Submission No 45

INQUIRY INTO URANIUM MINING AND NUCLEAR FACILITIES (PROHIBITIONS) REPEAL BILL 2019

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Inquiry into the Uranium Mining and Nuclear Facilities (Prohibitions) Repeal Bill 2019
A Submission to the NSW Legislative Council's Standing Committee on State Development

The world has changed since the NSW uranium mining and nuclear facilities prohibitions act was put in place in 1986. The object of the act was, and still is, to protect the health and safety of people and the environment.

I suggest that the committee needs to seek answers to **two questions**:

If the prohibitions act is repealed, **are there arrangements in place to ensure the health and safety of people and the environment?**
The answer to this question is yes.

Australia has two world class regulators in ARPANSA for nuclear safety and ASNO for security of nuclear materials. Both recently gave evidence to the 2019 Federal nuclear inquiry and confirmed that their organisations could handle a nuclear power program, with additional resources.
Uranium mining in NSW would be subject to NSW state regulation.

The second question is **do we see a role in NSW for the nuclear fuel cycle and particularly uranium mining and nuclear power?**

1. Uranium Mining

The primary use for uranium is fuel for nuclear power reactors for electricity generation. Australia only sells uranium for civil use. Nuclear power reactors generate electricity with zero CO_2 emissions, and 12 kg/MWh whole of life cycle emissions, the same as wind and less than solar PV (NFC Royal Commission). In 2018, 2,563 TWh was generated by nuclear power reactors worldwide, saving over 2 billion tonnes CO2-e emissions (World Nuclear Association). Nuclear power has made, and continues to make, a very significant contribution to reducing emissions from electricity generation worldwide. In 2018, nuclear power generated more electricity worldwide than solar and wind combined.
A second use for uranium is fuel for research reactors. An Australian example is ANSTO's OPAL reactor at Lucas Heights, NSW. OPAL produces life-saving medical isotopes.

Australia has the world's largest resources of uranium. Geoscience Australia estimates Australia's Reasonable Assured Resources (RAR) of uranium recoverable at costs of less than USD 130 per kilogram to be 1,270,000 tonnes uranium. This is more than twice the resources of any other country. Olympic Dam in South Australia has the world's largest uranium deposit being mined. There are also uranium mines on the east side of South Australia, near to the NSW border. The radioelement airborne geophysical data shows there are uranium deposits in west NSW towards the border with South Australia. Any new mining activities would be privately financed.

Uranium mining has bipartisan support at Federal level.
In 2012 the ban on exploring for uranium in NSW was removed, but mining is still prohibited under section 7 of the Prohibitions Act. There are strict regulations on uranium mining to ensure the safety of workers and the public. There is no technical reason why uranium

mining should be prohibited, especially as climate change has become a major issue and nuclear power is contributing to the solution in 31 countries and could contribute to the solution in Australia.

2. The Nuclear Fuel Cycle

The NSW UMNF (Prohibitions) Act prohibits the construction or operation of a conversion facility, enrichment facility, fuel fabrication facility, reprocessing plant and radioactive waste storage plant.

Uranium as mined contains 99.3% uranium-238 and 0.7% uranium-235. Only the uranium-235 is fissionable (i.e. can be used as a fuel) in most nuclear reactors.
The majority of power reactors require the proportion of U-235 to be enriched to 3-5%. Enrichment requires the uranium to be first converted into a gaseous form to allow physical separation of the uranium isotopes U-235 and U-238. All conversion plants convert the uranium to uranium hexafluoride UF_6. As the NFC Royal Commission concluded, conversion is a chemical process and the most significant safety and environmental risks are posed by toxic, corrosive or potentially explosive chemicals rather than the radioactivity of the materials. There is currently overcapacity in the conversion market but there is no technical reason to prohibit the construction or operation of a conversion plant.
A commercial enrichment plant increases the proportion of U-235 to 3%-5% for use in a power reactor. The most effective enrichment technology currently employed is centrifuge enrichment. This technology is tightly held and there is over-capacity in the market, but there is no reason for it to be prohibited.

A fuel fabrication plant manufactures nuclear fuel assemblies for a particular type of reactor. Again, there is currently over-capacity in the market, but no reason that this activity should be prohibited.

A reprocessing plant extracts and recycles the uranium and plutonium from used fuel. The plutonium from reprocessing used fuel from a power reactor is unsuitable for use in a nuclear weapon as it contains a mixture of isotopes. It can be reused in a power reactor as mixed oxide fuel (MOX) as in France, Japan and other countries. Reprocessing recycles 96% of the fuel, reduces the volume of waste by a factor of 5, reduces the radiotoxicity of waste by a factor of 10 and transforms the waste into a form suitable for a repository. The used fuel assemblies from ANSTO's research reactors are sent to France for reprocessing. The prohibition on a reprocessing plant can be removed.

Routine operations of fuel cycle facilities and nuclear power plants produce small quantities of low level waste (LLW). The only high level waste (HLW) produced is associated with used fuel from a nuclear power plant. The IAEA issues guidance on the requirements for radioactive waste repositories. Most countries have a simple near surface repository for LLW. The standard for HLW is a deep underground repository and the first of these for commercial used fuel is under construction in Finland. The prohibition on a radioactive waste storage plant or final repository can be removed.

3. Nuclear Power

We need a **reliable, low emissions, affordable electricity supply.**
Wind, solar PV, hydro and nuclear are the only low emissions technologies currently available for electricity generation. Hydro is very limited in Australia's dry climate.
Only nuclear is not weather dependant. .

Reliability is more important now than ever. The recent UK loss of supply illustrated that the grid can be restored quickly, but there was widespread disruption to transport, industry and people's lives which took many hours to restore.
Nuclear is reliable and independent of the weather.

Nuclear is **low emissions -** on a whole lifecycle basis nuclear has emissions of 12 kg/MWh - the same as wind and less than solar (NFC Royal Commission)
Nuclear ticks the boxes for reliable and low emissions.

So the question is "**is nuclear affordable**?"

The CSIRO/AEMO GenCost 2018 report includes a capital cost of $16,000/kW installed capacity for nuclear compared to $3,495/kW for solar plus a 2 hour battery (2018). GHD produced the cost reports for CSIRO/AEMO.
However the nuclear capital cost produced by GHD is based on:

- $16,000/kW with the source given as the World Nuclear Association. The WNA do not recognise this very high figure which is not in any of their reports and confirm they were not consulted on this matter (WNA submission 259 to the 2019 Federal Nuclear Inquiry)
- 300 MW Gen IV reactor constructed in 2035 and not the type of Gen III+ SMR that would most likely be built in Australia.

A more realistic figure for nuclear would be the US$3,600/kW detailed 'bottom up" estimate by Fluor for a NOAK (Nth of a Kind) NuScale SMR plant, which translates to A$5,100/kW.

According to the CSIRO/AEMO GenCost 2018 report, the levelised cost of electricity (LCOE) in 2020 of wind with 6 hours of pumped hydro storage as a representative firmed renewable is in the range of $100/MWh. (confirmed in AEMO submission 246 to the 2019 Federal Nuclear Inquiry). The LCOE of nuclear with a realistic capital cost is < $100/MWh.
Nuclear is competitive to VRE with firming.

When construction contracts for the first SMR plant are signed in the next two years we will have a better estimate of costs, but it will require a feasibility study in Australia to provide an accurate cost.

There would be other benefits from the deployment of nuclear power in NSW.
Nuclear provides **energy security.** A nuclear power plant would hold at least two years fuel supply on site in a room smaller than the NSW Parliament Macquaire room. This protects against supply chain disruptions. On 10 February 2017, the very hot day in NSW, the 667 MW Colongra Gas Turbine failed to start due to low gas pressure.
Nuclear provides **energy diversity.** NSW cannot rely on one source as the situation can change.
Nuclear provides **price stability**. Fuel costs are a lower proportion of operating costs and are less variable than coal or especially gas. New nuclear plants are designed to have at least a 60 year operating life.

Nuclear low emissions electricity is a **pathway to reduce emissions in other sectors,** e.g. transport. Unlike solar and wind, nuclear can provide **direct process heat** to reduce emissions from industry.
Nuclear has a **small environmental footprint.** A 720 MWe NucScale SMR would occupy 18 hectares compared to the 550 hectares for the new 150 MWe Coleambally NSW solar plant. Also wind requires 10x more concrete and steel per MW than a nuclear power plant (2015 US DOE Quadrennial Technology Review).

Nuclear would bring a new industry and new jobs particularly in regional areas. Australia could be part of the global nuclear supply chain.
The first deployment of the NuScale SMR will be the Utah Associated Municipal Power Systems (UAMPS) 12 module (720 MWeG) plant on the Idaho National Laboratory site. A study by the Idaho Department of Energy of the impact of the project on the town of Idaho Falls found:
1,100 direct construction jobs for 3 years plus 11,808 local jobs through 'inter-industry" trade and local services for the new workforce.
360 direct nuclear power plant operations jobs, 1,500 associated local jobs and an annual revenue of $389 million for local industry.

Small Modular Reactors (SMRs)
SMRs are nuclear power reactors with a unit output of < 300 MWe. They have a number of advantages:

- provide reliable, low emissions power in remote locations or for small grid systems
- Very high level of passive or inherent safety
- Reactor vessel can be installed below ground reducing the possibility of damage from external hazards or intrusion
- The reactor module is factory built, minimising on-site time and reducing risk of construction delays
- Lower initial capital cost than a large reactor. Scalable - modules can be added as required. Early revenue from first operating modules
- One module at a time is shutdown for refuelling with the other modules still generating electricity (capacity factor > 95%)
- Flexible operation, can load follow to support VRE
- Can supply process heat for desalination or industrial use
- Simpler to operate and maintain than a large reactor
- Compact, would fit on any existing power station site

Sources of factual data
I suggest that the committee look at two websites that provide current data and will assist in understanding current electricity generation in Australia and worldwide.

Australian Energy Market Operator (AEMO) data dashboard:
https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Data-dashboard#price-demand
This displays the current electricity demand and price in each state. Although it is often said that "base load" no longer exists, the data for NSW shows that there is a demand of 6,000 MW twenty four hours a day, seven days a week. This requires a supply of 52,560 GWh/year. The new Coleambally solar plant in NSW, the largest in

Australia (peak 150 MW, actual comparative capacity 46 MW[1]), is claimed to produce 380 GWh/year (Neon Coleambally website). This illustrates the scale of the problem in NSW when trying to replace even the basic demand with VRE.

The AEMO data dashboard also displays average price tables for day/month/year: https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Data-dashboard#average-price-table.
For South Australia, which has a high proportion of VRE, the daily average spot price in October 2019 has varied between -$23.15 and $125/MWh.
Price volatility is increasing which makes financing of new generation more difficult without subsidies.

The second website displays current generation by technology, emissions, prices and transfers between countries worldwide:
https://www.electricitymap.org
The Australian section of the map displays each state and the origin of electricity/carbon intensity/electricity prices for the last 24 hours.
As an illustration of the effect of VRE, on 15 October 2019 when the wind was not blowing in SA, the electricity generation source was 97% gas and the price $294/MWh. The contribution of wind in SA can be <10% to >80% leading to extreme price volatility.
It is useful to look at other countries on the map to see the emissions intensities with different generation mixes. Countries with low emissions intensities have either large hydro resources (Norway) or have nuclear as part of their energy mix (France, Belgium, Sweden).

Summary

Passing the Uranium Mining and Nuclear Facilities (Prohibitions) Repeal Bill 2019 will not lead to a detriment in the health and safety of people and the environment and would enable NSW and countries overseas to benefit from uranium mining.
Repealing the bill would also enable serious consideration of reliable nuclear power for NSW leading to lower emissions.
The challenge is to determine the mix of technologies going forward to achieve a low emissions, reliable electricity generation system at the lowest cost to customers. This requires a sophisticated comprehensive model which considers all technologies and system costs and examines a range of scenarios.

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[1] A 46 MWe plant operating at a capacity factor of 95% would produce 380 GWh/year