WHAT ROLE FOR NUCLEAR POWER IN THE AUSTRALIAN ELECTRICITY INDUSTRY?

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ABSTRACT

A Prime Ministerial Taskforce has recently been appointed to undertake a review into uranium mining, processing and longer-term contribution of nuclear energy in Australia. This raises the possibility that the Government sees a significant role for nuclear energy in the Australian electricity industry in contrast to the position taken in the Government's Energy White Paper of 2004, *Securing Australia's Energy Future*, in which nuclear power was regarded as a reserve option. However, nuclear power is unlikely to be competitive in the Australian National Electricity Market under present circumstances. This paper discussed the review and its outcomes to date, considering relevant issues such as climate change concerns and response options, the projected need for base-load generation, siting issues, alternative generation and demand-side options. It considers the implications for energy-intensive industry and the policy and the institutional questions that would arise from the introduction of nuclear energy into Australia's National Electricity Market.

INTRODUCTION

The Prime Minister has recently established a uranium mining, process and nuclear energy review with the following terms of reference[1,2]:

> **Economic issues**
>
> (a) The capacity for Australia to increase uranium mining and exports in response to growing global demand.
>
> (b) The potential for establishing other steps in the nuclear fuel cycle in Australia, such as fuel enrichment, fabrication and reprocessing, along with the costs and benefits associated with each step.
>
> (c) The extent and circumstances in which nuclear energy could in the longer term be economically competitive in Australia with other existing electricity generation technologies, including any implications this would have for the national electricity market.
>
> (d) The current state of nuclear energy research and development in Australia and the capacity for Australia to make a significantly greater contribution to international nuclear science.

[1] http://www.dpmc.gov.au/umpner/reference.cfm, accessed 29/9/06
[2] This in contrast to the position taken in the Government's Energy White Paper of 2004, *Securing Australia's Energy Future*, in which nuclear power was regarded as a reserve option.

Environment issues

(a) The extent to which nuclear energy will make a contribution to the reduction of global greenhouse gas emissions.

(b) The extent to which nuclear energy could contribute to the mix of emerging energy technologies in Australia.

Health, safety and proliferation issues

(a) The potential of 'next generation' nuclear energy technologies to meet safety, waste and proliferation concerns.

(b) The waste processing and storage issues associated with nuclear energy and current world's best practice.

(c) The security implications relating to nuclear energy.

(d) The health and safety implications relating to nuclear energy.

This paper will consider the implications of this review with particular reference to its implications for the use of nuclear power in the Australian electricity industry. However, to understand the implications of the review, it is important to first place the inquiry in the broader global context.

Global human society must now attempt to solve a set of complex, interrelated problems that Diamond (2005) characterises as fundamental threats to human civilisation:

1) Destruction of natural habitats
2) Collapse of wild fish stocks
3) Loss of biodiversity
4) Loss of soil quantity and quality
5) Fossil fuel constraints
6) Fresh water quantity and quality
7) Photosynthesis limits
8) Toxic chemicals
9) Introduced (alien) species
10) Climate change
11) Population growth
12) Per-capita human impact.

In the above list, nuclear energy has a direct relationship to 5 (its potential to ameliorate the impact of fossil fuel constraints), 6 (its need for cooling water), 8 (the impacts of the nuclear fuel cycle include the use and production of toxic chemicals with their inevitable impact on human health and the environment[3]), 10 (nuclear energy has a low climate change coefficient), 11 (nuclear energy would provide an additional energy resource for humans can exploit but would

[3] *Regulating the Ranger, Jabiluka, Beverly and Honeymoon Uranium Mines,* Senate Committee on Communications, Information Technology and the Arts, October 2003.

exacerbate other problems, including the proliferation of nuclear weapons[4] that are themselves threats to human civilisation) and 12 (related to 11).

From similar considerations, the World Energy Council has proposed three energy goals: *accessibility* to affordable energy services, *availability* of continuous and adequate quality supply and *acceptability* in terms of environmental goals and public attitudes[5]. These are now applicable to all humans rather than just the poor in developing countries, who were the original motivation for the goals.

Thus, like all energy supply technologies, nuclear energy has both advantages and disadvantages that must be weighed up in considering its future role. Given the ubiquitous role of energy in human society and the broad nature of the associated costs and benefits, it is important that decisions of this kind are taken in a manner that attempts to reach a broad societal consensus. As pointed out by Goldsworthy in his submission to the review, which promotes the idea that Australia should become a key player in the global nuclear fuel industry, "This effort must start with bi-partisan political support, without which Australia will be consigned to selling one of its most precious resources – uranium – as low value yellowcake." (Goldsworthy, 2006).

However, the Prime Minister may have pre-empted the process of building a societal consensus. For example, as reported in the Sydney Morning Herald, 18 July 2006:

> "John Howard wants Australia to become an "energy superpower", carving out a position as one of the world's biggest exporters of coal, natural gas, uranium and petroleum." … "As an efficient, reliable supplier, Australia has a massive opportunity to increase its share of global energy trade," he told a Committee for Economic Development of Australia lunch in Sydney…"The Government's energy policy framework unapologetically emphasises the role of new low- emission technologies to deliver a sustainable greenhouse outcome and it unapologetically seeks to preserve the economic value of our energy resources at a time of soaring global demand," he said[6].

The Prime Minister has the support of expert opinion for his implied conclusion that there is now an urgent need to reduce the climate change emissions arising from fossil fuel use (Hansen 2005). Moreover, he is presumably aware that the Australian electricity industry currently contributes around one third of Australian climate change emissions and has exhibited the highest emissions growth of any sector of the economy over the last decade.

In the remainder of this paper, we review the relevant issues facing the Australian electricity industry, with particular emphasis on the National Electricity Market. We consider what role nuclear power might play and what decision-making processes might be appropriate for the challenging problems we now face, where building and maintaining societal consensus is becoming ever more important.

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[4] See for example, the submission to the Uranium Mining, Processing and Nuclear Energy Review by the Department of Foreign Affairs and Trade, available from http://www.dpmc.gov.au/umpner/submissions.cfm.
[5] World Energy Council, Energy for Tomorrow's World. http://www.worldenergy.org/wec-geis/publications/reports/etwan/exec_summary/sum_energy_goals.asp accessed 30/9/06
[6] *We'll be an energy superpower: PM*, Wendy Frew, Environment Reporter, 18 July 2006.

INVESTMENT ISSUES FOR THE NATIONAL ELECTRICITY MARKET

Electricity industries operate as flow industries, establishing a continuous energy conversion chain from primary energy resources (fossil fuels, nuclear energy, renewable energy resources) via electrical energy, as an intermediate energy form in a transmission and distribution network, to be converted in end-use equipment into end-use energy forms while delivering valued energy services end-users (eg heat, light, communications, financial services, motive power).

Because electrical energy travels at the speed of light and is not stored in significant quantities in transmission and distribution networks, electricity industries are exposed to a continuing problem of maintaining continuity and stability of the energy flow. This results in the industry's key challenge of managing the risks to quality[7] and availability of supply at each node (location) in the transmission and distribution network.

The risks of poor quality or unavailability of supply (a blackout) may affect one or more nodes or even all nodes in the power system. Short-term risks (up one or two years) are regarded as operational risks. Longer-term risks are regarded as resource adequacy (or investment) risks where a potential shortfall may be rectified by investing in resources such as generators or demand-side options (eg flexible demand or improved end-use efficiency). Resources with storable primary energy forms (called dispatchable) can be usefully categorised as base-load (used whenever they are available), peak (used only at times of high demand or when base-load or intermediate resources are not available) or intermediate (between the above two categories).

Nuclear power would expect to operate as base-load generation (with limited dispatch capability) in competition with other technologies such as coal power stations, combined cycle gas turbines using gas, enhanced end-use efficiency and conservation. Generators using non-storable renewable energy resources, such as wind energy or run-of-river hydro, also tend to compete with base-load generation in the investment process.

In the National Electricity Market (NEM), a combination of spot and derivative markets for energy and frequency control ancillary services (FCAS) and power system security protocols manage short-term risks. The power system security protocols act as a backstop to the markets as well as deal with disturbances that are too large and/or rapid for the markets to manage. Derivative markets, in conjunction with projections of supply-demand balance, manage resource adequacy by supporting investment. The generation sector of the NEM is designed to be fully competitive. Thus, a generator is exposed to legal risks and does not have a guaranteed future income.

In theory, the NEM energy and FCAS spot and derivative markets direct cash flow from end-users to resource providers according to the value they deliver to end-users as indicated by their willingness to pay in either spot or derivative markets. However, restructuring has yet to fully engage end-users in the market processes and there are some shortcomings in practice compared to the ideal model.

[7] Voltage magnitude and frequency are key measures of quality

THE ROLE OF NUCLEAR ENERGY IN THE NATIONAL ELECTRICITY MARKET

As discussed in (MacGill et al, 2006), nuclear power has characteristics that differentiate it from other electricity generation options:

1) Its strong link to military use is unique among electricity generation options.
2) It has low probability but high impact risks that are difficult to quantify and to efficiently manage by market mechanisms.
3) The management of nuclear waste materials remains a matter of great concern. As SDC (2006) states, 'a dominant challenge of much nuclear waste is the period of hundreds of thousands of years over which it must be effectively isolated from people and the environment".
4) The widespread deployment of nuclear power around the world would increase the risk of its use in terrorist activities, and use of nuclear power by one state makes it difficult to deny the option to others. Moreover, "it is unlikely that terrorist threats involving a nuclear device or material can be eliminated by state-to-state cooperation, even where a terrorist group has the backing of another state. The logic of deterrence fails when one side does not have an easily identifiable or vital asset at which the other can aim" (Canberra Commission, 1997).

Thus, a decision to deploy nuclear power should be taken only with the informed consent of the population at large, rather than by a particular investor according to narrow economic criteria.

DECISION MAKING IN AN ELECTRICITY INDUSTRY FACING A COMPLEX FUTURE

The National Electricity Market implements a market-based approach to investment in energy resources. It implicitly assumes that the investor can be held accountable for most if not all risks associated with the investment decision and, in return, can retain the profits accruing to investment decisions that add value as perceived by end-users.

For reasons discussed above, nuclear power does not fit this model well because too many of the risks are borne by others than the power station owner, or arise from aspects of the nuclear fuel cycle that lie outside the responsibility of the power station owner. A similar issue is now arising with fossil fuel power stations, particularly coal-fired ones, due to growing concerns about their climate change impact. While the threat of litigation might act as a deterrent to investment in both cases, there is also a role for active policy development.

Experience with the Mandatory Renewable Energy Target scheme shows that environmental policy can be developed that is consistent with market-based investment. In fact it appears that in deciding not to extend the scheme as recommended by the government-appointed review panel, the Federal government may have been deterred more by the success of the scheme than its failings (Passey et al, 2006).

Will the nuclear review fare any better if it recommends the adoption of nuclear power in Australia? Given the Prime Minister's apparent enthusiasm, probably yes, at least in the short term. However, that may not be the end of the story. If the review recommends a narrow, nuclear

technology based subsidy, it may not receive the sustained bipartisan support over the timescale required for that to have practical effect. On the other hand, if the review recommends a broadly based policy such as a carbon price signal, it will be more likely to bring forward resource options other than nuclear power.

Another possibility is that this review will turn out to be a lost opportunity for Australia to have discussed the future of its electricity industry in an open and thoughtful manner. That would have required broader terms of reference and (perhaps – time will tell) a more effective and integrated public participation process. The review would have had to acknowledge and address the problem that experts (such as the members) are not the holders of all relevant knowledge in complex, inter-disciplinary matters. In fact, they may suffer important blind spots or biases. As pointed out by Healy:

> "While lay people may lack a detailed understanding of technicalities, experience suggests that they can be adept and skilful in playing a quality assurance role for complex technical proposals in which they are stakeholders. As a result a key challenge for public participation is to ensure the equitable integration of lay and expert perspectives. This requires processes able to creatively combine divergent perspectives, a fundamental prerequisite for which is the resolution of asymmetries in power, resources and trust between stakeholders. Resolving lay knowledge 'deficits' in a way that, at the same time, respects public knowledge and facilitates its integration with the more formal insights of expertise is fundamental to the resolution of these broader asymmetries." Healy, 2006)

Only time will tell what the outcome of the nuclear review will be. However, given its terms of reference there appears to be little opportunity for it to contribute to the vital question of how the Australian electricity industry can rapidly reduce its climate change emissions.

CONCLUSIONS

As has been illustrated above, nuclear power has "a troubled past … [and a] contested present and uncertain future" (MacGill et al, 2006). However, because "it offers overwhelming military force and considerable policy impact" (MacGill et al, 2006), humans are unlikely to forgo nuclear power despite its drawbacks. Given the risks involved, it is critical that we use nuclear power in the wisest possible way. In this context, it could be argued that nuclear power is best viewed as a global energy option of last resort that is used sparingly, at times and in locations where it can provide maximum value. It is unlikely that Australia would be a high priority for deploying nuclear power from such a perspective.

Furthermore, successful development of nuclear power in Australia would require the development of stable bi-partisan support at both Federal and State levels, which in turn would presumably require the development of broad and sustained societal support. The following issues act may against the formation of such a consensus:

1) Uranium mining uses and produces toxic chemicals that impact on human health and the environment. Mining companies will come under strong international competitive

pressure to avoid paying the cost of effectively controlling these impacts and this pressure will only increase as lower grade ores are mined. Similarly, the long-term management of high-level wastes remains unresolved. In both cases, independent, robust, persistent and well-resourced regulation will be required to avoid disastrous consequences. Experience to date has not been encouraging (ECITARC, 2003).

2) Uranium enrichment is subsidised and tightly controlled by the existing (and aspiring) nuclear weapon states because of its potential military role. It is unlikely to be profitable as an independent commercial venture and the technology may not even be made available to Australia. For example, "the rights to commercially deploy the SILEX technology [developed in Australia] have recently been granted to the General Electric Company (GE), under an agreement signed in May 2006. … Under the terms of this agreement, any future deployment of the SILEX Technology in Australia would be at the discretion of GE, and would require the approval of the US Government." (Goldsworthy, 2006).
3) Nuclear power stations have a broad set of implications that make them essentially incompatible with the design philosophy of the National Electricity Market, in which an individual investor is assumed to bear most if not all investment risks. Government subsidy of this risk exposure would distort the "level playing field" that the NEM is intended to create.
4) Australia won't have a competitive advantage in nuclear power. This is because there are industry-level economies of scale that could not be captured in Australia, the technology would be largely imported and nuclear fuel cycle costs would be little lower at best and more likely higher than in countries that had a more substantial nuclear power station fleet. Thus deployment of nuclear power in Australia would spell the end of the competitive advantages that Australia currently enjoys due to its low electricity prices.
5) Australia is already being seriously affected by climate change and must reduce its emissions as soon as possible. However, the emerging third generation nuclear power technologies are still to be proven in commercial service in their home countries and it would be imprudent to install them in Australia before that has happened. Thus, they would not begin to enter service for 15 to 20 years at the earliest.
6) Australia has other low-emission energy resource options for electricity generation that are commercially available now and that are more cost-effective and less contentious than the second generation of nuclear power stations. The most important low-emission of these are improved end-use efficiency and conservation, gas combined cycle and renewable energy in the form of wind energy, biomass and small hydro.

Thus the review may find it difficult to achieve what appear to be the Prime Minister's expectations, while at the same time, the vexed question of how to rapidly reduce the climate change emissions associated with the Australian electricity industry may remain unanswered.

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