built in 2015 will probably be shut down before 45 year lifetime is up, but may be kept open to maintain employment in regional Victoria.

The Alternate Vision

Australia's resources are stretched thin. The insurance industry has required government bailout after government bailout after failing to meet huge and repeated coastal storm damage payouts. Inland cities like Dubbo and Wagga are struggling to cope with influxes of new settlers fleeing coastal cities like Sydney, Melbourne and Brisbane that are hollowing out to ever stronger coastal storms and property damage.

Unrestricted uranium exports from Roxby Downs have led to 10 declared nuclear weapons capable states. Al Qaeda says it has the bomb.

Temperatures are reaching all time highs and the grid is struggling to cope. New carbon capture and storage aren't able to keep up with air conditioning demand due to temperature rises that have outstripped predictions.

The challenge for the public

With such an important threat facing life as we know it, it seems crazy the public has to fight for a smart future. But that's the way it is. Unfortunately, traditional energy industries hate renewable energy for two reasons. The first reason is that it requires change, and traditional energy industries have invested huge amounts of time in developing mechanisms and defenses against change. The second reason is that under an energy paradigm in which fuel is free (sun, wind, tides, for instance) an entire chain of middlemen from energy source to energy consumption is eliminated, and the energy cycle is flattened to two elements: the energy production system and the energy source. This is hugely threatening to the traditional economics of the energy industry.

The good news, however, is that the jury has returned. The verdict is in. Widespread investment in renewables over the next 10 years, coupled with a revamping of the nation's energy infrastructure which requires a facelift anyway, is providing an unprecedented opportunity to carry us all to a sunny, bright future.

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Plenty cooking with coal-seam gas

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Victoria
Carbon Storage
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Move Over, Oil, There's Money in Texas Wind

Other Technologies
Waves
Tapping energy from the ocean
Maui to use Oceanlinx power
Tapping energy from the ocean
Maui ocean wave-energy project planned
Value in sea of possibilities
Hydrogen
Scientists Would Turn Greenhouse Gas Into Gasoline
Tides
British company to build world's largest tidal power scheme

"We're not only just the Saudi Arabia of Wind, but we're also the Saudi Arabia of waves, and we're absolutely the Middle East of solar energy. There are so energy resources from renewable sources in WA that it's mind-boggling."
Dr. Ray Wills,
CEO, Western Australia Sustainable Energy Association

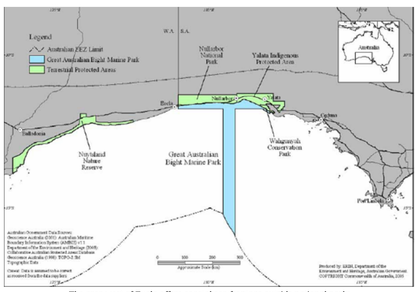
Nullarbor Wind

If a eastern electricity grid is connected, the question would become: what other energy besides nuclear, geothermal and solar could be fed into it. The answer: wind. But from where?

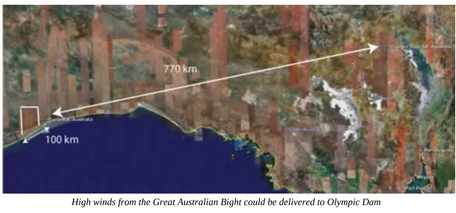
The national wind resource map below indicates that strong wind conditions (the dark blue) exist along most of the nation's southern coast, most of which -- but not all -- is inhabited.

Winds are strongest, and populations are smallest along the Nullarbor Plain

Therefore, along with the existing wind farm sites along Australia's coasts, and newer ones set to be built in places like Broken Hill, isolated, sparsely populated areas such as the Nullarbor Plain could become Outback power houses. For instance, there is a roughly 100 kilometer stretch of the Nullarbor plain around Eucla, Western Australia that isn't enclosed in national park. A series of wind farms located in this isolated area and connected to Olympic Dam by high-capacity power lines could provide a huge amount of power for the nation. In addition, stringing power lines through the area would encourage economic development of mining, agriculture and additonal energy projects in the region (like solar and wave energy).



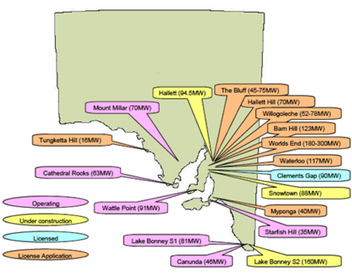
The area west of Eucla offers coastal sea frontage outside national parks



High winds from the Great Australian Bight could be delivered to Olympic Dam

A rough rule of thumb is that wind turbines should be placed roughly five times their diameter apart across the wind, and 10 times their diameter in the direction of prevailing winds. Given this, using a 100-kilometer long coastal frontage near Eucla 20 kilometers deep could yield a massive 2,000MW of power, and could be expanded. This would help bring new economies of scale to the Australian wind industry, driving down costs immensely in an industry which to date has been installing only smaller wind farms. For instance, in South Australia, the most aggressive of the states so far in encouraging wind developments, only a few farms are over 100MW.

Figure 3-4 – Wind Farm Locations around South Australia



Utilising the open spaces of the Nullarbor Plain would enable a huge increase in wind capacity in South Australia, already the nation's win capital
"2007 Annual Planning Report," *Electricity Supply Industry Planning Council*

California has been no stranger to large wind farms, with one - the Altamont Pass, at 562MW and the other, Tehachapi Ranges, at 710MW. And these are old wind farms. Newer technologies have come along to make wind farming much more efficient.

Figure 1. Existing Wind Resource Areas in California
(Source: Energy Commission WPRS 2003)

Large wind farms have been installed for years in California
"California Wind Resources Staff White Paper," *California Energy Commission*, 2005

Yes, the Nullarbor is remote and yes, stringing the power lines to get the energy to market will be expensive. But the Overland Telegraph and the Snowy Scheme were both considered expensive when they were built, and both in hindsight were unambiguously considered to be good deals. What's more, plans to build long power lines strung to bring on line promising new sources of clean energy are becoming more commonplace.

In addition to power lines proposed for bringing North African solar power to Europe, the Southwest Power Pool of Texas is designing a integrated AC/DC transmission system for west Texas that could carry up to 10GW of power from the windswept, sparsely inhabited region of American frontier lore. Meanwhile, North American energy infrastructure company TransCanada, Inc. is proposing to build a 3,666 kilometer long power line to carry wind energy from America's windy northern plains states of Montana and Wyoming to the burgeoning city of Las Vegas and the Southern California grid.

Even in Australia, the drive to scale is underway. For instance, Macquarie Bank is moving ahead to bankroll Australia's largest wind farm to date, a $2 billion, 1,000MW wind farm near Broken Hill. And in the UK, politicians now speak seriously about the potential for wind power to satisfy ALL the UK's power needs.

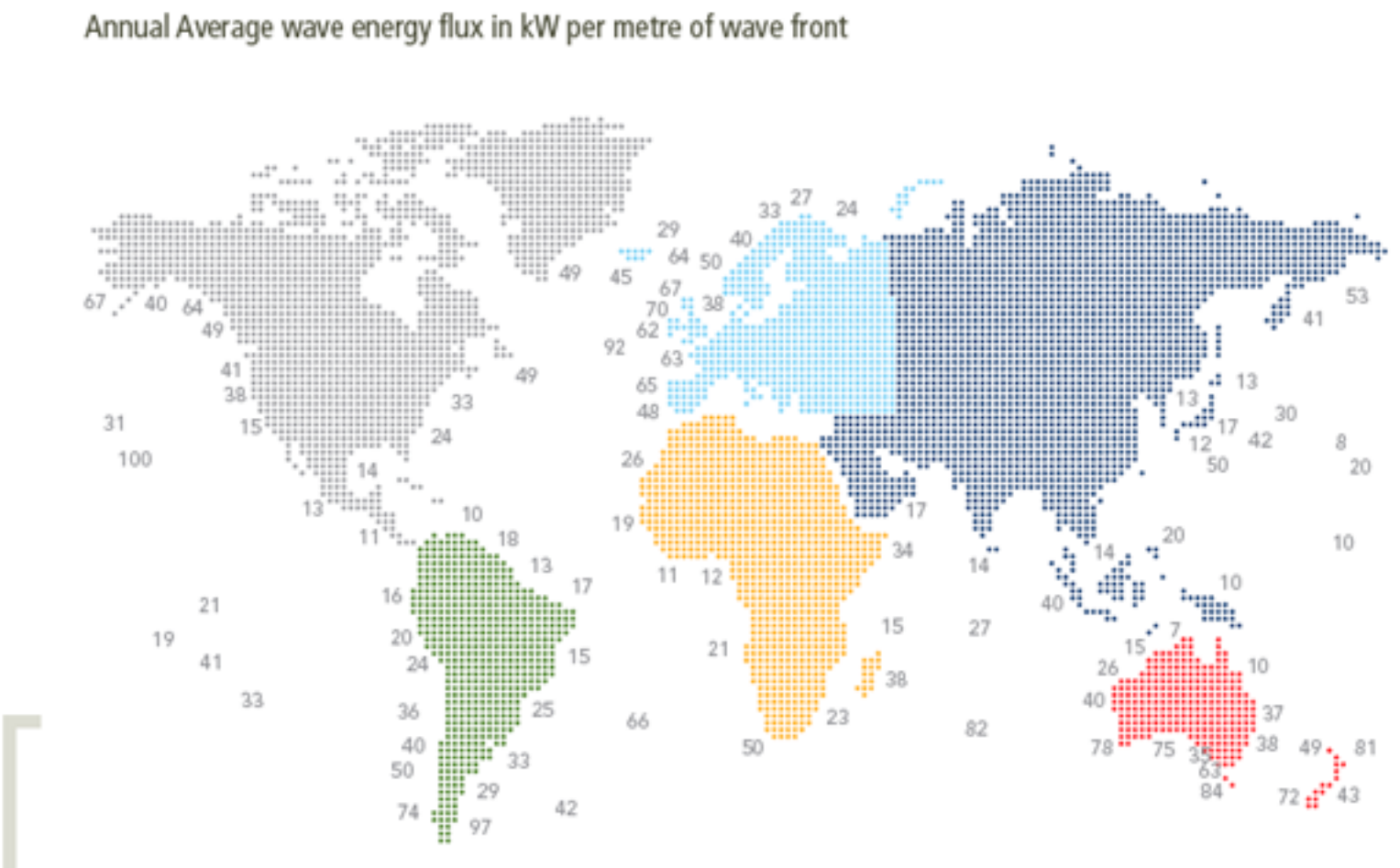
Over time, a development in the Nullarbor region could provide springboard to moving offshore into the Great Australian Bight with wind turbines, possibly operating in conjunction with wave energy machines, to provide massive power completely away from the Australian mainland. Here again, there's a template: the 400MW Borkum-2 wind project to be located 100km offshore of Germany in the North Sea with power brought to land by high capacity direct current power lines.

Other Technology solutions

The potential in more speculative technologies is almost too large to catalog. Nonetheless, below are a few ASFEE believes bear watching:

Wave Energy

Some of the strongest wave energy in the world exists off southern Australia. Coupled with wind energy from the Nullabor plain as outlined in the previous appendix, a huge energy machine could be harnessed in the Great Australian Bight.



Some of the world's most powerful wave energy exists off the Nullarbor Plain

Source: "2007 Annual Report," *Carnegie Corp.*

Two companies in Australia, Carnegie Corp. and Oceanlinx have highly promising ideas for harnessing wave energy. These remain highly speculative, but offer huge potential solutions for Australia's energy needs. Both bear watching, as do all technologies aimed at harnessing what may be one of the Earth's largest and most predictable energy sources: tides and waves. For its part, Oceanlinx is already active overseas.

Biofuels

To date these have gotten a bad name. Early candidates for petroleum substitutes look like negative sum solutions. But this avenue of clean energy has a long way to run. Alot of research is underway in many areas. One New Zealand company believes it can make a form of biodiesel from muncipal sewage. Several companies are claiming progress in developing the precursors of biofuels from particular forms of algae. Some Australian researchers believes certain forms of organic waste can be made into energy, while still others beleve hardy trees like jatropha will yield new energy stocks. It's far too early to write off this industry. Too much is happening.

Ocean Generated Air Conditioning

Air conditioning consumes huge amounts of energy, so much so that it can cause blackouts by overloading the grid on hot afternoons. Solutions are desperately needed. One of these is to let the ocean do the work. Below the surface of the sea, water temperatures drop sharply. Why not take this cold water and pump it through buildings to cool the air? It's such an incredibly simple idea it's hard to believe no one's thought of it before. One company, Honolulu Seawater AC, is moving ahead with a trial deployment. Shoud it succeed, the replication potential for Australia would be immense.

Smart Electricity Grids

So much has been written about the huge energy savings that can be achieved by revamping energy systems that ASFEE won't add to the literature. However, the potential is huge. It can and should be bundled into the overall restructuring of the global energy industry as aging assets in both electricity generation and transmission are replaced.

About ASFEE

The Australian Society of Foreign Energy Executives represents foreign-born experts currently working in the Australian energy industry.

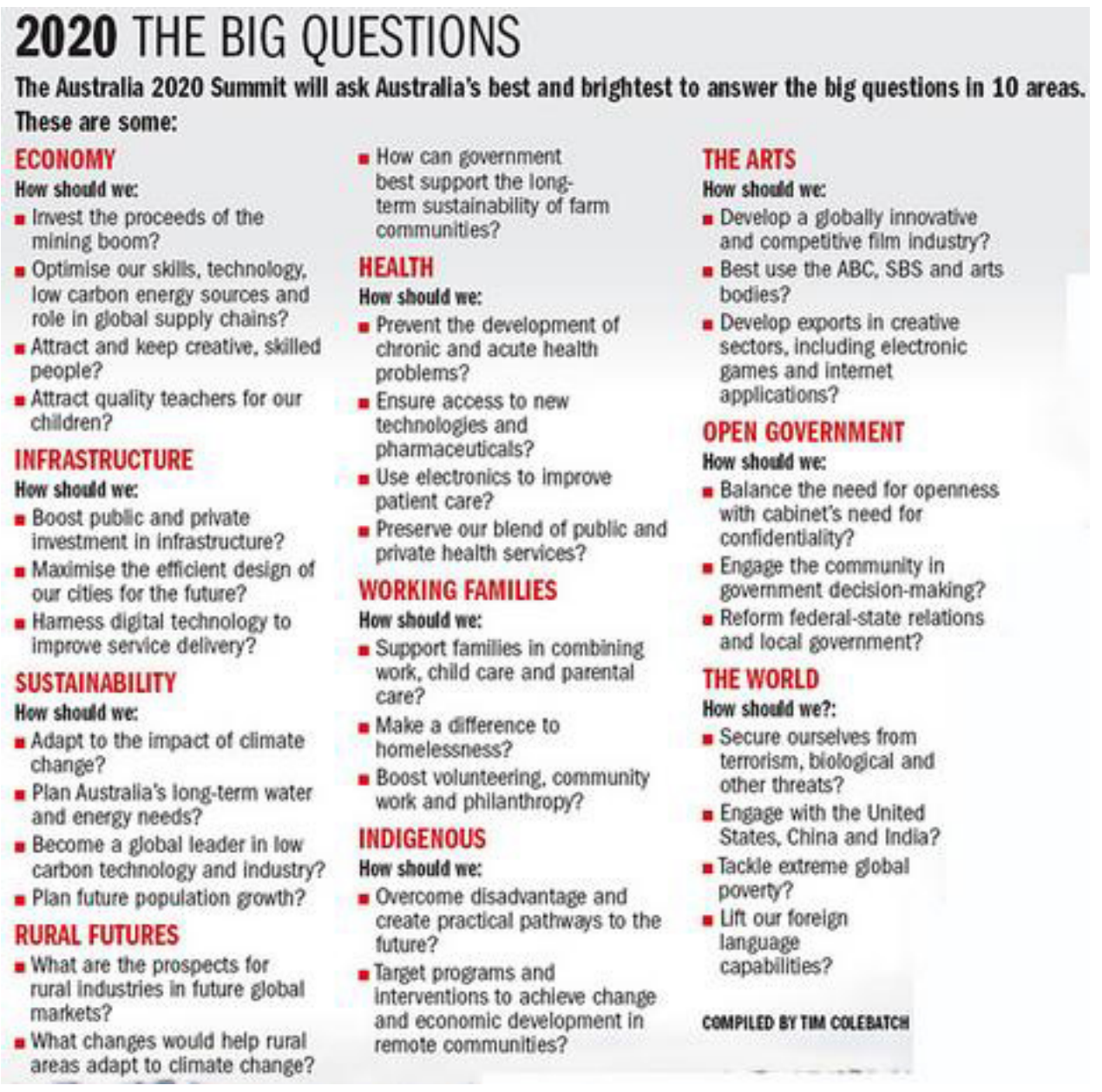
"Crusty Coal to Clean Kilowatts: Decarbonising Australia by 2040" represents their views on Australia's opportunity to become a 'clean energy superpower' in a post fossil-fuel global economy centered around networked renewable energy.

The Great Infrastructure Buildout

The Rudd govenment is committed to building out Australia's infrastructure. Right now, with a huge amount of aging coal-fired capacity in need of replacement, there's a once in a lifetime opportunity to make a major leap forward. This should include creating a future-proof energy system that would serve the country well for a century or more, possibly forever.

Australia needs to spend $20-35 billion in coming years on replacing electricity generation capacity. It probably needs to spend about the same on water. It also needs to spend big on power lines and pipes to get this electricity and water to its populace. Applying flexible, proven technology and accompanying it with economic reform will create an energy and water system that should pay for itself. With an infrastructure deficit now looming of roughly $90 billion, it's important for Australia's future economic growth to get this right. The Committee for Economic Development of Australia estimated Australia's GDP could be 0.8% a year higher -- or roughly $6 billion -- with the right infrastructure in place.

This study has outlined specific ideas such as stringing high capacity power lines to the outback, nuclear power at Roxby Downs, power parks, wind and wave energy from the Nullarbor. Not all of these may come to fruition, but they do bear thinking about. At this unique juncture in Australia's history, it's time for us all to dream a little



2020 THE BIG QUESTIONS

The Australia 2020 Summit will ask Australia's best and brightest to answer the big questions in 10 areas. These are some:

ECONOMY
How should we:
- Invest the proceeds of the mining boom?
- Optimise our skills, technology, low carbon energy sources and role in global supply chains?
- Attract and keep creative, skilled people?
- Attract quality teachers for our children?

INFRASTRUCTURE
How should we:
- Boost public and private investment in infrastructure?
- Maximise the efficient design of our cities for the future?
- Harness digital technology to improve service delivery?

SUSTAINABILITY
How should we:
- Adapt to the impact of climate change?
- Plan Australia's long-term water and energy needs?
- Become a global leader in low carbon technology and industry?
- Plan future population growth?

RURAL FUTURES
- What are the prospects for rural industries in future global markets?
- What changes would help rural areas adapt to climate change?
- How can government best support the long-term sustainability of farm communities?

HEALTH
How should we:
- Prevent the development of chronic and acute health problems?
- Ensure access to new technologies and pharmaceuticals?
- Use electronics to improve patient care?
- Preserve our blend of public and private health services?

WORKING FAMILIES
How should we:
- Support families in combining work, child care and parental care?
- Make a difference to homelessness?
- Boost volunteering, community work and philanthropy?

INDIGENOUS
How should we:
- Overcome disadvantage and create practical pathways to the future?
- Target programs and interventions to achieve change and economic development in remote communities?

THE ARTS
How should we:
- Develop a globally innovative and competitive film industry?
- Best use the ABC, SBS and arts bodies?
- Develop exports in creative sectors, including electronic games and internet applications?

OPEN GOVERNMENT
How should we:
- Balance the need for openness with cabinet's need for confidentiality?
- Engage the community in government decision-making?
- Reform federal-state relations and local government?

THE WORLD
How should we?:
- Secure ourselves from terrorism, biological and other threats?
- Engage with the United States, China and India?
- Tackle extreme global poverty?
- Lift our foreign language capabilities?

COMPILED BY TIM COLEBATCH

ASFEE's proposals fit many of the answers sought by the Rudd government's 2020 Summit

Source: *Sydney Morning Herald*