ANSTO submission to Owen Inquiry into NSW Energy needs June 2007 (extract)

Overview

This submission discusses the environmental, technical and economic reasons why NSW should consider nuclear power, the types of technologies available and addresses the concerns most commonly raised by the public in discussion about nuclear power.

Why NSW should consider nuclear

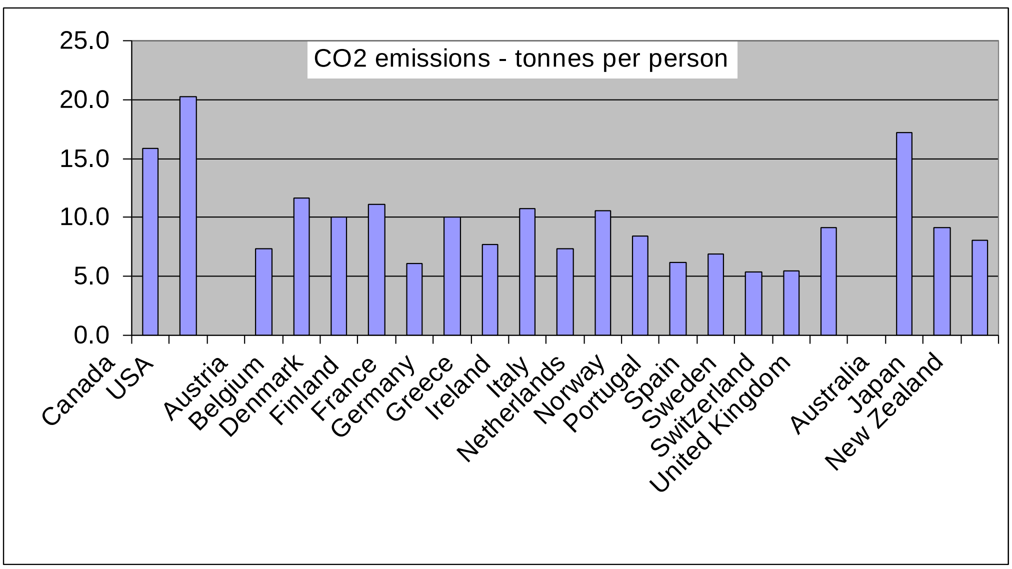
In considering the future base load energy needs of NSW, there are three proven options: coal, gas and nuclear. Hydroelectric is potentially both peaking and base load, but it is generally agreed has limited opportunities for expansion in Australia. Options such as wind, solar, and wave power do not provide consistent power, and potential future options such as carbon sequestration, clean coal and geothermal are not yet proven or established.

Australia's carbon emissions to the atmosphere are among the highest *per capita* in the world, and are predominantly produced by fossil fuel power stations. The fuel mix for electricity production in NSW is dominated by coal, which explains the high level of carbon dioxide emissions per unit of electricity produced.

If carbon emissions and their consequences are given substantial weight, then the adoption of nuclear power generation must be considered.

In addition to base load carbon mitigation strategies, renewable power sources, especially wind, should be developed as part of the State's energy mix, together with strategies for

Comparative CO_2 emissions by Country



CO_2 emissions data from OECD; population data from UNFPA

conservation and efficiency

Nuclear power has been demonstrated to operate at the scale required, and in overseas markets is competitive in cost terms with other energy sources even before carbon pricing is taken into account.

Projections of Australian greenhouse gas emissions beyond 2010 show approximately 70% of the projected increase of 90 Mt CO_2-e in emissions from stationary energy sources is attributable to electricity generation.

If Australian is to meet its greenhouse targets, it will be essential for NSW, its most populous state, to move to low emissions technologies for electricity generation. Internationally, nuclear power generation is increasingly being advocated as part of a strategy to reduce CO_2 emissions and mitigate global climate change. The reasons for this include demonstration of the safety and reliability of nuclear power over the past 20 years, the need to conserve liquid fuel energy sources for transportation, and the requirements to limit the production of greenhouse gases, particulates, other combustion by-products, and acid rain, which are all associated with the combustion of fossil fuels.

The power of nuclear to cut CO_2 emissions

NSW has recognised that it needs a reliable source of base-load electricity generation that does not emit major amounts of CO_2. This would ameliorate Australia's emissions per unit of energy produced, which compare unfavourably with other countries, as the graph below shows. Because of our high coal dependency, we rank third behind China and India. To achieve the lower emission levels of other countries, it will be necessary to emulate the countries lower on the chart, which have higher renewable and nuclear dependency. With few exceptions, these countries have nuclear power as a key part of their energy mix. The balance is primarily hydroelectric, for which opportunities in Australia are few.

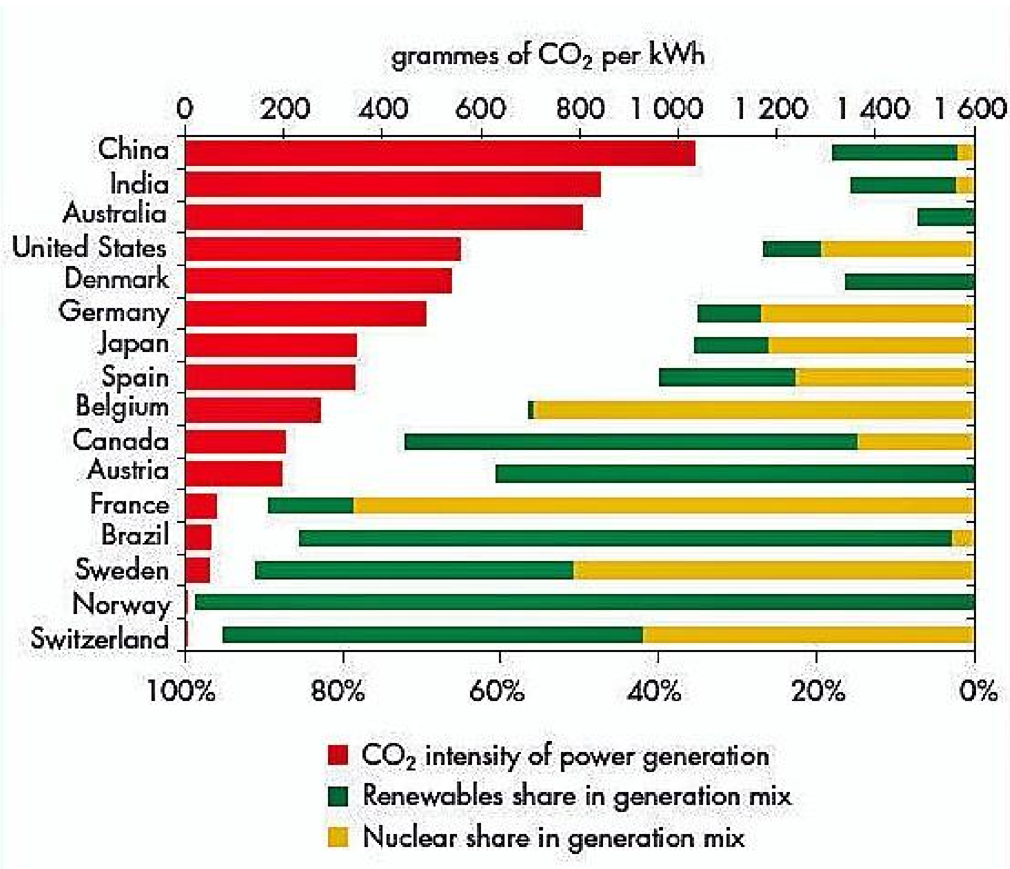
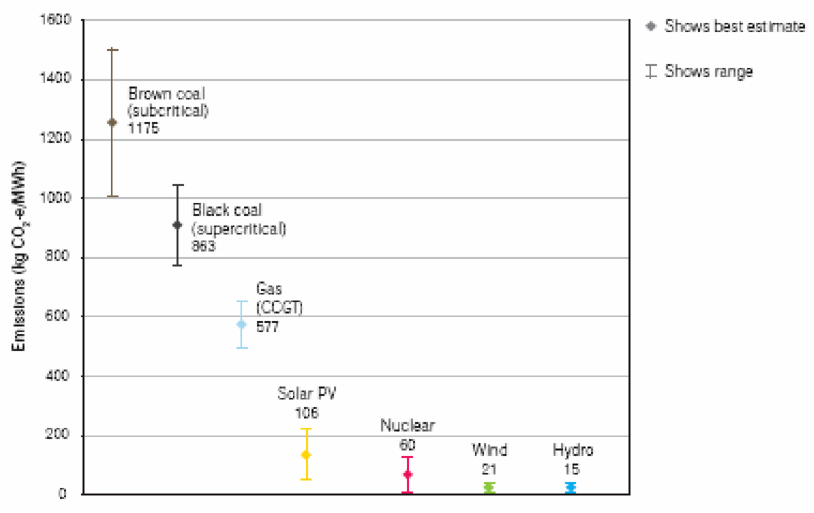


Figure showing power sector CO_2 emissions per kWh and shares of nuclear power and renewable in selected countries (Source: IEA 2004)

If NSW is serious about reducing greenhouse gas emissions, then it must consider that it is estimated that each nuclear power plant saves emissions of around 10 million tonnes of CO_2 annually. Nuclear is the only base-load option available that has a low CO_2 emission rate, as can be seen from the figure from the UMPNER review below. This also shows that nuclear is comparable with wind and hydro and more ‘green’ than solar power, where production of the photovoltaic cells requires substantial quantities of power.



Estimated life cycle emissions for various technologies

(CO_2–e = carbon dioxide equivalent; MWh = megawatt hour; PV = photovoltaic: CCGT = combined cycle gas turbine)

Source: UMPNER review

The economic benefits of nuclear

Nuclear energy is an extremely efficient way to produce heat for electricity generation compared to other base-load options, primarily due to the nature of the nuclear fission reaction. The fission of one uranium atom liberates large amounts of energy, namely some 200 MeV compared with a few eV from burning one carbon atom. A 1000 MWe plant running on fossil fuels would require 4,000,000 tonnes of fuel per annum, whereas the equivalent nuclear power station would require only 25 tonnes of fuel.

Enriched uranium, in the form of uranium oxide, is compacted into pellets that are fired to a hard ceramic. A single nuclear reactor fuel pellet weighing 7-8 grams has a diameter of 8 mm, is 10 mm long and can produce as much energy as 1.5 tonnes of coal.

Uranium oxide pellets

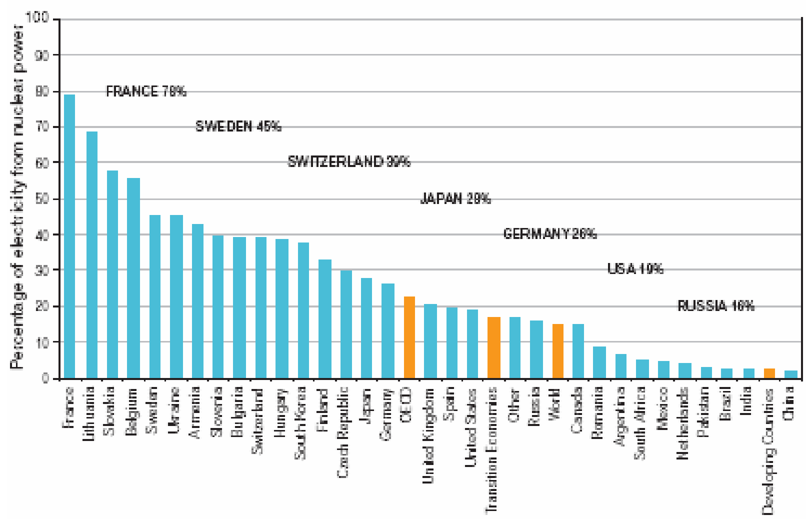
One pellet can produce as much energy as 1.5 tonnes of coal

The volume of waste produced by a nuclear plant is also greatly reduced compared to the millions of tonnes per year from a fossil fuel plant.

Why the rest of the world is turning to nuclear

NSW and Australia are not alone in this issue. There are 31 countries currently using nuclear power, and a further 18 considering it. Existing reactors save 2,500 million tonnes

Nuclear share of electricity



Source:UMPNER

of CO_2 per year, equivalent to the Kyoto protocol reduction targets for all countries.

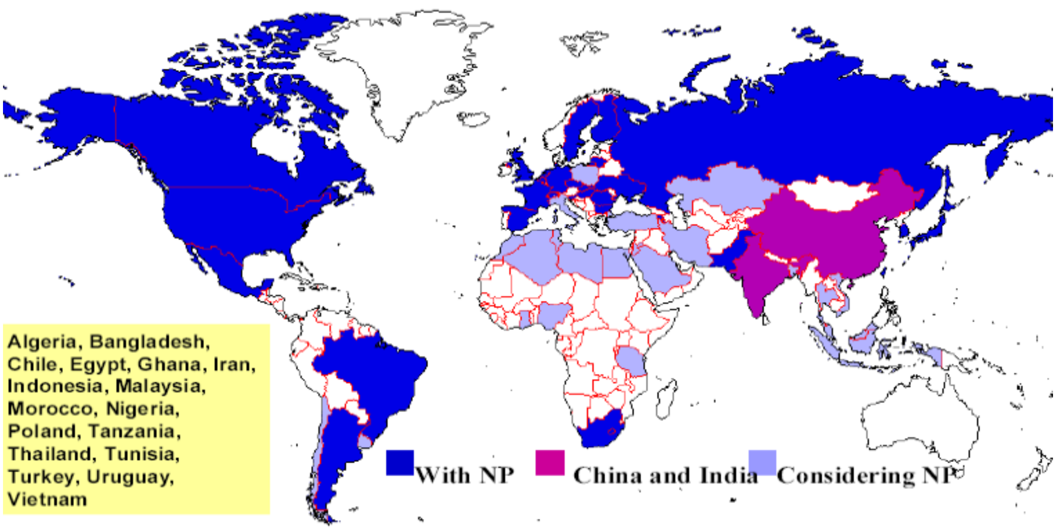
Nuclear power has been in use for over five decades. It grew most rapidly in the 1970s in response to the oil crisis at that time, but slowed during the 1980s after the Three Mile Island and Chernobyl accidents and after oil prices eased. Currently, approximately 17% of the world's total electricity production comes from 443 nuclear power plants located around the globe.

Many countries that currently use nuclear power are planning new nuclear power plants, and about 18 other countries are now considering the nuclear power option. In the next 30 years the strongest growth of the nuclear power industry will be in Asia, with substantial expansion programs in China and India and Indonesia, Malaysia, Thailand and Vietnam all planning new plants (see figure over). In total, apart from 30 new nuclear power plants currently under construction, a further 70 nuclear plants are planned worldwide and a further 150 are proposed.

In fact, the current level of nuclear construction or planned construction is at an all time peak largely due to nuclear construction in the Asian region, but also in the US and Europe. The reasons for this renaissance of the nuclear industry lie in three broad areas:

- concerns surrounding the contribution of carbon dioxide to global climate change, given the increasing evidence of real effects - CO_2 levels are rising rapidly and, if we want to stabilise these levels, the time for decisions is very short.;
- considerations of security of energy supply, driven by concerns about oil and gas prices and availability - the much greater energy efficiency of uranium enables much greater security of supply; and
- attractive economic outcomes and projections for nuclear electricity production - the relatively low sensitivity of nuclear power to movements in the price of its raw material offers stability in electricity prices.

Nuclear power map



Environmental opinion

Prominent environmentalists and scientists from a range of backgrounds have expressed the view that nuclear power is an important potential contributor to the world's energy requirements. These include James Lovelock, who as one of the world's eminent environmental urges that environmentalists should *'drop their wrongheaded objection to nuclear energy'*. He states that it is a *'secure, safe and reliable source of energy'* that poses a threat which is *'insignificant compared to the real threat of intolerable and lethal heatwaves and sea levels rising'*.

Patrick Moore, the co-founder of Greenpeace has said *'My views have changed because nuclear energy is the* ***only non-greenhouse emitting power source that can effectively replace fossil fuels while*** *satisfying the world's increasing demand for energy.'*

At the present time there is no feasible and proven greenhouse friendly base-load option other than nuclear power. With its significant population and associated infrastructure, NSW is ideally placed to lead the nation in nuclear power and resulting decreased greenhouse gas emissions.

Considerations for introducing nuclear power plant

Any nuclear power plants would need to be sited so as to access the power grid. Access to water, whilst convenient for cooling purposes, is not essential, given examples of air-cooled nuclear power plants overseas. If water is to be used for cooling, it would be preferable to locate the plant on the coast in order to use seawater, given the pressure of NSW freshwater supplies, or treated waste water has also been utilised overseas.

If NSW were to make a decision to move to nuclear power in the next 5 to 10 years, then it would look to Generation III reactors, of which there are several proven designs available. Reactors with settled down costs could be chosen; however there would still be first-of-a-kind costs in introducing a new technology into Australia. The development of Generation IV reactors with long-term demonstration of reliability allowing commercial deployment is likely to be at least 30 years away. Large scale carbon capture and sequestration is likely to be available only in the same time frame.

Why nuclear waste can be managed

The operation of nuclear power plants results in radioactive waste. The activity of the various types of radioactive wastes diminishes over time down to levels equivalent to background radiation.

Radiation emissions from the world's nuclear industry are small compared to natural background radiation. The OECD has estimated that the cumulative radiation dose to the world population arising from the entire world nuclear industry (including power plants, uranium mining and other fuel cycle facilities), averaged over 50 years, is approximately 0.3% of the natural background (OECD, 1998).

Natural radiation exposure is highly variable, depending on natural radiation sources in the locality. For example, the average background dose is 1.5 mSv/yr in Australia, but is 50 mSv/year in parts of India and up to 260 mSv/year in Ramsar in Iran. Furthermore, it is possible to receive a radiation dose of 0.15 mSv due to cosmic radiation on a typical airline flight. This reinforces the fact that radiation exposure attributable to the entire nuclear industry is trivial compared to other common radiation sources.

To contrast again with coal, a typical 1000 MW coal burning power station will release over 5 tonnes of uranium into the environment each year. The levels of uranium in coal ash are so high in some instances that recovery of uranium from coal-fired power station wastes is being considered overseas. The global releases of radioactivity from fossil fuel combustion should be considered when comparing overall environmental impacts of coal burning with the nuclear fuel cycle.

The major radioactive waste arising from nuclear power plants is irradiated (spent) nuclear fuel, although low-level waste (LLW) and intermediate-level waste (ILW) are also produced.

Spent fuel from nuclear power plants contains a number of relatively short-lived fission products, the decay of which generates significant amounts of heat. Consequently, after discharge the spent fuel is generally stored at the reactor site in storage ponds for at least three to five years. The ponds perform the dual purpose of providing cooling as well as shielding from the intense radiation.

Low-level wastes can include lightly contaminated items such as paper, plastics, rags, protective clothing, glassware, etc. Special shielding is not normally required for transport and handling. The low levels of radiation in low-level waste mean that near-surface burial in containers is regarded as a safe method of disposal.

Intermediate level wastes are those emitting higher levels of radiation, with this category including short-lived and long-lived intermediate level wastes. Disposal options for short-lived intermediate level waste are similar to those for low-level waste. There are more than 100 near-surface repositories for low level and short-lived intermediate level radioactive waste operating around the world.

Long-lived intermediate level wastes include by-products from the treatment of spent nuclear fuel, some wastes produced by the operation of nuclear reactors, and some long-lived radiation sources used in industrial applications. Long-lived intermediate level waste is not suitable for near-surface disposal. The preferred approach is usually long-term above-ground storage, pending eventual disposal in a geological repository. A number of countries are developing deep geological repositories.

Waste minimisation using reprocessing

Reprocessing is the physical and chemical processing of spent fuel from nuclear power stations to separate uranium and plutonium from other radioactive waste products. Reprocessing of spent fuel allows the unused fissile uranium content to be re-used, as well as enabling the plutonium created during irradiation to be re-cycled in MOX fuel.

The waste remaining after plutonium and uranium are removed is high-level waste, containing about 3% of the used fuel in the form of fission products and minor actinides (neptunium, americium, and curium). It is highly radioactive, continues to generate significant heat and requires immobilisation in a suitable waste form before disposal.

Synroc ('synthetic rock') is an Australian-developed nuclear waste immobilisation technology that contains mixtures of minerals that have been shown in nature to lock up radioactive elements for millions of years. A full-scale Synroc demonstration plant is currently being constructed in the UK to treat waste from early fuel development. In the US, Synroc is currently being evaluated for the treatment of high level waste at the Idaho National Laboratory.

Volumes of wastes from coal and nuclear power

The worldwide consumption of fossil fuels produces about 25,000 million tonnes of CO_2 annually, enough to make (if solidified) a mountain about 1.5 km high and with a base nearly 20 km in circumference. The same quantity of energy produced from nuclear fission reactions would generate approximately two million times less waste, and it would occupy only a 16 metre cube.

A comparison of waste production is shown below. The annual volume of waste from a typical 1000 MW coal power station would fill 3200 Olympic swimming pools.

Comparative annual waste production
1000 MW power plant

Coal fired		Nuclear	
CO_2	8,800,000 t	CO_2	35,000 t
Solid	3,300,000 m^3	high level waste	0.9 m^3
		spent fuel	16 m^3
		intermediate waste	75 m^3
		low level waste	222 m^3
uranium	5.2 t		
sulphur dioxide	100,000 t		
nitrous oxides	75,000 t		
carcinogens			
heavy metals			
arsenic			
mercury			

If placed end-to-end, these would extend from Sydney to Gosford. To produce the same power output the high level waste from a nuclear plant would fill two four-drawer filing cabinets, and the total solid wastes would take ten years to fill one Olympic-sized pool.

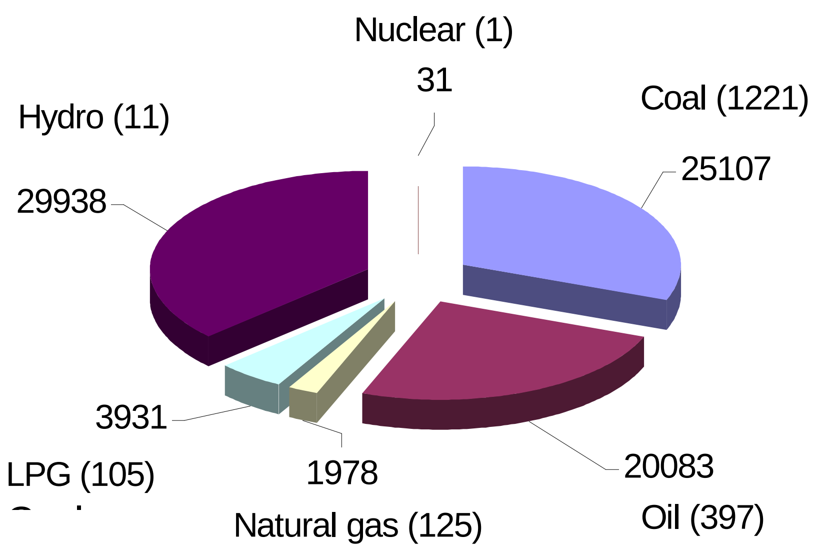
It should also be noted that waste from nuclear power generation is contained, which is not the case for coal-fired production, where much of the waste products are emitted into the atmosphere.

Why nuclear power is safe

Nuclear power has an excellent safety record compared to other base load options.

There have been two major reactor accidents in the history of civil nuclear power - Three Mile Island and Chernobyl. Three Mile Island was contained without harm to anyone ,and Chernobyl involved an intense fire in a reactor which lacked provision for containment

Fatalities in the energy production sector 1969-2000



and would not have been licensable in a Western country. These are the only major accidents to have occurred in more than 12,000 cumulative reactor-years of commercial operation.

Immediate deaths from the Chernobyl accident were 31, with a further 25 after 20 years including 9 children from thyroid cancer (out of 4000 cases). Thyroid cancer in children, which has a high cure rate, would have been avoidable had iodine tablets been provided to the affected communities at the time. It has been estimated that several thousand people may die prematurely as a result of doses received at the time.

This compares to the Bhopal chemical plant disaster in 1984, which caused 4,000 immediate fatalities and 15,000 in following years. There have been 112 deaths in NSW coal mines since 1979.

Non-proliferation

The Non-Proliferation Treaty requires non nuclear-weapons states to allow the International Atomic Energy Agency (IAEA) scrutiny of their nuclear activities. This is to ensure that there is no diversion of uranium or plutonium from peaceful uses to weapons applications. All states apart from India, Pakistan and Israel are party to the NPT.

As a major uranium supply nation Australia is a founding member of the IAEA and is represented on the Board of Governors by ANSTO.

Uranium that is used for power purposes is typically enriched to 3.5 to 6%. This is well below the level required for weapons which is typically in the order of 90%. Enrichment plants can enrich up to weapons level but their operations are also under IAEA Safeguards and the supply of technology is controlled by a consortium of countries in the Nuclear Suppliers Group.

There are no safeguards impediments to the introduction of nuclear power into Australia. Australia has excellent non-proliferation credentials, having led the way in the development and introduction of new verification standards and procedures.

Conclusion

The primary considerations for NSW in introducing nuclear power are cost, safety, greenhouse gas emissions and waste.

Nuclear power is cost competitive with other forms of power, particularly when carbon emission costs are taken into accounted. A detailed analysis of power generation cost is outlined in the Commonwealth government's UMPNER report. ANSTO notes the finding of the UMPNER review that “Nuclear power is the least-cost low-emission technology that can provide base load power.” The report also goes on to note the uncertainties of costs and timescales for renewable options.

The nuclear power industry has an excellent safety record when compared to other energy production methods.

Nuclear waste can be safely managed. Volumes of waste are small compared to those from coal-fired energy production.

Greenhouse gas emissions are essentially zero for nuclear power production. Even when emissions are calculated over the life cycle of nuclear power, the emissions are negligible compared to the power produced over the lifetime of the reactor, and much less than any fossil-fired technology.

Nuclear power is clearly a base-load option that is available to efficiently meet future energy needs for NSW. Currently, real options for base load power are limited and it is impossible to genuinely consider base load power options without consideration of nuclear power. This becomes even more important when considering options that reduce greenhouse gas emissions.

It is worth noting the synergy between the ‘green’ consistent base load supplied by nuclear power and desalination of seawater. In Japan and other countries nuclear/desalination plants are located in tandem. Desalination requires consistent electricity supply, which renewables such as wind and solar cannot provide.

The nuclear power industry is a mature industry, currently enjoying a global renaissance. More and more environmental scientists admit that the gains made by utilising nuclear power in reducing greenhouse gas emissions far outweigh the concerns in areas such as radioactive waste management where most of the technical problems have been solved and the outstanding difficulties are in many respects political.

If appropriate legal, regulatory and training systems were put into place, NSW would have the population base, skills and infrastructure to carry out a nuclear power program. Existing Australian expertise in nuclear science and technology resides in NSW. Geographically, there are a number of ideal sites for nuclear power reactors.

NSW has the opportunity to lead the nation in clean, safe and efficient base load power generation.