URANIUM MINING AND NUCLEAR POWER – NEW ENERGY

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INTRODUCTION

Global demand for energy, and specifically electricity, continues to grow by 1- 2% per year. Economic growth, prosperity and rising standards of living always drive a nation's energy intensity.

Notwithstanding the popular rhetoric of energy conservation and productivity, the economic and social goals of all countries require more energy, not less – for decades to come.

This implies a doubling of global capacity for electricity by 2030 and of aggregate energy by 2050.

Australia will follow a similar trajectory of demand growth.

There is little difficulty in meeting such demand growth –power generation technologies are well established and fossil fuels are widely available but the challenge is to produce more clean energy which is environmentally benign.

And to follow a path which improves a country's energy security while reducing dependence upon geopolitically volatile sources of supply – especially for oil and gas.

As a result, there has been a revival of interest in nuclear power globally

CASE STUDY – ITALY

Beginning in 1946, Italy had been a pioneer in civilian nuclear power but a year after the tragic disaster in Chernobyl, a 1987 referendum determined the phasing out of all nuclear energy.

(Globally, new construction of reactors halted in western economies for almost 20 years.)

By 2008, Italy had become the world's largest net importer of electricity with prices 30% higher than the EU average.

And 60% higher than in France from which it imported nuclear generated electricity.

In May 2008, the Italian government confirmed it would commence building new nuclear power plants within 5 years to reduce the country's dependence upon oil, gas and imported power.

The phasing out of nuclear power has been described as a 'terrible mistake' by the Italian Minister of Economic Development, Claudio Scajola.

Italy, the world's 7th largest national economy, now has a new vision – to be the European energy hub via a diversified strategy including gas pipelines, liquid natural gas and nuclear power.

The government plans an electricity mix in 2030 of 50% fossil fuels, 25% renewable and 25% nuclear.

8-10 reactors will have to be in operation by then. A new nuclear authority will be set up by year end; locations for the new plants are expected to be identified within 6 months and construction to start by 2013.

Motivated by hardcore economics (plus the desire for more energy independence and the requirement for a cleaner energy mix), from a standing start Italy will be producing 13GWe in the 2020s from nuclear power.

That's about 30% of Australia's electricity capacity today.

A public opinion poll in July 2008 found 54% supported nuclear power in Italy and 36% opposed it (compared to 82% opposition in 2007).

Such shifts in positive public attitudes to nuclear power have become familiar including in Australia.

COPENHAGEN AHEAD

What will Australia's energy and climate change representatives be reminded of when they arrive in Copenhagen in December?

- 15% of global electricity is already produced from nuclear power at 440 reactors in 31 countries
- Two thirds of the world's population get some of their electricity from nuclear reactors; and most of the other one third aspire to a similar position
- Countries which had paused in their deployment of nuclear power – Sweden, UK, Italy, USA – are reactivating their programs while others such as Germany and Spain have reopened debate
- Neighbouring countries most affected by the fallout from the Chernobyl reactor fire – Ukraine, Russia, Finland – are increasing their nuclear networks and others like Poland and Belarus are about to start down this path
- The UK – a beacon of climate change leadership – is committed to accelerate its nuclear build program, replacing its current fleet of 19 reactors as its chief energy adviser forecasts

35-40% share of electricity generation in the 2030s – double current levels. The UK has established a new sophisticated regulatory environment to support their program

- In Latin America, Brazil has announced an ambitious construction program and Argentina has restarted its deployment of small scale systems
- The US delegation will echo President Obama's view that the US cannot meet its climate change goals without more nuclear power
- And the chairman of the IPCC will extend that comment to the world in general
- The countries with the most ambitious nuclear outlooks are China, India, Brazil and Russia. The most dynamic developer of uranium resources is now Kazakhstan. Some of these countries present interesting geopolitical challenges and opportunities for Australia

With the exception of Italy which can purchase nuclear electricity, no economy of Australia's size or larger is without nuclear power (ie 14 countries).

Indeed, Australia now stands alone among the world's top 25 economies in excluding consideration of nuclear power in our long term energy and climate change strategy.

BASELOAD ELECTRICITY

Most electricity demand is for continuous reliable supply around the clock.

This is met by what we call baseload supply.

The options available for the production of baseload electricity are well known and limited:

- Burning of fossil fuels such as coal, gas and oil
- Hydroelectricity
- Nuclear power

If we have little tolerance for brownouts and blackouts and require that 80% of our electricity capacity be always available – to power appliances, buildings and homes, hospitals, public transport, traffic lights etc – only the options noted above work.

Expecting more from hydroelectricity is impractical for most geographies given the uncertainties of reliable water flows in the future.

Geothermal offers some promise of abundant baseload power but, except for some local and niche applications, widespread cost effective availability looks decades away. Wave and tidal power are later still.

Wind and solar power will make increasing contributions but remain handicapped by the inherently intermittent nature of the source. (*High temperature solar may be developed to address some baseload requirements. Projects in Spain and California have foreshadowed this but the plants are small (100MW) and unproven and remain hostage to weather patterns.)*

Most countries confronting the challenge of adding new and clean energy capacity have concluded that nuclear power must be in the mix because:

- Nuclear technology is well established, available off-the-shelf today, and not dependent upon heroic assumptions of cost or technology breakthroughs in the future
- Nuclear electricity is truly baseload, optimised for 24/7 operation, and couples into national electricity grids just as gas or coal fired power does
- Whole of life (ie from uranium mining to reactor decommissioning and long term storage of spent fuel) greenhouse gas emissions are very low and similar to solar and wind.
- Generating costs are comparable to coal and gas in most of the world, and even here with moderate carbon costs ($A15-40 per tonne of CO2/year)
- The nuclear power industry in most economies fully funds its lifecycle costs including decommissioning and waste management

To address GHG targets such as 50-90% emissions reductions from 1990 levels by 2050 by western economies, some countries are flagging an interim electricity generation mix of 50% fossil fuels/25% nuclear/25% renewables by 2030 (eg Italy above).

Given our starting point, this seems both responsible and challenging as an interim milestone (yet given continuing growth in energy demand, this mix alone still won't arrest overall growth in global GHG emissions without successful and widespread carbon capture and storage processes).

NATIONAL ENERGY STRATEGY

Australia's energy and climate change strategy is based upon expected contributions from energy conservation and productivity, accelerated deployment of renewable energy, a substitution of coal by gas, and the presumed success of clean coal technologies and associated carbon capture and storage.

There can be no question as to the merit of pursuing each element in this approach.

The least problematic of these is the proposed increased use of gas. Yet because of the cost differential between coal and gas, its increased use is dependent upon a substantial carbon price, for which there is not yet sufficient appetite.

Yet gas in Australia is still modestly priced by world standards so growing demand and parity pricing will further increase the premium to coal fuel costs.

And gas being a fossil fuel, its combustion continues the build up of GHG but at a slower rate.

So with household demand for energy increasing not reducing, renewables contributing 2% to our current energy generation capacity, and CCS yet to be demonstrated as a scalable, cost effective and safe process, we may be the only country whose total strategy is based upon such fragile assumptions.

Current energy policy, in Australia and many other countries, is to require that 20% of energy generation be by renewable sources by 2020. This has been translated to the need for 9 GWe capacity by wind energy – since neither solar nor geothermal energy (nor indeed nuclear) can make any significant contribution over the next decade.

Being intermittent, wind must be paired with complementary back up power from dependable fossil fuel sources. As much or more conventional capacity must be added to ensure efficacious use of wind energy. Our Renewable Energy Target is in fact a policy to promote increased use of gas – a fortunate outcome given our gas reserves and the efficiency of modern gas plants.

A hybrid wind-gas platform is not near zero GHG emitting. But at least the combination holds out the promise of an industrial strength electricity network versus the cottage industry that purveyors of wind mills and solar panels sometimes describe.

(*In my opinion, the enthusiasm for wind energy generation as a senior player in our future energy mix is misplaced.*

It's analogous to replacing the world's commercial shipping fleets and supertankers with sailing boats, albeit fabricated from the most modern materials, and of course backed up by old fashioned diesel power for the two thirds of the time that the wind is not strong enough or in the right direction.

Sounds unreal and surely can only be a transitional phase.

Proponents of wind seldom talk about "power delivered", instead "installed capacity" which neatly avoids stating the problem of intermittency and availability. Australia currently has about 1GWe of "installed wind capacity" and prospective 9GWe installed capacity at a high 33% capacity factor would deliver an "effective capacity" of 3 GWe

Germany with an economy nearly 4x ours, has 24GWe wind, which produced 43TWh (21% capacity factor and 7% of total production) in 2008, after 30 years of investment and just about the world's highest feedin tariffs. All onshore sites have been used up. With some of the lowest average wind speeds in the EU, German utilities must now keep spinning reserves in lignite(brown coal)-fueled plants, as gas turbines are not enough to cope with the drop in wind speed during the day.

Their paradox appears to be that as more wind capacity is now added, the faster will CO2 emissions increase!

Global installed capacity is 120GWe currently. Denmark has just over 3GWe installed wind capacity, 0.4 GWe is offshore. Germany is often vaunted as having 15% "renewable production" this is composed of biomass, "non-renewable waste", wind, "hydraulic" and solar PV. If the German mix was corrected to exclude hydraulic and "non-renewable waste" which are normally reported separately, their "renewables" would be 12% of which wind contributes 7% and biomass (not carbon friendly) growing fastest.

In the US all renewables (wood, black liquor, other wood waste, biogenic municipal solid waste, landfill gas, sludge waste, agriculture byproducts, other biomass, geothermal, solar thermal, photovoltaic energy, and wind.) produce about 2% of all power. The US today has as much wind power "capacity" as Germany.)

Much has been made of the fact that Australia is blessed with abundant sunshine and wind as if this might be a source of comparative advantage.

The opposite may be the case.

Sunshine and wind are more democratically distributed than fuel resources such as oil, coal, gas and uranium. Most countries have plenty.

That we appear to have proportionately more is a statement of our low population density - something that translates into a small economy and fewer intellectual and commercial resources to exploit the technologies.

As we transition to a low carbon economy, our traditional sources of competitive advantage – ie abundant and inexpensive fossil fuels – will be overtaken by new generation technologies such as nuclear power where we have no presence.

And our competitive advantage will disappear.

NUCLEAR SCENARIOS FOR AUSTRALIA

In allowing coal to be demonised as a dirty fuel, and barring any consideration of nuclear energy as an option, our policy makers may be shaping an energy future disproportionately dependent upon technologies which may compromise the reliability, productivity and low cost of our current electricity system.

(Incidentally, more than 80% of the world's energy is produced from fossil fuels. To presume this global level of dependence will change quickly fails to appreciate the huge growth in oil, coal and gas demand that will be driven by the emerging economies of China and India, or the challenge inherent in displacing technologies like the internal combustion petrol engine with cleaner alternatives.)

Viewed from afar, our energy strategy seems to be more about nuclear avoidance rather than embracing solutions that seem obvious and sensible to others.

This is very frustrating as we may be pursuing a complex, high risk, speculative path when international experience points to a simpler road forward – ie augmenting our proven coal and gas fired facilities with equally proven nuclear power, initially to meet growth in energy demand, and eventually displacing fossil fuel infrastructure at the end of its working life.

This should be the plan for the next 50 years.

The UMPNER study of 2006 described a scenario where Australia installed its first reactor in 15 years time during the 2020s and built a fleet of 25 reactors by 2050 which could then provide a third of our electricity needs.

This outlook is now too conservative.

With nuclear and environment regulators around the world striving for consistent, simplified rules and reactor vendors introducing more standardised, efficient and safer designs, an estimate of 15 years to commission Australia's first reactor is needlessly cautious.

For example, the plan in Italy anticipates less than 10 years.

Even Egypt, new to the nuclear field, has just signed a contract with Australia's Worley Parsons to project manage the construction of its first 1.2 GWe reactor for generation of electricity in 2017 – 8 years hence.

Australia could and should plan for its first nuclear reactor by 2020 aiming for a fleet size of 50 large reactors producing 75GWe by 2050. (Forecasts are for between 1140 and 3500GWe nuclear generation in 2060 implying around 1000 reactors of this size around the world by mid-century).

With a moderate amount of hydroelectricity, renewable and residual coal/gas, this will meet all Australia's electricity needs – reliably, safely, cleanly and cost effectively.

- It solves our GHG challenge in the electricity sector completely.
- It ensures an industrial strength energy infrastructure with baseload integrity.
- It provides for energy security and independence given Australia's extensive uranium reserves.
- It creates a modern industry of high technology and with sophisticated jobs.
- It establishes the energy platform which can charge electric cars and produce hydrogen fuel dependably and cleanly as will be required in the latter part of this century. (Indeed as recharging electric vehicles will drive off peak demand, pressure on baseload generation will grow proportionately faster at double the growth rate of overall demand)

And with the arrival of small, 50-200MWe gas cooled reactors around 2015, these modular units (some compact enough to fit in a shipping container) could contemporaneously be deployed to meet the needs of towns not reached by the main grids, industrial sites such as mines, smelters, and our growing number of desalination plants.

WHAT ABOUT LOCATIONS? WASTE MANAGEMENT?

People with reservations about nuclear energy generally raise two concerns: the location of reactors and the management of radioactive waste.

The criteria for siting reactors include proximity to the main electricity grid, availability of water (including sea water) and access to consumer and industrial markets.

In larger networks, reactors are typically built in configurations of 2-4 operating units.

An Australian national network of fifty reactors would require from 13-25 sites which, in the main, could be co-located with existing power stations which automatically satisfy the criteria above.

The two most energy intensive states in Australia are NSW and Victoria.

The former has a land area of 809 thousand square kilometres (km2), the latter is 238 thousand km2.

Country	Area (000 km2)	Population (m)	#Reactors
UK	245	61	19
France	551	58	59
Japan	378	127	55
S Korea	100	48	20
Italy	301	59	8-10 (by 2030)

All countries in the table have population densities much greater than any found in Australia, and in the cases of Japan, S Korea and Italy, have more difficult and less stable geologies.

Yet all have identified satisfactory locations for their reactors in numbers much greater than would be contemplated in Australian states.

The task of finding suitable locations in Australia is simple, even if the political and social challenges may be difficult, at least for the first step.

Coal-fired power station sites are close to ideal: remote from urban settlement, adequate real estate, available cooling water, easy grid connection, good construction access, trained workforce and culture etc.

The US Nuclear Regulatory Commission has determined that used nuclear fuel can be stored safely and with no environmental impact indefinitely and certainly for at least 30 years beyond the licensed operating period of a nuclear power plant.

Accordingly, most spent fuel is kept on site either in pools of water which cool and shield it, or in dry storage – ventilated concrete casks about 6 metres high alongside the plant. This can continue beyond the reactor's 40-60 year operating life until the spent fuel is transported by road or rail to national repositories for long term storage.

A single large reactor serving a million people produces a volume of nuclear 'waste' equivalent to that of the size of a passenger car per year. This is judged to be very small.

No national storage facility is currently complete; several will open in the next 10 years (eg Finland, Sweden).

The industry for civilian power is 54 years old so some reactors are now approaching the end of their useful lives and decisions for disposal of spent fuel and decommissioning of reactors will be addressed in the decades ahead.

In Australia's case, design of a national storage facility for spent fuel assemblies could probably begin around 2060 when the global experience with such structures will be extensive.

Or earlier should Australia develop a fuel leasing business to approved international clients with subsequent high level waste disposal in engineered repositories.

Criteria for selection of a deep geologic disposal site require low seismic activity, no nearby water flows, and a reasonable distance from population centres.

95% of our continent satisfies such requirements.

If global warming is a serious issue, then given the choice of managing the legacy of nuclear waste produced at 1000 (or even 5000) well engineered and carefully controlled reactor locations globally versus managing the consequences of runaway climate change at the end of this century, the decision should be obvious.

NEXT STEPS

Our current national debate about greenhouse gases and an emissions trading scheme is the first step of a larger agenda.

The main game is to design an evolutionary path along which the Australian economy progressively reduces its dependence on fossil fuels while enhancing its productivity and competitiveness.

Assembling a range of novel, niche energy technologies may be interesting and intellectually satisfying but is inefficient when better industrial-grade solutions are available.

Nuclear power must be in the mix, and we should be prepared for it to be most of the answer within a few decades. (France achieved this state in the 1980s with almost 80% of its electricity being nuclear generated).

Here are the conclusions of a UK Government White Paper from 2008:

The (UK) Government believes new nuclear power stations should have a role to play in this country's future energy mix alongside other low carbon sources: that it would be in the public interest to allow energy companies the option of investing in new nuclear power stations; and that the government should take active steps to facilitate this.

It will be for the energy companies to fund, develop and build new nuclear power stations (in the UK) including meeting the full costs of decommissioning, and their full share of waste management costs.

This seems a very sensible starting position for Australia to emulate.

We must have bipartisan agreement on the legitimacy of nuclear power in our planning.

The work of the 2006 UMPNER Task Force should be updated perhaps by the Productivity Commission as issues of relative costs are becoming more important and better data are now available.

(The Australian Academy of Technological Sciences and Engineering is already undertaking a comparative analysis of generation options available to Australia in 2050)

We must authorise and resource our nuclear regulators to design appropriate protocols and regimes for a fast growing domestic nuclear industry.

We must re-establish the tertiary level education and training capabilities that such an industry would demand. International collaborations will be important.

We should start the determination of prospective sites for the first reactors.

Our goal should be to have nuclear electricity supplying our grid from our first reactor by 2020.

Ten 1000 MWe reactors by 2030 could deliver 25% of our electricity needs.

Then 50 reactors by 2050 could produce 90%.

The main role for government should be

- Clarity about our energy strategy and goals
- Achieving bipartisan support for nuclear reactor deployment
- Establishment of a world class nuclear regulatory authority to oversee the industry