Submission to Legislative Council Environment and Planning Committee Inquiry into nuclear prohibition

Dylan McConnell

September 2020

The development of nuclear power capacity in the Victoria electricity system faces significant barriers. In this submission I focus on the challenges and barriers facing the financing nuclear of power plants in competitive wholesale electricity markets in Australia. The two key and inter-related points are:

- The generations profile and cost are a poor fit for the evolving Australian market
- The financing of nuclear power stations face structural challenges in liberalised electricity markets

Generation profile and cost

Nuclear power plants are characterised by high upfront capital costs, and low on going operating costs. In this sense, they are somewhat similar to brown coal. The cost profile of such capacity means that running at high capacity factors (or alternatively a high number of full load hours) is the most economic operating regime. The impact of capacity factor levelised costs is illustrated in figure 1 below.

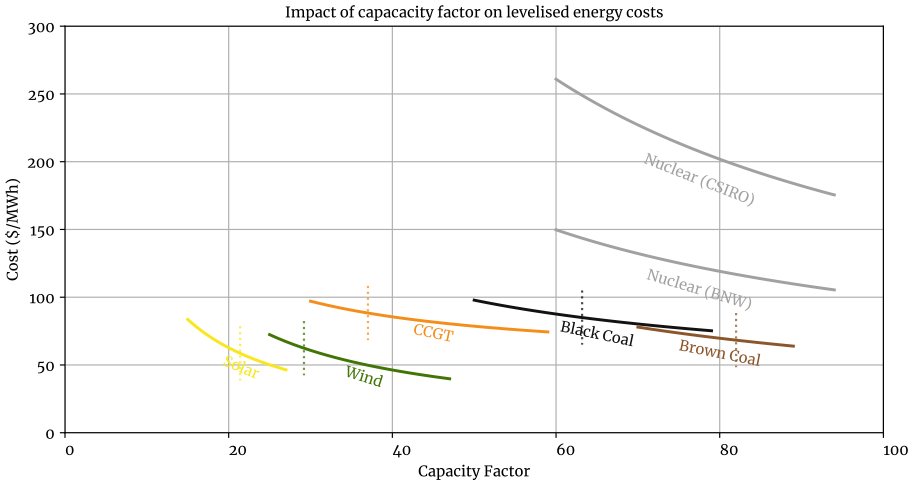

Figure 1: This figure illustrates the sensitivity to capacity factor to the levelised cost of a range of energy generation technologies. The actual capacity factors achieved by these technologies in financial year 2020 in the National Electricity Market is shown in dashed lines. The levelised cost calculation used here is based on data from the CSIRO's Gen Cost report (Graham et al. 2020), and uses a consistent discount rate across all technologies. Data from Bright New World's submission to the Gen Cost report is also included (Heard 2020).

Ideally, the such plants would be run at full capacity, unless on scheduled or unscheduled outage. While it is possible for both nuclear and coal capacity to load follow, doing so means that it is running below full capacity. It's worth noting that fully amortised brown coal fleet, with lower operation costs than nuclear power plants, do not currently achieve high capacity factors. The Yallourn power station capacity factor over the last 12 months was 74%.

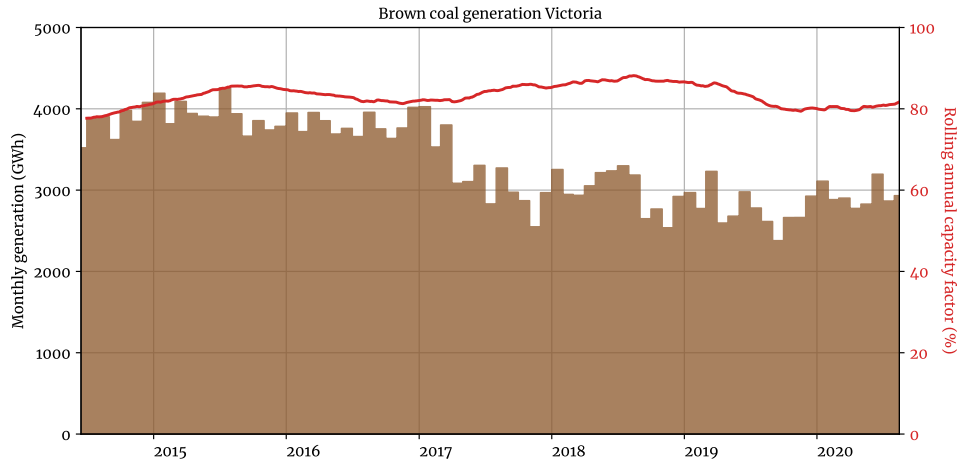

Figure 2: Monthly output of brown coal generators in Victoria since the beginning of financial year 2014. The closure of the Hazelwood power station in early 2017 resulted in improved fleet-wide capacity factor. This fleet-wide capacity factor has since deteriorated and is expected to continue declining, as more renewable energy capacity enters the system.

Residual load

As renewable energy is added to the system, the characteristics of the generation required to ensure supply and demand is met changes. Systems with high penetrations of renewable energy need other flexible forms of generation that complement or balance the variability of the renewable resources.

The requirements of the balancing generation can be characterised by the *residual load*. This is a measure of difference between the demand (load) on the system from energy users, and the amount provide by variable renewable energy generation. The figure below provides an illustration of the residual load in South Australia from the start of September this year.

South Australia currently has a much high penetration of renewable energy than Victoria. Last financial year renewable energy generated the equivalent of 57% of the States consumption. That said, South Australia may provide a useful representation of what the residual load profile may be like in Victoria in the years to come. The market operator projects that Victoria will be above 50% renewable energy by 2030 (AEMO 2020), and this is also Victorian Government policy (Renewable Energy (Jobs and Investment) Act 2017 2020).

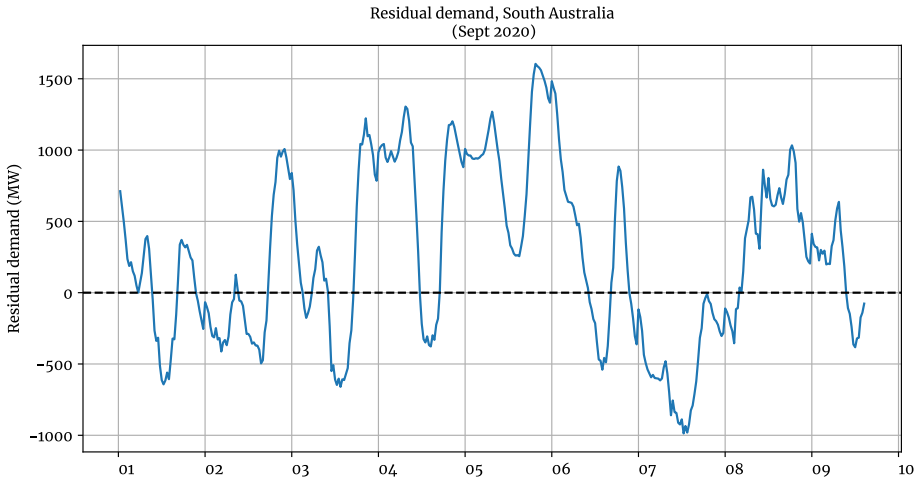

Figure 3: Illustrative residual load in a jurisdiction with high levels of renewable energy generation. The residual load represents the difference between the system demand and power provided by renewable energy generation. Negative regions indicate renewable supply is excess of local demand. This represents the supply that needs to be delivered by other resources to ensure that demand is met.

The residual load could be delivered by multiple zero or low carbon resources. In Australia, technologies that are currently considered include (but are not limited to):

- Energy storage technologies, including pumped-hydro, lithium batteries or hydrogen
- Biomass derived energy
- Existing hydro
- Concentrating solar thermal, with thermal energy storage

In addition, transmission infrastructure allows the benefits of geographical diversity to be reduce the requirement for balancing technologies.

Nuclear power could also provide balancing capabilities. However, as mentioned, by doing so the capacity factor and utilisation would be greatly diminished, which does not sit favourably with the cost structure of nuclear power technologies. In South Australia, balancing is predominantly provided by gas generators. These generators generally have capacity factors well below 50%. Nuclear power would be an extremely expensive technology, to provide a similar service.

Liberalised electricity markets

Victoria is connected to an electricity system that spans the eastern seaboard states and South Australia. In the 1990's this system was substantially restructured, aiming to drive efficiency improvements via the introduction of a competitive electricity market. This occurred alongside vertical disaggregation, corporatisation and various degrees of privatisation.

Nuclear power plants have proven difficult to finance and construct in such liberalised electricity markets around the world. The challenge of financing new nuclear capacity in competitive electricity markets was recently pointed out in a publication by the International Energy Agency last year (IEA 2019):

> *It has become increasingly clear that the construction of a new wave of large-scale Generation III reactors in all European or North American electricity markets is inconceivable without strong government intervention in view of the policy, technology and project management risks, as well as market and financing barriers.*

Nuclear power plants operating in competitive electricity markets today were largely built by vertically integrated utilities, prior to liberalisation. Where nuclear power does exist or is under-construction, a variety of additional mechanisms are used. Investments in new nuclear plants are generally supported through national specific financing arrangements (IEA 2020).

The most widespread model of nuclear power plant construction is direct investment by state-owned entities. Most of the projects under construction and most of the planned projects that are most likely to proceed are either being led by 100% state-owned companies or majority state-owned corporations (IEA 2019). This includes many of the those being built in the European Union and other advanced economies.

Regulated utilities are another common mechanism through which nuclear is financed, particularly in the case of the United States (IEA 2019). In this case, a power plant is included in the regulated asset base of the utility, on which the utility is entitled to earn a rate of return. A regulatory decision may allow a utility to include the cost of new nuclear assets in a utility's asset base. The UK Government is also considering turning to a Regulated Asset Base model for financing new nuclear projects (BEIS 2019). While this model is used in Australia for transmission development, we do not have regulated utilities in the generation sector that could rate-base the cost of a nuclear power plant. There is not even any preliminary discussion to move to such a system.

Other mechanisms such as long term price guarantees, or loan guarantees are also commonly used. In some cases, an "all of the above" approach is required. The Hinkley Point C power station in the United Kingdom is good example of this, and the initial shared history of our power market provides a useful comparison. The Hinkley Point C project:

- is predominantly financed by two state-owned entities (France's EDF and China's General Nuclear Power Group, CGN).
- is rate-payer backed, only possible after substantial reforms to their electricity market.
- has received a guarantee from the British government (guaranteed 2012 fixed price of £92.50/MWh, which is approximately $196.70/MWh in current AUD)

Australia's electricity sector structure presents a significant challenge to financing new nuclear power plants. We no longer have the the institutional framework for a regulated utility to construct a nuclear power plant. Financing a power plant in a competitive, liberalised electricity market would require substantial additional government intervention or re-regulation.

References

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