Submission No 47

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

Name: Mr Ian Hore-Lacy

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Submission relating to NSW Uranium Mining and Nuclear Facilities Repeal Bill

Ian Hore-Lacy

Australia has been involved with nuclear science and technology for more than fifty years. It has a reputable regulatory authority in ARPANSA.

Uranium has been mined in Australia for many decades, and since the mid 1970s that has been done with full and professional regard for environmental considerations.

Nuclear power provides more than one tenth of the world's electricity from about 450 power reactors totalling almost 400 GWe of capacity, about six times Australia's total.

Australia's considerable dependence on coal for its electricity so far has enabled low-cost reliable supply - both characteristics being vital for our economy.

Replacing coal-based generation with intermittent renewables (wind and solar) inevitably results in escalating system costs as the proportion increases. At high levels this will be unaffordable, as is increasingly realised. I append a summary paper supporting this contention.

The looming electricity supply crisis in Victoria due to excessive incentives to build unreliable wind and solar capacity, and to depend on that, will affect other states also. I point to the recent McKinsey report on Germany's disastrous experience: https://www.mckinsey.de/branchen/chemie-energie-rohstoffe/energiewende-index showing that the country's energy transition to renewables poses a significant threat to the nation's economy and energy supply. With no electricity import and export possibilities, Australia would be in a much worse position than Germany from similar policies.

Nuclear power is a proven reliable and relatively low-cost source of electricity, as shown over more than fifty years in many countries. It causes virtually no CO2 emissions from the full fuel cycle. Nuclear reactors are the low-carbon backbone of electricity systems in over 15 countries which do not have abundant hydro-electric resources.

Materials intensity in generating plants per unit of power delivered is many times better with nuclear power than wind or solar sources of generation.

Considering safety and wastes, nuclear power is distinctly superior to alternatives, despite contrary folklore and assertions. Factual comparison is straightforward.

Any capital investment in new power generation sources of any kind will need some assurance of reasonable returns over two or three decades, as today with renewables. Government-sponsored structuring and financing, similar to what is deployed for variable renewables will be required, otherwise, in a volatile electricity market, there will be no new investment in anything.

Beyond the vital question of market structures for power, questions of capital cost can be left to investors once impediments to the proper consideration of nuclear power are removed.

Beyond uranium mining – where Australia has almost one third of the world's known resources – Australia should not set up other front-end fuel cycle facilities: conversion, enrichment, or fuel fabrication since these services are readily and cheaply available internationally.

Policies to provide electricity and other energy long-term need to be clean, practical and effective, not tokenistic, wasteful and extravagant. Nuclear power is therefore essential.

It is incongruous that one of the two main clean electricity sources in the world is not able to be considered here, let alone deployed. There is little scope for increasing the other major clean source: hydro.

As well as repealing the NSW prohibition legislation, two bits of federal law need repealing to get the question of nuclear power properly on to the table, and then some clear focus on what scale of power reactors are needed and where. Start with removing the nuclear power prohibitions in the *Environment Protection and Biodiversity Conservation Act 1999* (section 140A) and *Australian Radiation Protection and Nuclear Safety Act 1998* (section 10).

Finally, to quote Bill Gates re US situation: *"A bipartisan group in the US Senate has introduced the Nuclear Energy Leadership Act, which establishes an ambitious plan to accelerate the development of advanced nuclear reactor technologies. I can't overstate how important this is."* To which he subsequently added: *"I'm thrilled that senators from both sides of the aisle have come together to support advanced nuclear. This is exactly the kind of leadership our country needs to both solve the climate challenge and reassert our leadership in this important industry."* Such bipartisanship is exactly what Australia needs also, at both state and federal levels!

Ian Hore-Lacy
Senior Advisor, World Nuclear Association, London
(with 25 years experience in the nuclear industry)

Appendix: *Nuclear power? Why not stick with 'free' wind and solar PV?*

Nuclear power? Why not stick with 'free' wind and solar PV?

(Based on paper for AusIMM Uranium Conference, 4 June 2019.)

Ian Hore-Lacy.
Senior Advisor, World Nuclear Association, London.

There are calls from various quarters for Australia to have a fresh look at using nuclear power for our electricity. But what is the point of that if we have so much momentum in building wind farms and also behind-the-meter solar PV on millions of roofs?

And the price of those is coming down. We are assured that the generation cost of wind power is now lower than alternatives. However, that is far from the full picture.

From both local and international analyses, confirmed by German experience, it is clear why a high proportion of wind and solar power in our Australian grid will be unaffordable, no matter what.

An occasional and unreliable supply needs to be matched to steady ongoing demand 24/7, and the challenge and cost of achieving that increases dramatically as the proportion of such supply increases.

If we want reliable electricity supply from intrinsically intermittent sources like wind it becomes very expensive. The downstream cost of making so-called green power stable, reliable, and useful in the electric grid can be considerable, however cheap it may be per kilowatt-hour to generate. But we need to understand why.

First, you need to build a lot more generating capacity. *Prima facie*, if you want 20% of electricity to come from wind turbines, and these have a 25% capacity factor, you need four times as much capacity, so for Australia if we want 20% of 250 TWh from wind then think adding nearly 80% of our present 66 GWe total to do it in meeting the demand from industry, public transport, homes, etc. Just building all that is very expensive.

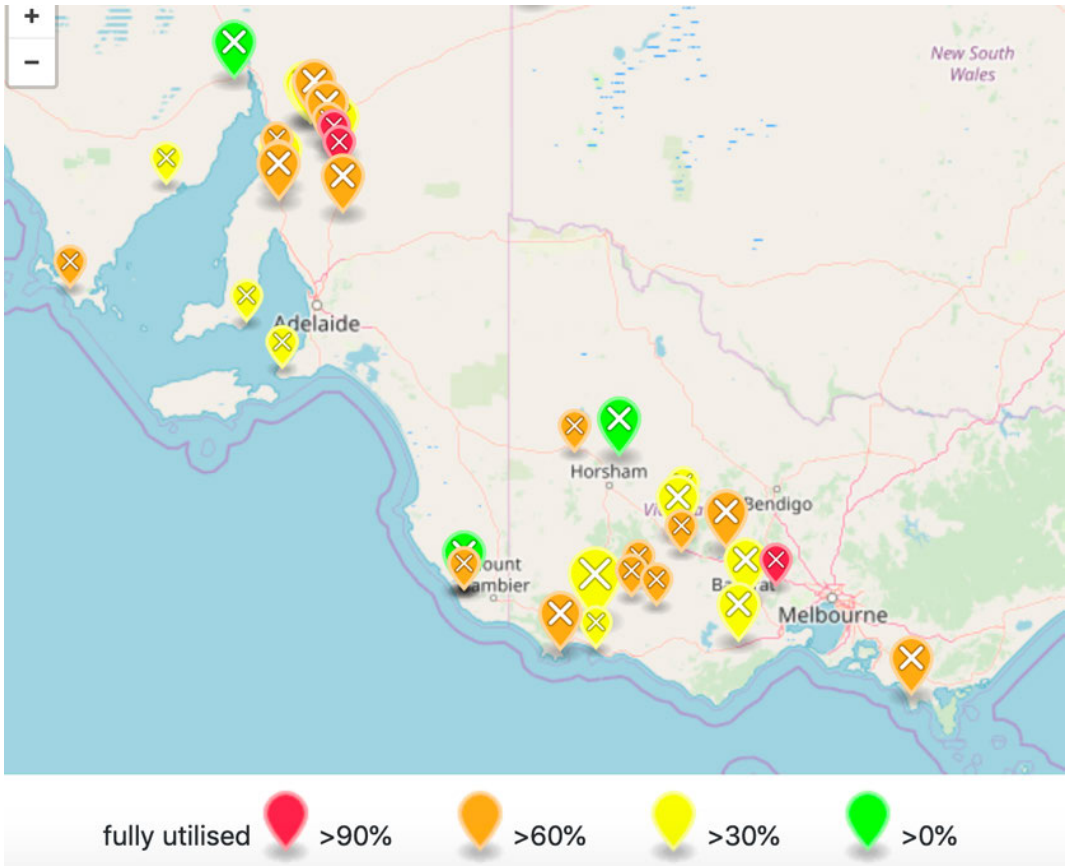
The Labor target for wind plus solar PV was 45% (after 5% from hydro), for which the overall capacity requirement would have to escalate dramatically.

Let's look next at the materials involved in getting a lot of power from those renewable sources. Figures from the US Quadrennial Technology Review 2015 show hugely greater materials required per kilowatt hour generated from wind or solar PV as the source. Apart from concrete, and considering just metals, solar needs 55 times as much as nuclear or gas combined cycle, and wind 11.6 times as much. The difference is less compared with coal. Not only do these materials cost money, but they have CO2 implications.

Energy storage doesn't get us off the hook here. About 95% of the world's storage in electric grid systems is pumped hydro, which needs both water and gravity. Limited potential in Australia. Batteries are far from practical or affordable on any scale for storing actual energy, though they are very valuable for their power in short-duration integration of renewables into a grid.

A second reason for expense is the balancing costs to prepare for unpredictable changes in wind speed and solar input beyond forecast changes. These costs escalate with proportion of renewables. Voltage- and frequency-control become problematical when synchronous generators with a lot of inertia – coal, nuclear, gas, hydro - are replaced by DC sources such as wind and solar. And more obviously, there must be dispatchable back-up capacity for when wind and solar are not producing, and if this is playing second fiddle to occasional wind and solar inputs it is less efficient.

A third reason why depending on wind and solar renewables is very expensive is that we need increased outlays for distribution and transmission, due to their small unit size and distance from load centres. Already, a high proportion of our electricity bill is attributed to transmission and distribution even when power stations are located not too far from load centres.

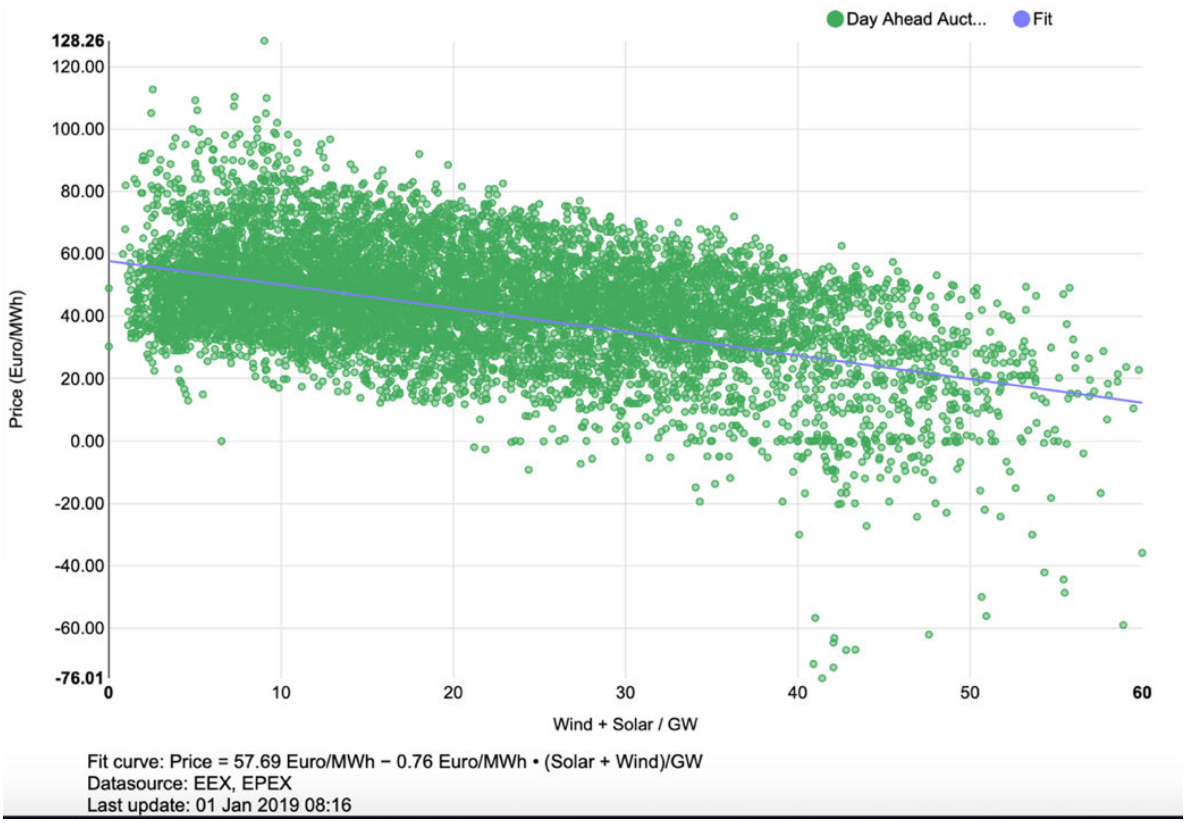


Transmission links to dispersed wind and grid-scale solar generation have low capacity utilisation, like the sources, and hence cost a lot per unit of power transmitted. AEMO said recently that marginal loss factors threatened the viability of some new renewables projects and called for urgent investment in transmission lines.[1]

A fourth reason is that deploying a lot of wind and solar PV with low marginal generating cost creates a substantial increase in the volatility of electricity prices, and at 20% wind/solar or above, zero prices sometimes occur. This value decline caused by wind and solar generating most of their output during times of self-imposed electricity oversupply is marked, and magnifies with their share increasing. German data for 2018 show that as day-ahead

[1] Long d stance transm ss on costs about $2/kW/km and can face arge add t ona costs from pub c res stance.

wind+solar power reaches 50 GWe – about half normal demand there - due to self-imposed oversupply the average price drops from about €58/MWh to €20/MWh.



Fraunhofer ISE

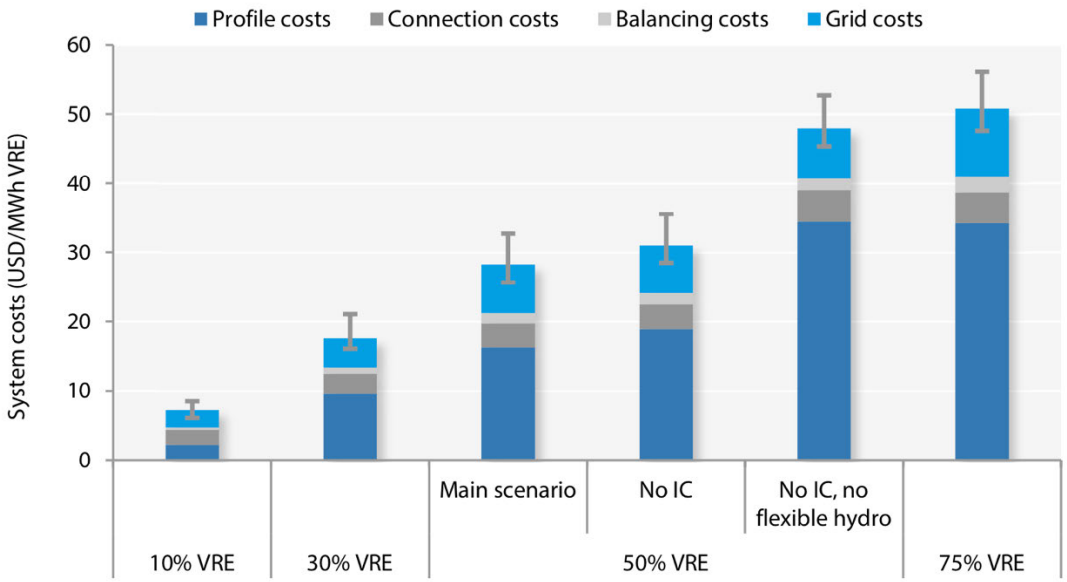
Apart from guaranteed subsidies of various kinds, this is distressing financially to both producers and the back-up reliable plants apart from gas, and it's not compensated by the price peaks when those renewables are insufficient. The price volatility is a major disincentive to investment in new plant, whether nuclear or renewable, if not regulated or subsidized.

Since wind and solar PV output correlates with meteorological conditions across a wide area, an increased proportion of them also means that the average price received by those producers – especially solar PV - declines significantly as their penetration increases, magnifying this value decline. At a penetration level of 22.5%, the value of a kilowatt-hour from wind is reduced by 25% in an OECD model[2], and in Germany in 2018 the effect was even larger.

So how does all this show up in system costs? In Europe there is a high degree of interconnection among countries, and all these effects can be mitigated to some extent by exporting surplus from wind and solar and importing when needed. Australia does not have that situation, so the system costs bite harder.

[2] The Costs of Decarbonisation – system costs with high shares of nuclear and renewables, OECD NEA, 2019

Figure ES6. **System costs per MWh of VRE**



OECD NEA 2019

OECD modelling suggests that for a situation such as Australia's, achieving 50% wind and solar supply in the system would incur a system cost of about $70 per megawatt-hour on top of the actual generating cost, so it more than doubles today's average wholesale price. At the moment we have less than 10% from those two sources (plus 5% from hydro which is dispatchable on demand).

In Germany, with good cross-border links, total installed generating capacity has more than doubled since 1990 to give only 19% more power, with 25% share from wind+solar - which now represent half the total capacity – and electricity costs have risen about 50% just in the last decade.

The other thing to note in the OECD model is that escalating share of wind and solar drives out steady reliable low-cost sources (such as nuclear and coal) in favour of more flexible gas. The nuclear units must ramp up and down by 30-35% of their installed capacity in one hour – not optimal operationally or economically, and the same would be true for coal.

The figures modelled by OECD are consistent with those now observable in some parts of the world, where increasing wind and solar share above about 10% results in substantial inefficiencies in the grid system and consequent high costs for consumers. For instance, Germany has spent hundreds of billions on wind and solar over the last ten years - at least EUR 160 billion just in the last five years - while maintaining emissions at a fairly steady high level, but the delivered electricity cost has risen inexorably.

Finally, and as strikingly shown in China in the last three years, high wind and solar capacity means high curtailment rate on its output (up to 50% in some provinces in China). This is both wasteful and expensive, driving that country's high-level commitment to relentless nuclear power expansion.

The main contributors to high system costs with escalating wind and solar proportion can be summarised as:

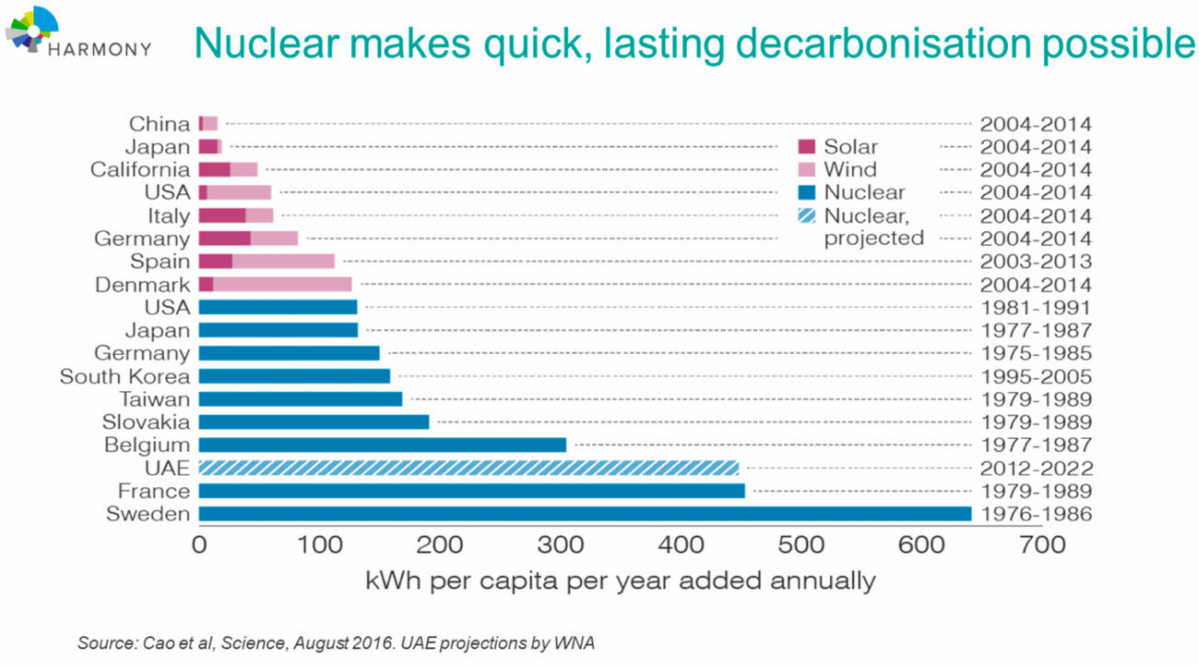
- Much greater total capacity built than system peak requirement
- Inefficient operation of dispatchable plant required to maintain reliability of supply, with balancing costs, ancillary services issues
- Grid connection costs with low utilisation – AEMO has started to report on this
- Volatile wholesale prices with diminished average prices, giving investment disincentive
- Wasteful and expensive curtailment

The Australian picture features subsidies through the RET scheme for wind and solar, which effectively allocate the system costs to consumers.

Brian Fisher's authoritative and balanced report from BAEconomics released in February addressed the Australian energy policy mess. It is focused simply on coal and gas versus wind and solar, and quantifies how the system cost escalates dramatically for different scenarios proposed by federal and state governments.

From various analyses, confirmed by German experience, it is clear why a high proportion of wind and solar power in any grid will be very expensive, no matter what. And now we have a major report from Australia's superannuation industry saying the same.

As demonstrated by France especially, if a country wants reliable electricity without CO2 emissions it needs to prioritise nuclear power rather than being diverted by the rhetoric of ever-increasing wind and solar renewables. On their own, they are completely the wrong way to go!



So, in Australia we can have a high proportion of zero-carbon power generation, but not by relying on wind and solar. Our 5% hydro is limited.

The Low-hydro countries with large proportion zero-CO2 generation include:

- France – 90% zero-CO2
- UK – 38% zero-CO2
- USA – 35-40% zero-CO2 – all with significant nuclear input

- (cf Germany's 16% wind, 6% solar PV in 2017.)

In Germany its ideological obsession with closing down nuclear capacity and building extraordinary amounts on wind and solar capacity is now so obviously stupid that it is threatening the government. And that's with less than one quarter of supply from wind and solar. The headline justification for Energiewende was limiting CO2 emissions, but in fact they have not diminished to any extent.

The World Nuclear Association's Harmony goal is for nuclear power to supply at least 25% of global electricity demand by 2050, which is in line with the near six-fold increase in clean energy required by the IPCC 'middle of the road' scenario.

The immediate challenge is for system costs of intermittent renewables to be fully and widely recognised so that the world's largest source of zero CO2 emission power apart from hydro is inexorably a real and hopefully very attractive proposition.

If we want reliable electricity without CO2 emissions we need to get nuclear power front and centre on the national policy agenda.