CLIMATE CHANGE AND NUCLEAR POWER IN AUSTRALIA

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Context for the nuclear debate

In introducing the topic of the nuclear fuel cycle to public debate last year, the government probably had three considerations in mind:

1) The demand for electricity is expected to grow by 1.5%-2%/year into the future. This means that Australian use of electricity will be double today's levels during the 2040s and planning for, and investment in, electricity generation need to happen now. And all available platforms for generation must to be on the table. For baseload generation, there are probably only four options: coal, gas, hydro (now in question) and nuclear.
2) There has been a 20 year hiatus in discussion of nuclear power in Australia following the abandonment of plans to construct our first power reactor in 1973, and then restrictions on uranium mining from 1983. If nuclear energy is to be thoughtfully considered, public understanding of the technology, recent experiences of nuclear powered countries, possible domestic scenarios, and answers to many thorny questions including re waste and proliferation, need to be updated.
3) There is no difficulty in generating electricity in Australia. Our reserves of coal and gas are the envy of all countries and fossil fuels provide 90% of our power. The challenge is not how to power growth, our prosperity and quality of life; the issue is what environmental price are we prepared to pay? Nuclear energy may offer the possibility of truly clean, green and safe electricity.

Findings of the 2006 Nuclear Review

The Review commenced its work in July 2006, and issued its Report at year end. Its mandate was to inform the public debate – help Australians understand the issues in the context of contemporary developments. Its role is not to be an advocate of nuclear power. The work has been comprehensively reported, broadly reviewed and debated in the media and academia (insightful and balanced) and continues to contribute to an informed public debate.

The headline findings were:

1) Uranium Mining No reason to limit our prospecting, mining and export. Demand is solid and will grow, prices are currently very high, and overseas companies like dealing with Australian suppliers because our mines are world class, have excellent safety records, supply chain management has integrity, and we are compliant to the most stringent international nuclear protocols. The business opportunities are compelling.

2) Value Adding Substantially this is about enrichment of uranium to power reactor grade level (from 0.7 to 3-5% U235). It is presently illegal to enrich uranium in Australia. The Review concluded that, while there was little reason to explicitly prohibit downstream processing of uranium, the business case for any multibillion dollar investment was a difficult one, the technology is tightly controlled, and current enrichment capacity sufficient to meet global demand for more than the next decade. Although a year ago the value split between mining and downstream processing was 40-60, with the sharp recent increase in uranium prices, that ratio will move closer to 70-30 suggesting the Australian miners will capture most of the value in the production of nuclear fuel for reactor operations.

3) Nuclear Power

   Presently 31 nuclear powered countries; 20 more in the queue
   443 reactors (plus about 150 nuclear powered aircraft carriers and submarines)
   15% of global electricity; 23% in OECD
   Some appeal for desalination, hydrogen production

   but

   20-50% more costly at the generation stage (although differential goes away with moderate carbon pricing)
   10-20 years out
   Potential need for government to kickstart the industry as has happened in all other countries

   Beginning in the 2020s, Australia could have 25 reactors by 2050 producing a third of our electricity needs with near zero GHG emissions. Total GHG abatement would be 18% vs business as usual. A valid part of a portfolio approach, but not a ‘silver bullet’.

4) Waste/Proliferation

   Spent fuels rods go to long term storage in 500m+ deep wells.
   Globally agreed strategy but no operating repository yet for long lived high level waste.

Need a geologically and hydrologically stable location some distance from population centres. 90% of the Australian continent qualifies.
One national facility over a few square kilometers available around 2080 would be sufficient for Australia.

Proliferation and illegal diversion of nuclear materials have not been issues for compliant regimes (and note that in our region we are already in a community of nuclear powered countries).

But the management of long lived radioactive waste remains a concern for many people who argue the risks to the environment from any misadventure, and the burden bequeathed future generations.
No country accepts nuclear waste from any other country for permanent storage – a position supported by the Review. Some countries have enacted laws that require them to have in place acceptable plans for permanent local storage of the spent fuel and prohibit consideration of exporting such materials.

Current status

Over 12 months, quite remarkable progress has been made.

a) There is now bipartisan support federally for removal of impediments to U mining and export – but still a State matter
b) Bipartisan support for an Emissions Trading framework with (key) details still to be developed
c) Steps proposed to overhaul federal legislation to permit broader involvement in the nuclear fuel cycle
d) Investment in skills and training, curriculum design to address a 20 year gap in our competency building re nuclear technology (we need nuclear engineers, radiation chemists, geophysicists, occupational health technologists, regulators). Interestingly, the successful completion of the OPAL Research Reactor at Lucas Heights, and the Australian Synchrotron in Melbourne – both in recent months – demonstrate world class capabilities in nuclear project management and engineering.
e) Decision for ANSTO to join the international Gen 1V consortium to help develop next generation nuclear reactors
f) Announcement by the government of an education program to continue the public conversation about the nuclear fuel cycle.

At the 12 month anniversary of the Nuclear Review, we have come from a position where nuclear power was not an acceptable topic within polite Australian society, to one where many people have an informed view and are open to debate – though not necessarily supportive.

Community attitudes

In 2006, top three objections to introduction of nuclear power to Australia were: 1) long lived toxic waste; 2) possibility of a catastrophic accident like Chernobyl; and 3) terrorism and proliferation.
In 2007, these concerns, although still there, have been overtaken by: 1) costs of nuclear power; 2) long 10-20 year leadtimes; and 3) proposed location of reactors. Waste remains of broad general concern.
These changes reflect a shift from opinions formed from the Cold War, Three Mile Island (1979), Chernobyl (1986), upper atmosphere testing by the French of atomic weapons in the 70s…… to largely commercial challenges – 'costs too much, takes too long, and won't get environmental approval for site selection'. If these orthodox business case challenges when translated to the 2020s cannot be overcome, then nuclear power cannot and should not be an option for Australia.

Why the urgency?

Given that investment decisions for new electricity capacity play out over the years (and commit us to a specific technology for 30-50 years), and Climate Change itself is measurable over generations, not months, why is there a national urgency to establish policies in this area?

Three possible reasons:

1. 2007 is an election year with energy and climate strategy a matter of sharp policy differences between the parties, at least perceptionally. Positions will be taken in the months ahead which will define government policy for some years ahead.
2. Global decisions will be made around us by our trading partners. We need to get to 'the main table' to help shape international thinking, and protect/advance our commercial interests.
3. Significant infrastructure investments have been queued up awaiting more certainty about future rules esp re carbon costs, targets for renewable energy etc. The past hesitation to invest may yet cause energy shortages in the years ahead. Investments need also to properly reflect long term national aspirations as they will bind us to particular technological platforms for up to 50 years, and for which retrofitting environmental filters may not be a practical option.

Challenges specific to nuclear power

Overseas experience suggests that once nuclear power is up and running, some communities move progressively to a position of neutrality or support for nuclear electricity, indeed sometimes competing to be the preferred location for future facilities. But the process to fund and install the first reactor almost always faces significant challenges, and in Australia these include:

- Lack of bipartisan support for nuclear power- a sovereign risk
- Nuclear is the most capital intensive of energy technologies – around $3billion per reactor. Such an investment in a project with long lead times, with some technology risk, with regulated retail prices makes any business case quite difficult. (Nevertheless nuclear power holds the promise of being the lowest cost, near zero GHG emitting source of electricity in the 2020s).
- The structure, including diverse ownership, of the country's electricity grid makes any reactor decision a very significant one for the utility or state government involved. There is a potential lack of scale to accommodate the most efficient large reactors.
- There is no regulatory framework yet in place for an industry highly dependent on appropriate licensing and compliance processes, with expensive projects vulnerable to unplanned delays.

Notwithstanding such hurdles, another 20 countries are queuing up to install their first reactor.

Climate Change

The science of climate change is sound. The forecasts are the outputs of the most sophisticated climate models available to us.
We are living through a significant warming period largely driven by the accumulation of GHG in the atmosphere arising from our use of fossil fuels such as coal, gas and petrol. The vivid depictions of the consequences of a warmer environment (droughts, water shortages, bleached corals, receding glaciers, melting icebergs, species destruction, rising sea levels, more intense cyclones and hurricanes etc) are consistent with the scientific analyses.
To limit temperature increases to below 3 degrees (beyond which climate models suggest dangerously unstable global conditions may occur) by the end of this century requires changing the trajectory of current **global** emissions from a possible doubling by 2050 to a level 60% below the 1990 level – a five fold decrease in emissions per unit of energy!
The IPCC does not recommend targets – it describes various scenarios. But many countries have adopted this -60% GHG reduction goal although none has a coherent plan to achieve it, and global emissions continue to rise.
While some regions in the world will benefit from a warmer climate (eg Scandinavia, Russia, parts of the US), and therefore welcome a degree of warming, Australia will find it more difficult. Warming across the continent is predicted to be uneven – most severe in the South East; little change in the North.

It is in our interests to limit global warming in the generations ahead – accepting that no intervention can affect the warming trend for perhaps 30 years given the legacy of global emissions which live in the atmosphere for 100 years +, and the reality of our installed base of fossil fueled infrastructure.

What should we do?

Firstly, our contribution to global GHG accumulation in the decades ahead will be about 1%. Focusing upon a domestic set of initiatives, though worthy, might prove pointless. All our steps should be directed to making a difference globally – climate change is a global phenomenon driven by the sum of all emissions. This inevitably requires agreement among the world's largest economies/emitters.
Six communities – US, China, Japan, Russia, India and the European Union – account for 70% of the world's emissions. What they do collectively matters. The rest of us have parts to play but they are meaningful only if they help drive sensible global initiatives.

Our priorities should be :

- Given that more than 70% of the world's electricity comes from coal (and will be so for decades to come), and the importance of that product to our economy ($23billion annual revenues), a national priority must be to make coal a cleaner fuel source. In particular, if research into geosequestration might enable early implementation of carbon capture and storage, Australia should take the lead.
- To the extent that Australia can influence the major emitters to set upon a GHG reduction path, we should do so. Here our relationships with regional partners (esp China, Japan and Indonesia) and the US are especially relevant.
- Financial engineering in its positive sense is a national competence. The design of a carbon costing regime (such as an emissions trading framework) whose structure allows for ready coupling to a global scheme plays to our strengths.
- Support the international expansion of nuclear power by opening up our uranium mining and export industry and continuing to operate to the highest standards when supplying uranium to our customers. Today, Australian uranium and coal contribute roughly similar quantities of electricity worldwide. As that balance shifts to more nuclear power, so will the GHG challenge become more manageable.

Our domestic strategy needs to be one of **adapting** to a progressively warmer climate – indeed learning to thrive in it.
Water availability is already a major national challenge, but unlike global warming, water management is a local issue under our control.
Increasing numbers of bushfires and extreme weather events are expected – emergency service protocols need continuing improvement.
Warmer temperatures require different building designs and codes.
Some industries and their employees may need to relocate.
There will be winners and losers over the decades as fossil fuels are displaced by cleaner alternatives.

Energy costs will increase, perhaps substantially. Energy efficiency and conservation will become important.
New business opportunities will appear and reward the inventive, farsighted and entrepreneurial.

Remaining Issues and Conclusions

Obviously many questions remain.

- What is the proper role for government – to pick winners? design even handed incentive schemes? set priorities? (Is Global Warming **the** issue of our generation, but what about poverty, malnutrition/famine, health/AIDS, illiteracy/education, terrorism, ethnic violence, drugs, pedophilia, crime etc etc?)
- Should we put more emphasis on renewables (solar, wind, geothermal, tidal, wave power) and demand more of our national R+D?
- Do we focus upon climate change – a global phenomenon, or climate adaptation – a local challenge? Or both?
- Whether we invest 1% GDP each year (as recommended by Stern), and/or accept a few % reduction in GDP from environmental initiatives and costs, this is a trillion dollar decision by 2050. Are we prepared to make it?

The Rio Earth Summit put Climate Change on the international agenda in 1992.
Kyoto attempted to start the process of controlling emissions in 1996.
But 2006 will be judged by history as when the alarm bells were heard globally,
and 2007 when Australians set their course to address the implications of global warming in our backyards.

Thank you.

FACTOIDS

Nuclear Power

- If Australia had the OECD level of nuclear electricity (23%), it would have 12 reactors today
- The fissionable isotope, U235, represents 0.7% of natural uranium. It is enriched to between 3-5% for a power reactor, but more than 90% for weapons production
- A typical reactor has a fuel load of 200 tonnes of enriched uranium in its core. About one third is replaced each year. This 70 tonnes annually of spent fuel rods

(about a volume of a 2m cube) is stored on the reactor site until ready for long term storage in a deep repository.

- Over a typical 60 year lifetime of a nuclear reactor, the volume of (4200 tonnes of) spent fuel rods produced would fit a cube 8m each side – about the volume of a small single level suburban house.
- One tonne of carbon dioxide has the same volume. Australia emits 560 million tonnes of GHG each year.
- The price of uranium has increased more than 10-fold in recent years to above $US130/lb. Australia has 38% of the world's recoverable reserves. Some forecasts anticipate a uranium export industry approaching $10billion/year by 2020 making uranium one of our top 5 export revenue earners. Coal contributes $23billion/year today.
- In our region, the following countries are nuclear powered – China, Japan, India, Pakistan, S Korea, Taiwan. The next with plans to go nuclear are Indonesia and Vietnam.
- Approximately 20 countries are planning to introduce nuclear power in the next 15 years, and four are planning to reduce (Germany, Sweden, Portugal, Belgium). Both Germany and Sweden are again reconsidering their positions.
- France produces more than 80% of its electricity from its 59 nuclear reactors. It is three time our population and economy, but with a slightly smaller absolute level of greenhouse gas emissions.
- Current projections see about 10 new reactors being built globally each year meaning that the reactor population will be double today's 443 during the 2050s. Even at this rate, nuclear power will barely keep up with the growth in global demand for electricity overall.
- Nuclear costs for electricity generation would be higher than for fossil fuel alternatives in Australia today by 20-50%. Generation costs represent one third of retail costs (the rest being in transmission, distribution and retailing). Even if nuclear were twice as expensive to generate (unlikely in a carbon costed world), if by 2050 a third of Australia's electricity was produced by 25 reactors, then the average household electricity bill could be 10% higher in 2050 than might otherwise be the case. This increase would occur over more than 25 years at a rate of perhaps 0.5% per year – ie about $1 extra every quarterly electricity bill.
- This calculation extends to all new forms of energy including renewables. Early concerns with uncompetitive costs will be overtaken by the introduction of carbon costs for fossil fuels, reducing costs of new technologies, higher community priorities for cleaner energy, and social acceptance of slowly increasing energy bills in general.

Climate Change

- The goal of greenhouse gas (GHG) abatement is to stabilize global GHG concentrations to between 450-550ppm by the middle of the century to limit global warming to +2 to 3 degrees C by the end of the century.

- The average temperature across Australian population centres (across day and night, and all seasons) is about 15 degrees. While the average warming trend of 2-3 degrees over a century seems relatively benign (Melbourne climate will be more like Adelaide, Sydney like Brisbane), such increases may have dramatic impacts upon the global ecosystem. In 2005, the hottest year on record, 35000 people died from heat related causes in Europe.
- GHG concentration is presently about 380ppm and is expected to reach 480ppm in 50 years. Of this increase in 100ppm, Australia will be responsible for 1ppm.
- In next 18 months, the US and China will emit more GHG than Australia will to 2050.
- Six communities – USA, China, Japan, Russia, India and the European Union - account for 70% of the world's emissions. Alignment of these major emitters regarding GHG reductions is critical to any global climate change strategy.
- One typical example of energy trends – SE Queensland usage of electricity was 6.4 MWhrs/person in 1996, and 10.4 in 2006 (a little above the OECD average). This 5% annual increase was driven by growth in access to air conditioning and household appliances (eg plasma TVs) – an ongoing trend across the country.
- More GHG (11% of annual emissions) are produced by the nation's livestock (methane from belching by cattle and sheep, and decomposing manure) than by our 10m passenger vehicles (8%), although the latter are growing more quickly.
- China and India hold 37% of the world's population, with about half their people living on less than $US1/day. Access to electricity is an understandably higher priority for these countries than climate change. Each country continues to markedly increase its networks of fossil fuel plants.