Environmental Impact Statement Submission - Ted Woodley[1]

10 June 2021

Snowy Hydro's Kurri Kurri Gas/Diesel Power Station

"not needed, and can only run on gas for a few hours anyway"

This Submission contends that the proposed Kurri Kurri Power Station would:

- not be needed – there is no supply gap when Liddell closes in 2023
- be incapable of providing dispatchable capacity over extended periods - the fundamental function of a gas-fired power station
- run out of gas after a few hours, even if storage is added, and take a day to recharge, due to its poor location beyond the end of the heavily constrained Sydney-Newcastle gas pipeline
- only be capable of generating at capacity for two days using all its diesel storage as well
- be unlikely to attain its claimed capacity factor of 2% (only)
- 'compete' with Snowy Hydro's nearby Colongra Gas Power Station (capacity factor 0.4%)
- be in the same market as, and be comprehensively outcompeted by, batteries
- cost around $1 billion, not $600 million, all at taxpayer's expense
- have a market value of less than Colongra's purchase price ($234 million), with no possibility of a financial return
- not reduce electricity prices (as claimed) and put upward pressure on Hunter gas prices
- involve just 125 jobs (average) over its two-year construction (not up to 600 jobs as claimed), and 10 operational jobs
- emit pollutants over the Hunter/Newcastle region, with a greenhouse gas emission intensity more than 60% that of Liddell, the coal-fired station it is allegedly 'partly replacing'

On 13 May 2021, the Environmental Impact Statement for Snowy Hydro's Hunter Power Project (Kurri Kurri Power Station) was exhibited. The gas/diesel fired power station is proposed to be built on a former aluminium smelter site at Kurri Kurri, in the Hunter Valley of NSW. The $610 million station is to have a capacity of up to 750 MW from two Open Cycle Gas Turbines (OCGT) and be operational in 2023:

> *"The power station is expected to have a generation capacity of up to approximately 750 megawatts (MW), which would be generated via two industrial frame heavy duty F-Class gas turbine units in open cycle gas turbine configuration.*
> *The gas turbines would primarily be fired on natural gas with the use of diesel fuel as a backup.*
> *The Proposal [consisting of a power station, electrical switchyard and associated supporting infrastructure] has a capital cost of approximately $610 million, and is anticipated to be*

[1] Ted Woodley BSc, BE(Hons1), FIEAust, FAIE, FIML, FAICD. Former Managing Director, PowerNet, GasNet, EnergyAustralia, GrainCorp; GM Power Systems, CLP (Hong Kong)

operational by the end of 2023."

A week later the Commonwealth Government announced a $600 million commitment for the 660 MW project (revised capacity) to reduce the impact of the closure of Liddell Power Station - Protecting families and businesses from higher energy prices, 19 May 2021.

> *"The Morrison Government is stepping up and building a new gas power plant in the Hunter Valley, which will create jobs, keep energy prices low, keep the lights on and help reduce emissions.*
> *This important project delivers on the Government's 1,000 MW target set last September, which was created to avoid unacceptable price increases following the closure of the Liddell power station in 2023.*
> *In the 2021-22 Budget, the Government committed up to $600 million for Snowy Hydro Limited to construct a 660 MW open cycle gas turbine at Kurri Kurri in the Hunter Valley."*

The project had previously been declared to be Critical State Significant Infrastructure (CSSI) by the NSW Planning Minister (Critical declaration for Hunter gas-fired power plant, 23 December 2020), who lauded the project for its 600 jobs, reducing electricity prices and ensuring energy security:

> *"With another player in the energy market, it increases competition and will help mitigate the closure of Liddell's coal-fired power station in 2023, putting downward pressure on electricity prices. Gas-fired power stations will have a critical role to play in ensuring our energy security as we transition to a low-carbon emissions economy with renewable energy projects such as wind and solar.*
> *As well, this project could create jobs for up to 600 construction workers and generate around $800 million worth of investment for the local economy."*

The EIS provides only cursory (and misleading) information and fails to justify the project.

Snowy Hydro has advised that the KKPS Business Case will be released in July 2021 after the major contracts are finalised. As Australian taxpayers would be funding the project and taking the entire project risk, it is essential there be an independent expert analysis of the Case.

This is especially important following the Government's previous approval of the Business Case for the Snowy 2.0 pumped storage project, without a comprehensive independent assessment. That Business Case has since been shown to be fatally flawed, with assumed revenues at least twice that now forecast and costs of half that now expected.

Alarmingly, there are many parallels with Snowy 2.0 (see Section 12).

This Submission contends that besides not being needed in the first place, the primary failing of KKPS is that it cannot fulfill the fundamental function of a gas-fired power station. It cannot provide dispatchable (or firming) capacity over extended periods – it doesn't have the gas! Why build a gas-fired power station at a location where there is insufficient gas to run for extended periods?

And KKPS will be comprehensively outcompeted by batteries in the short-term peaking market, especially due to its inordinately slow response capability in the forthcoming 5-minute settlement market.

The author of this Submission has drawn extensively from a Victoria Energy Policy Centre Research

Paper[2] ("Paper"), which he co-authored. That Paper forms an integral part of this Submission.

The Paper's main conclusions are:

1. There is no supply gap when Liddell closes in 2023
2. KKPS will be inflexible and slow to respond, rendering it useless in the coming 5-minute settlement market (October 2021). The claim that KKPS will reduce electricity prices is tenuous
3. There is no demand for long duration peaking gas generation in the period to 2030
4. KKPS is likely to cost at least 50% more than $600 million
5. KKPS is unlikely to be capable of running at capacity for more than a few hours on gas or 40 hours with diesel as well

The Paper concludes that*" there is at best a tiny market for the sort of service that KKPS can offer and so it has no prospect of earning anywhere near the revenues needed to recover its outlay."*

1 Not needed

1.1 EIS fails to satisfy SEARs request for project justification

The Secretary's Environmental Assessment Requirements (SEARs) includes two matters that the EIS must cover concerning the need for the project:

i) "a justification for the proposed project as opposed to other alternatives"

As KKPS can only run on gas for a few hours, the obvious alternative is a battery. As outlined in the Paper and below, particularly Section 5, batteries are already superior to KKPS, and future increases in capacity and decreases in costs will consolidate that superiority.

ii) "the strategic need and justification for the project having regard to energy security and reliability in NSW and the broader National Electricity Market including an analysis of gas supply availability"

Appendix A summarises the 'justification' for KKPS provided in the EIS, concluding there is manifestly no need for a gas (or diesel) generator to be built, at taxpayer expense, by 2023 or beyond. Also refer to Section 4.1 of the Paper. The EIS fails to include an analysis of gas supply availability, as required in the SEARs, particularly the severe limitation on KKPS's operating duration.

Even if there were a strategic need for a gas peaking station, KKPS cannot perform that function for any more than a few hours.

1.2 Colongra Gas Power Station is a good comparator, and also a 'competitor'

Snowy Hydro's Colongra gas-fired Power Station is located on the Central Coast, near the former Munmorah Power Station. Colongra has four OCGTs, with a combined capacity of 724 MW (non-summer rating; 667 MW summer rating).

KKPS would be similar in size, technology, operation, and would also be connected to the Sydney-Newcastle Gas Pipeline.

[2] "Kurri Kurri Power Station: charging taxpayers for hot air", Victoria Energy Policy Centre, June 2021 https://www.vepc.org.au/reports-and-working-papers

Colongra rarely runs. Over the past five years its capacity factor[3] has been 0.4%[4]. That is equivalent to running 35 hours per year (1½ days) at full capacity. On average it started 32 times a year, usually running for a few minutes up to an hour or so. Only twice over the past five years did the station run at full capacity until its gas ran out (five hours – see later). Figure 1 demonstrates its infrequent use.

Further information on Colongra's minimal use is provided in Appendix C of this Submission, showing it only 'set' the NEM price nine times in five years, and in Section 2.3 of the Paper.

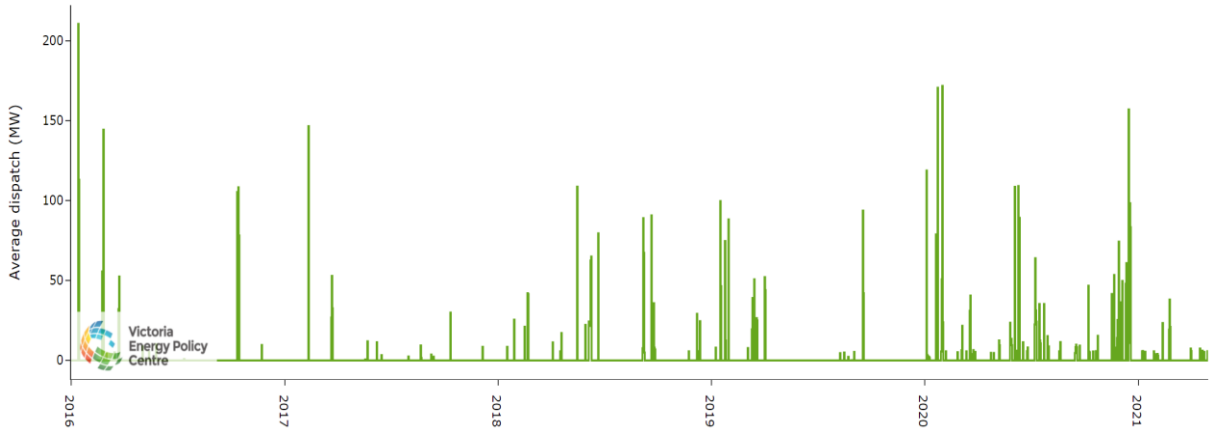


Figure 1 – Colongra Power Station Dispatch[4] (2016 – 2021)

The case for Snowy Hydro to build a new gas/diesel power station should only have been contemplated if Colongra had been more fully utilised, which is unlikely to occur this decade, if ever.

It is noted that Snowy Hydro's two other gas power stations (in Victoria) also rarely run. The capacity factors over the past five years for the 300 MW Valley Power Station and the 320 MW Laverton Power Station were 0.4% and 3.0%, respectively.

2 Insufficient gas to run more than a few hours

2.1 Limited gas supply

The EIS notes that a 17 km long gas transmission and storage spur pipeline is needed to connect KKPS to the Sydney-Newcastle Gas Pipeline and will be the subject of a separate EIS (hence its details and cost have yet to be revealed):

> *"The Proposal would require connection to a new gas transmission and storage pipeline, which would connect into the existing Sydney to Newcastle Jemena Gas Networks (JGN) gas transmission pipeline, with the tie in point to be located within the proximity of the Newcastle area. The new gas transmission and storage pipeline, and the gas receiving station, would be designed, constructed, operated and maintained by a third party, and would be the subject of a separate application for approval."*

Ever since the Sydney-Newcastle Pipeline was built (in 1982) supply is often constrained. The AEMO Gas Statement of Opportunities (GSOO), Mar 2021 notes that the pipeline, at only 508mm diameter,

[3] The capacity factor is the proportion of actual energy generated per year (expressed as MWh) compared with the total energy that could have been produced if operating at full load for every hour of the year (expressed as MWh).

[4] Information sourced from Australian NEM Data Dashboard https://vepc-data.appspot.com/generator

is considered to be a distribution-sized trunk-line and may need expansion or duplication (p 50):

> *"Sydney-Newcastle Pipeline connects Newcastle to Sydney (and draws supply from the Moomba-Sydney Pipeline and the Eastern Gas Pipeline). Presently this is not considered to be a transmission pipeline, but is a large full regulation distribution pipeline. However, given Newcastle proposals for a new LNG import terminal, a new Gas Power Generator [i.e. KKPS] or the Queensland-Hunter Gas Pipeline, this pipeline may need expansion or even duplication".*

When looking for potential sites for a gas power station in the Newcastle-Sydney-Wollongong area, Kurri Kurri would have to be among the worst in terms of the obvious prerequisite of access to an adequate gas supply.

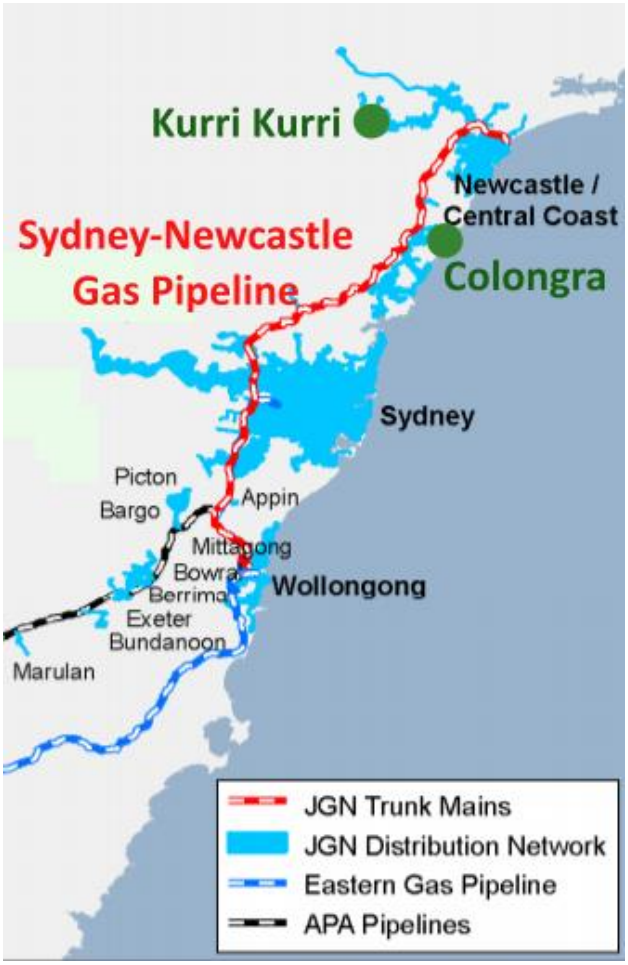


Figure 2 – Map of Sydney-Newcastle Gas Pipeline with Colongra and Kurri Kurri[5]

KKPS cannot simply connect to the Sydney-Newcastle Pipeline and receive unlimited gas, as implied in the EIS, as there is insufficient supply and line-pack pressure. KKPS would need a storage system to attain even a few hours operation.

The EIS provides no information on a gas storage system for KKPS.

[5] Base Map from "Access arrangement information for JGN's NSW gas distribution networks July 2010 – June 2015 (Fig 2-1) https://www.aemc.gov.au/sites/default/files/content/c9c87d28-f057-4bb4-ba05-cf5921311653/Amended-access-arrangement-information-by-order-of-the-Australian-Competition-Tribunal-%28including-amendments-with-regards-to-mine-subsidence-expenditure%29.pdf

The spur pipeline/storage connection to Colongra Power Station, described in the box below, provides an indication of what may be intended for KKPS.

Colongra Pipeline/Storage Connection

The spur pipeline/storage connection from the Sydney-Newcastle Gas Pipeline to Colongra Power Station, described as *"the largest on-shore gas pipeline in Australia*[6]*",* enables enough gas to be stored to achieve five hours operation.

The connection consists of a dual compressor station to raise the gas pressure from around 3 MPa (Megapascal) to 13 MPa and a 8.6km pipeline that includes 4km of looped 1,067mm diameter storage pipeline.

Twin 4.2 MW water bath heaters pre-heat the gas before it cools during pressure reduction for supply into the turbines.

This spur pipeline/storage system can store up to 40 TJ (Terajoules), which is sufficient to run the four turbines at full capacity for five hours (each turbine consumes 8 TJ/hour when running at capacity).

Recharging the pipeline storage system takes 22 hours at a maximum rate of 1.8 TJ/hour, provided sufficient gas is available from the Sydney-Newcastle Pipeline.

The spur pipeline/compressor storage system was constructed in 2009 at a cost of $104 million.

If a similar system to that at Colongra is built, it would cost over $104 million (it's twice the length) and at best enable operation at full capacity for around five hours. KKPS would then cease generating or, if the market prices were sufficiently high, change over to diesel.

After exhausting its gas storage, KKPS would take at least a day to recharge, noting it is in a worse location than Colongra, being beyond the end of the Sydney-Newcastle Pipeline, and there will be times when gas supply is limited. Also, one would expect KKPS and Colongra to sometimes operate in parallel, so the recharge time for both could well be longer as they would be 'competing' for gas from the same pipeline.

Further gas supplies to KKPS could potentially come from a mooted gas import terminal at Newcastle, or a Queensland-Hunter Gas Pipeline, or a second Sydney-Newcastle pipeline, but no such projects are well advanced, or on the verge of being committed.

Finally, KKPS would add a substantial, albeit intermittent, load at the end of the overloaded Sydney-Newcastle Pipeline, potentially impacting other gas users by reducing their access to gas supplies (when electricity prices are high) and putting upward pressure on gas prices.

[6] Colongra Gas Transmission & Storage Pipeline, Jemena https://jemena.com.au/pipelines/colongra-gas-transmission-and-storage-pipeline
https://jemena.com.au/getattachment/industry/pipelines/Colongra-Gas-Transmission-and-Storage-Pipeline/Map.pdf.aspx

2.2 Diesel 'back-up'

The EIS acknowledges the limited gas supply, without revealing the full extent or implications:

> *"For times where natural gas is not available or is constrained, back-up fuel such as diesel can provide added security. The Proposal is seeking approval for a capacity factor … of up to 2 per cent on diesel …"*

Two diesel storage tanks are proposed, each with a volume of 1.75 million litres, having the capacity to run the generators for 30 hours at maximum output.

Gas is not expected to be available for the first six months of KKPS's operation, due to the time required to construct the connecting pipeline. Diesel usage of up to 2% capacity factor is envisaged during this period.

Once gas is available it is inferred that the ratio of usage of diesel and gas is 2:10 (i.e. around 20% diesel). However, if gas supply is an issue or limited storage is constructed, KKPS would have to run on diesel for a greater percentage of time, increasing its costs and emissions and reducing its operating hours and financial viability.

Might KKPS really become a diesel/gas generator, rather than a gas/diesel generator? If so, it would only be economic to run very rarely.

3 Unlikely to achieve a capacity factor of even 2%

The EIS states:

> *"The Proposal is seeking approval for a capacity factor of up to 10 per cent on natural gas and up to 2 per cent on diesel (providing a combined capacity factor of 12 per cent) in any given year. However, it is expected that likely operations would result in a capacity factor of 2 per cent in any given year."*
>
> *"Annual start-ups would range from 50 to approximately 200 occasions per year. Start-up would take approximately 30 minutes to reach the full rated load".*

A 2% capacity factor translates to 175 hours (one week) a year at full load. Or just over 3 hours a week. No detail is provided on the determination of the capacity factor, nor the estimated running periods or output or electricity prices – all are critical to assess the financial viability of KKPS (and would be expected to be in the Business Case).

The Environmental and Planning Scoping Report, 20 Dec 2020 stated:

> *"Based on this capacity factor [2%] the projected annual gas consumption for the Proposal would be in the order of 0.5 to 1.0 petajoules/year"*

According to the article Hunter Valley gas plant 'would only operate a week a year', SMH 13 May 2020, the estimated usage of gas of 0.5-1.0 PJ/year translates to a capacity factor of 0.7-1.4%.

As noted above, Colongra Power Station has been running at a capacity factor of 0.4%. In future that generation would have be 'shared' with KKPS, potentially resulting in both stations having a capacity factor less than 0.4%. However, as Colongra has four units, with a faster run-up response rate, it is a

little more flexible than KKPS and may run more often.

The Paper suggests that the competitiveness of OCGTs will significantly deteriorate when the market settlement period drops from 30 minutes to 5 minutes on 1 October 2021. OCGTs that take 30 minutes to ramp up to capacity will struggle to compete in a 5-minute market, further reducing their capacity factor.

The Paper concludes there is no demand for long duration peaking gas generation in the period to 2030. Consistent with this, AEMO's ISP forecasts that NSW's peaking gas generation will collectively produce electricity for just 4 hours per year in the period to 2030 (in the Central Scenario) or 13 hours per year (in the Fast Change Scenario). This is equivalent to capacity factors of 0.05% and 0.12%, respectively.

It seems unlikely KKPS would start-up 50 to 200 occasions a year or reach a capacity factor of 2%, as estimated.

4 Cannot provide dispatchable capacity over extended periods

The EIS states that the primary function of gas fuelled peaking generation is to provide dispatchable capacity over extended periods:

> *"The objective of the Proposal is to provide dispatchable capacity and other services into the NEM, and to meet demand when the needs of electricity consumers are highest. Although a combination of grid-scale batteries and fast-start gas turbines could provide these capabilities, gas fuelled peaking generation is considered to be best suited, as it provides an increased level of energy reliability to the NEM primarily through provision of firming capacity over extended periods, as and when required. The Proposal would operate in conjunction with the various forms of energy storage (such as batteries), as these are further developed in the NEM."*

Clearly KKPS cannot fulfill this function on gas (nor on diesel either).

Assuming KKPS had a five-hour gas storage, after running at capacity for that time it would need to shut down or change over to diesel, which also has limited capacity (30 hours tank storage). Even allowing for recharging of the gas storage and some diesel tanker supplies, KKPS would at most be able to run at capacity for less than 2 days (5 hours gas, then 22 hours diesel, then 5 hours gas, then ~8 hours diesel, depending on the volume in the tanks = 40 hours).

Obviously, the run time would be longer when KKPS is not generating at full capacity, but the fundamental function of a gas power station is to be able to run at maximum capacity for extended periods.

5 No guarantee KKPS will be available when needed

The performance of Colongra in an emergency situation gives no confidence that KKPS would be available when needed.

The AEMO Incident Report[7] on the operation of the NEM and national power grid in NSW on 10 February 2017 during a heatwave, when operational demand peaked at 14,181 MW (just below the record of 14,744 MW) states:

> *"Coincident with the peak of demand for the day, the Colongra units were unable to start, due to low gas pressure in the fuel supply lines."*

Extracts from the timeline of events (see below) illustrate that all NSW generators were advised at 7am of a potential supply shortfall later in the day. At 4:30pm Colongra was requested to start-up and responded that all four units were expected to synchronise in 13 minutes. However, there was little gas and efforts over the next two hours to start on back-up diesel largely failed. Snowy Hydro advised *"there will be more gas available tomorrow".*

Date/Time	Events/Comment
10/02/2017 06:30	AEMO and TransGrid discuss the likely conditions for the day – high temperatures and high demand, reserve conditions, and the potential for load shedding.
10/02/2017 07:00	Responsible Officer (R/O) teleconference is held. LOR 3 conditions are forecast for five trading intervals (1500–1730 hrs). It is noted that according to the current forecast demand outlook there is a maximum of 327 MW (may change) of supply shortfall in the NSW region. All generators in NSW have been contacted by AEMO to confirm capacity and / or potential availability for direction if required.
10/02/2017 16:30	The power system is not in a secure operating state. AEMO must take all reasonable actions, including intervention if necessary, to return the power system to a secure operating state within 30 minutes.
10/02/2017 16:30	AEMO contacts Colongra power station. Colongra personnel confirm they had seen the start signal for the units and were intending to synchronise the 4 units. Snowy confirms the units would be started and were expected to synchronise within 13 minutes.
10/02/2017 16:50	AEMO contacts Colongra power station and is advised all 4 Colongra units had failed to start. The units were being started on fuel oil as the units had run on gas earlier in the day and gas supply was very low. Personnel are attempting to get at least one unit started on gas and then switch over to fuel oil as there is two unit hours of gas in the pipe. If this is successful, another unit will be started in a similar manner.
10/02/2017 16:56	Snowy Hydro contacts AEMO in relation to the Colongra units. Had tried to start on diesel and all 4 tripped, now attempting to start on gas and switch to diesel. On diesel they can get 15 MW more output. Very tight with gas supply. It will take some time as all 4 cannot start on gas at once. Risk of a trip again on the diesel switch over.
10/02/2017 17:15	Colongra unit 4 in service.
10/02/2017 17:20	Colongra units 2 and 3 in service.
10/02/2017 18:08	Snowy Hydro advises AEMO that Colongra unit 4 has been started and transitioned to fuel oil. Will try other units.
10/02/2017 18:37	Snowy trader advises AEMO that Colongra units 3 and 4 successfully transitioned to fuel oil but the gas ran out before units 2 and 1 could be changed over. They advise there is 6 to 8 hours of fuel oil available, more fuel oil is ordered for tomorrow, and there will be more gas available tomorrow. Units 1 and 2 will be bid available but will have to start on fuel oil – there is concern whether the units will start.

6 KKPS would be outcompeted by batteries

6.1 Batteries are now of an equivalent capacity and directly compete with KKPS

KKPS could not run on gas for any longer than high-capacity batteries and would be comprehensively outcompeted in every facet - construction cost, operating cost, response rate, emissions and impact on electricity prices.

[7] System Event Report NSW 10 February 2017, AEMO https://www.aemo.com.au/-/media/Files/Electricity/NEM/Market_Notices_and_Events/Power_System_Incident_Reports/2017/Incident-report-NSW-10-February-2017.pdf

Snowy Hydro's Managing Director and Chief Operating Officer gave evidence at the Environment and Communications Legislation Committee Hearing (22 March 2021) that KKPS and batteries compete in 'different parts of the market' – batteries for short periods and KKPS for much longer durations:

> *"Essentially, batteries provide energy for a very short period of time. Conversely, gas turbines provide energy for much longer durations under critical demand conditions. Take, for example, the extended weather system that we're seeing at the moment, where solar is not viable for very extended periods due to cloud cover et cetera. Under those sorts of conditions, batteries simply cannot provide energy for any sustainable period of time—hence, gas turbines come into their own for those sorts of circumstances. In that way, they compete in very different parts of the market."*

However, this is clearly not the case. KKPS and batteries would be competing in the same market, 'up to five hours', not different markets.

The Paper outlines the increasing capacity of batteries from just over one hour a few years ago to four hours now (Section 2.4). Four-hour big batteries are now commercial, with further increases in capacity expected in coming years. For example four-hour batteries have been announced at Loy Yang (200 MW) and Torrens Island (250 MW).

Coincidentally the world's biggest battery (1,200 MW) is proposed to be built at Kurri Kurri by CEP Energy World's biggest battery at Kurri Kurri will deflate Morrison's gas dreams, 5 Feb 2021. We will have to wait to see if it materialises, but even if it had only two-hour storage it would still match the capacity of KKPS.

In practice, KKPS would only run when all battery storage is exhausted. A most infrequent event if ever, with the proliferation of battery installations.

Ill-informed supporters of KKPS are unaware of its limited gas supply and run duration (e.g. Tomago Aluminium's Chief Executive considers[8] *"the Kurri Kurri plant is needed to replace Liddell as saying batteries could do the job was like saying a bicycle can replace a car"*).

6.2 Cheaper capital cost

AEMO's 2020 ISP indicates that the construction cost of two-hour storage batteries is already much cheaper than Open Cycle Gas Turbines and is expected to reduce another 50% by the end of the decade (see Appendix B). Four-hour batteries are marginally dearer than OCGTs at present, but expected to be substantially cheaper well before the end of the decade:

- OCGT 2022-23 $1,411/kW; 2029-30 $1,395/kW
- 2-hour battery storage 2022-23 $1,087/kW; 2029-30 $584/kW
- 4-hour battery storage 2022-23 $1,716/kW; 2029-30 $922/kW

6.3 Substantially cheaper operating and maintenance costs

The operating cost for batteries is mainly the cost of 'buying' energy for around $0 - $20/MWh. Allowing for losses, about 90% of that energy is sold at the spot price. Whereas the operating cost

[8] "'No coherent plan': experts reject Coalition's rationale for taxpayer-funded gas power plant", The Guardian 22 May 2021 https://www.theguardian.com/australia-news/2021/may/22/no-coherent-plan-experts-reject-coalitions-rationale-for-taxpayer-funded-gas-power-plant

for gas and diesel generation is approximately $100/MWh and $250/MWh, respectively.

Section 2.2 of the Paper provides comparative information on the spot prices and arbitrage margins needed for OCGT and batteries to recovery their capital cost.

The maintenance costs for batteries are practically zero, whereas they are considerable for gas generators.

6.4 Infinitely faster response

The EIS boasts of the 30-minute fast start-up capability of KKPS:

> *"given its fast start capacity, gas fired generation can be used for firming of renewable energies and as a peaking facility."*
> *"KKPS would feature fast start heavy duty gas turbines, which are suitable for peaking power generation. Start-up would take approximately 30 minutes to reach the full rated load".*

A 30-minute 'fast' start-up will not be competitive in the forthcoming 5-minute settlement market.

Batteries take a few milliseconds to transfer from fully charging to fully discharging, and vice versa.

'Batteries will have finished the after-dinner mints before gas generators have begun the entrée'.

6.5 Higher reliability

Batteries are usually on-line continuously and available to immediately ramp up or down.

On the other hand, gas generators are rarely on-line and cannot be guaranteed to start when needed. The system emergency incident referred to in Section 5 illustrates the unsuccessful attempts to start Colongra on gas (there was none) and diesel. Also, during that incident the Tallawarra gas generators (408 MW) suffered a forced outage, resulting in over 1,000 MW of NSW gas generation being unavailable at the very time it was critically needed.

6.6 Faster recharge

Batteries can recharge at the same rate as they discharge. For example, a 4-hour battery can recharge in four hours and be ready to discharge again. Theoretically a 4-hour battery could complete the cycle of fully discharging and recharging three times a day.

KKPS will take a day or so to recharge its gas storage and possibly several days to recharge its diesel tanks (about 70 B-double truck deliveries of 50,000 litres).

6.7 Zero emissions

Batteries emit no greenhouse gases, compared to KKPS's 500,299 tonnes/year plus other pollutants (see Sections 8 & 9).

6.8 Batteries provide two services

To state the obvious, gas power stations only produce energy, whereas batteries both 'produce' energy (when discharging) and store energy.

Batteries store energy when the price is low (the sun is shining and/or the wind is blowing and/or base-load coal-fired generators cannot be further backed off), and then feeds it back into the grid

when prices are higher. Batteries assist the NEM to smooth the differences between demand and supply.

6.9 Batteries push prices down, gas generators push prices up

Gas generators are at the top of the price dispatch list, only below diesel generators. They only operate when all other generators, including batteries, have been dispatched.

It is in Snowy Hydro's commercial interest to extract maximum electricity prices and returns from its plant. KKPS is likely to adopt a similar strategy as Colongra and bid into the market at over $1,000/MWh, belying the Government's claims that KKPS would 'put downward pressure on electricity prices' and 'avoid unacceptable price increases following the closure of the Liddell power station in 2023'.

Batteries invariably offer a lower price than gas generators. Batteries reduce the price of peak power and put a floor on low prices, reducing the volatility of prices and providing a net dampening impact on the average electricity price.

7 Project cost is understated, and would be funded by taxpayers

7.1 Likely to cost $1 billion or more

There is a discrepancy between the $610 million estimated capital cost in the EIS, for the power station (up to 750 MW), electrical switchyard and associated infrastructure, and the $600 million that the Government committed in the 2021-22 budget, for a 660 MW station. Also Minister Stokes, stated the project would generate around $800 million worth of investment for the local community.

A capital cost for the entire project of around $600 million seems to be understated.

Applying AEMO's indicative cost for OCGTs of $1,411/kW in 2022-23 (Appendix B), a 660 MW OCGT station would cost around $930 million. (Section 4.3 of the Paper cites OCGT projects with a similar cost/kW).

Further costs to be added include the electrical switchyard, the spur pipeline/storage connection ($100+ million), project approval and management, contingencies and financing.

The financing cost to Snowy Hydro may well be zero if all funding is from the Government, as seems inevitable (see below). But government financing would be a lost opportunity cost and hence should be included as a cost of the project in the Business Case analysis. Taxpayer financing of the project does not come 'free'.

The full cost of the project is likely to add up to $1 billion or more, especially when one considers the almost inevitable budget (and time) overruns of practically every major infrastructure project.

7.2 Snowy Hydro's financial position is dire, high likelihood of further taxpayer support

Snowy Hydro's financial position has been steadily deteriorating over the past decade, with ever declining profits (last year's loss of $59.1 million of Consolidated Statement of Comprehensive Income was the first ever) and dividends[9]. The financing of Snowy 2.0 is adding considerable

[9] Snowy Hydro gas plant expansions likely to be fuelled with taxpayer funds, IEEFA Australia 18 Nov 2020 https://ieefa.org/ieefa-australia-snowy-hydro-gas-plant-expansions-likely-to-be-fuelled-with-taxpayer-funds/

pressure.

This deterioration was starkly demonstrated by the downgrading of Snowy Hydro's stand-alone credit rating to BB+ (colloquially classified as 'junk status') in September 2020. The rating agency, Standard & Poors (S&P), warned that *"Snowy Hydro Ltd.'s [downgraded] credit quality incorporates our expectation of a high likelihood of extraordinary government support".*

Also, as a harbinger of Snowy Hydro's aspirations, S&P indicated that building a gas power station would need to be paid for by the Government – "*we expect that Snowy will not undertake any other major projects (such as additional gas fired generation) in a manner that would place pressure on the balance sheet of the company, or without appropriate support from the shareholders".* This prediction has now proven to be true.

After the KKPS announcement, S&P immediately issued a bulletin stating that the decision to inject $600 million, even accepting that as the full cost of the project, may not be enough to relieve Snowy Hydro's balance sheet pressures. S&P stated that ongoing government support will be necessary given the tough operating environment, with wholesale electricity prices predicted to fall further over the next few years – driven in part by surging investment in new wind and solar projects – and the cost of gas expected to push higher.

As Snowy Hydro's financial position is so stretched the Government has no option but to pay the entire cost of KKPS.

7.3 KKPS's market value would be far less than its build cost

A direct comparator of the value of KKPS is the Colongra Power Station, built by the NSW Government-owned Delta Electricity in 2009 and purchased by Snowy Hydro in 2015 for $234 million.

It is relevant to note that gas supply limitations and high transportation costs were well known at the time (Snowy Hydro buys Colongra peaking plant from Delta Electricity):

> *"The power station is constrained, however, by the high cost of gas and limited supplies, since it is located at the end of gas pipelines which extend from Moomba in central Australia and from Bass Strait in southern Australia, to Newcastle, north of Sydney, resulting in high gas transportation costs."*

One could conjecture that it is most unlikely that the market value of Colongra would have increased since its purchase, six years ago. In fact its value may well have decreased considering its very infrequent usage. The Paper suggests that Colongra's income has been insufficient to recover its purchase cost (Section 2.3) and that future income will be even less due to its inflexibility in the 5-minute market and battery competition.

KKPS is likely to end up costing five times the purchase price of the better-located Colongra Power Station. What is the point of building a new power station for around $1 billion, when its market value ends up being about $200 million, or even less?

7.4 The KKPS Business Case must be reviewed by independent experts

The Paper concludes (Section 4.5) *"that KKPS has no chance of competing effectively with batteries and so cannot expect to generate revenues that come anywhere close to those needed to recover its outlays".*

Snowy Hydro has a poor track record in estimating costs and completion times for major projects and in preparing a sound Business Case.

When Snowy 2.0 was announced (March 2017) it was to be built in four years (i.e. 2021), at a cost of $2 billion, without taxpayer support. Those expectations have turned out to be wildly inaccurate. The latest commissioning date is 2026; the major contract was awarded for $5.1 billion, and the total cost is likely to be around $10 billion, when all components including transmission connections are incorporated; and $1.38 billion has already been kicked in by the Government to shore up Snowy 2.0's Business Case.

The Snowy 2.0 Business Case was never released, but it has become evident that it was seriously flawed. Compared to its assumptions, costs have since doubled, and projected income halved.

Snowy Hydro's Managing Director, Mr Broad, assured the Environment and Communications Legislation Committee Hearing (on 22 March 2021) that KKPS provides 'a very, very strong case [for the Government] to invest':

> "Senator WATERS: *Would additional support from the government, on top of the previously committed $1.38 billion equity injection, be necessary? If so, how much would you estimate it to be?*
> Mr Broad: *I don't want to go into the specifics of the financing until we've had the discussion with the shareholders. I can say, though, that all of the work we've done to date clearly shows that there's a very, very strong financial case to invest*."

However, he also said there would be no economic case for building KKPS if 1,000 MW of new investment were built:

> "Senator McALLISTER: *I have a final question. Is there a business case for building the Kurri Kurri plant even if sufficient new investment to replace Liddell is made?*
> Mr Broad: *No. I think the government has clearly said if this 1,000 megawatts is generated by the private sector, they won't be calling on us to build.*
> Senator McALLISTER: *It's not really my question. My question is about the business case, not about the government's policy preferences. Is there an economic case for building it even if sufficient new investment to replace Liddell is made by the private sector?*
> Mr Broad: *If sufficient new capacity were built into the system prior to Liddell, we wouldn't build—"*

As this has turned out to be the case, why is Snowy Hydro persevering with KKPS?

At the Budget Estimates Hearing on 25 May 2021 Mr Broad agreed to release the KKPS Business Case after the major contracts are finalised, which is expected to be within two months. An independent expert analysis of the Business Case is essential - a further $1+ billion of taxpayer's funds is at stake.

8 125 construction jobs (average) and 10 permanent jobs

Minister Stokes welcomed the creation of *"up to 600 jobs in construction"* and Minister Taylor announced, *"the Hunter Power Project will deliver an important economic boost to the region, creating up to 600 new jobs during peak construction and 1,200 indirect jobs across NSW"*.

It is evident that both Ministers were provided with exaggerated figures and interesting that neither mentioned the small number of ongoing operational jobs.

The EIS states that that there would be 250 jobs at the peak of construction and 10 permanent jobs:

> *"Construction of the Proposal would generate up to approximately 250 full time equivalent positions at the peak of construction activity, and about 10 permanent full time equivalent jobs on site during operation"* (page vii)

As shown in Figure 3, peak construction is just three months long, when there would be 250 jobs. The average number of jobs over the two-year construction period is about 125.

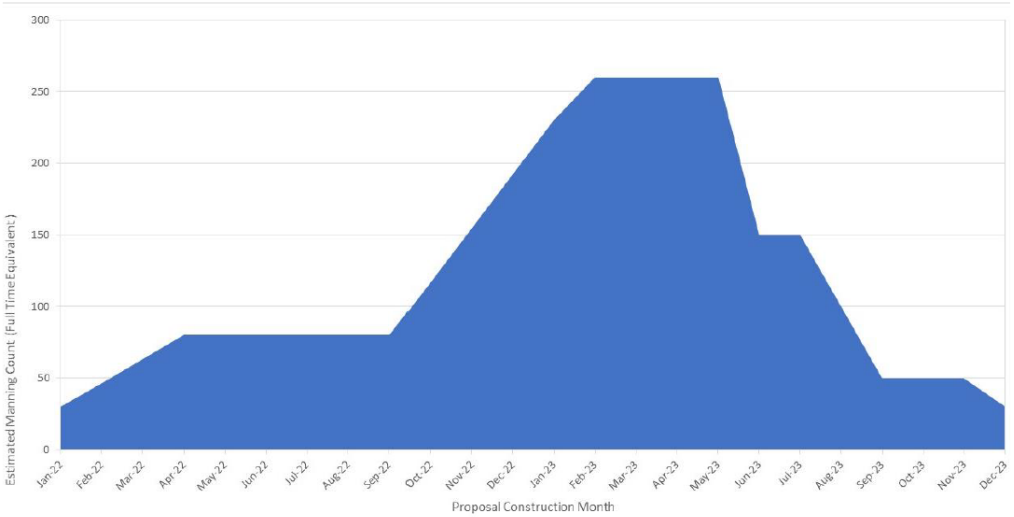


Figure 3 – Construction Workforce (EIS Figure 2.3)

9 Upward pressure on gas and (possibly) electricity prices

Minister Taylor backed KKPS for reducing electricity prices and keeping the lights on:

> *"Cheap power is crucial to ensuring families, businesses and job-creating industries in NSW can thrive, which is why we are committed to replacing the energy generated by Liddell to keep prices down.*
>
> *This important project is good news for NSW as well as the broader National Electricity Market. We were very clear from the start – we will not stand by and watch prices go up and the lights go off. This project will deliver flexible gas generation to replace Liddell and maintain reliable power alongside Australia's world-leading investment in renewables."*

9.1 Gas

KKPS would put upward pressure on gas prices, particularly in Newcastle, due to its added load on the constrained Sydney-Newcastle Pipeline.

9.2 Electricity

The Paper concludes that the claim that KKPS will reduce prices is tenuous. In principle, greater supply has the potential to reduce prices in any market. But KKPS is inflexible and slow to respond,

rendering it useless in most circumstances in the coming 5-minute settlement market.

It is also relevant to note that whilst KKPS would operate infrequently, Snowy Hydro would increase its dominance in gas peaking generation across the Newcastle-Sydney-Wollongong area to 65%:

Snowy Hydro		**EnergyAustralia**	
Colongra	724 MW	Tallawarra A	440 MW
Kurri Kurri	660 MW	Tallawarra B	312 MW
	1,384 MW		752 MW

Snowy Hydro has substantial peaking plant on the NEM (4,000 MW of hydro, pumped storage, gas and diesel). Its dominant position and market power would further increase with KKPS and Snowy 2.0, to nearly 7,000 MW of peaking plant.

10 Pollutants over Hunter Valley and Newcastle

The EIS concludes there is *"no significant risk of air quality impacts due to emissions"*:

> *"The Proposal's operation would generate air pollutant emissions from the combustion of natural gas and diesel fuel. Both of these fuel sources generate emissions of carbon monoxide, carbon dioxide (CO2), nitrogen oxides, sulphur oxides, suspended particulate matter (such as PM10 and PM2.5), and unburnt hydrocarbons and other volatile organic compounds … air quality modelling demonstrated that the emitted concentrations of all airborne substances and particulate matter would be low and not expected to cause adverse air quality impacts in the vicinity of the Proposal Site nor in the region, and would not cause any additional exceedances of EPA criteria.*

The EIS notes that *"the most common winds in the area are from the west-northwest",* resulting in airborne pollutants from KKPS blowing down the Hunter Valley and over Newcastle.

Contrasting the claim of insignificant risks, Section 4.4.3 notes the unsuitability of the Colongra site for an expanded gas power station due to the proximity of 'sensitive receivers'[10]:

> *"The (other) brownfield option considered was Snowy Hydro's Colongra site, but this was ruled out as a viable location for an expanded open cycle power station footprint, due to the proximity of sensitive receivers".*

Whilst the land surrounding the Kurri Kurri site has fewer sensitive receivers (residences, schools etc) than Colongra, the impact of noxious pollutants would still be as relevant for those receivers as it would be for receivers in the Colongra area:

> *"The Proposal Site is located in the small suburb of Loxford, north of Kurri Kurri, in the Lower Hunter Valley, with relatively flat terrain in the vicinity of the Proposal Site. Most of the sensitive receptors closest to the Proposal Site are isolated residences"*

If locating the new station at Colongra was ruled out, why is Kurri Kurri acceptable and what is to be done to reduce the impact on the nearby 'sensitive receivers'?

[10] A sensitive receiver is where people are likely to work or reside and therefore have the potential to experience an air quality impact.

10.1 Would KKPS preclude proposed rezoning of surrounding land?

The EIS notes a proposal for rezoning the site and surrounding land for other uses:

> *"A proposal is currently before the NSW DPIE to rezone the former Hydro Aluminum smelter site and surrounding land to a combination of residential, general and heavy industrial, business, rural, recreation, special purpose and environmental zones. This would designate the Proposal Site as Heavy Industrial. However, whether the Proposal Site is eventually zoned for General Industrial or Heavy Industrial is unlikely to affect the planning outcome of this Proposal, or have any material bearing on the ultimate Ministerial determination. The Proposal would not be incompatible with the local council's land use objectives for either the current zoning or proposed rezoning type."*

Might construction of KKPS preclude or reduce the opportunity for such other uses, even though the EIS suggests it to not be an issue. One would presume that at the least there would need to be a buffer zone between the power station and other development.

If KKPS did preclude other land uses, then this is a lost opportunity (and cost) that needs to be included in the appraisal of the Business Case.

11 Greenhouse Gas emissions

The EIS estimates greenhouse gas emissions of 500,299 tonnes CO2 equivalent per year, which is no doubt overstated as it is based on a capacity factor of 12%:

> *"A greenhouse gas (GHG) assessment was conducted in accordance with National Greenhouse Accounts guidance, to estimate GHG emissions for the construction and operational phases of the Proposal, and the operational phase GHG emissions compared to the overall energy output of the Proposal. The operational phase emissions were calculated as 500,299 tonnes of CO2 equivalent per annum. Taking into account its annual energy output, the Proposal would have an emission intensity of approximately 0.52 tonnes CO2 equivalent/MWh (Scope 1 + 2)."*

However, the estimated figure does not include emissions upstream of KKPS. Such emissions would be produced from the extraction of natural gas (fugitive emissions) and its transportation from the gas fields (in Moomba and Bass Strait) to KKPS. Transport emissions occur both through leakage (minor) and the use of gas in powering multiple compressor stations along the pipelines.

Also, in the case of KKPS, further compressors would be required for the spur line storage system, incurring additional energy usage and emissions.

The EIS makes no mention of such upstream emissions and therefore understates the quantity of emissions incurred by KKPS – they would be significant and should be included in the estimate.

The EIS states that *"total emissions from the Proposal would be low compared to baseload coal".* This is only true because peaking gas generators operate for only a fraction of the time of baseload coal-fired generators.

The more relevant comparator is the intensity of emissions.

Table 15.15 in the EIS estimates the KKPS emission intensity to be 0.52 tonnes CO2e/MWh. The

addition of fugitive emissions and emissions from transportation and spur line compressors is likely to result in an emission intensity of more than 60% of Liddell Power Station (0.93 t CO2e/MWh). That is, KKPS only reduces the emission intensity of the coal-fired station it is ostensibly 'supplanting' by less than 40%.

It is noted that a recent CSIRO Report[11] determined a reduction of only 31% when comparing gas generation to coal generation - *"a comparison of GHG emissions from electricity production in Australia from Queensland thermal coal or natural gas derived from Surat Basin CSG showed a reduction in emissions of 31% (open cycle gas turbine)".*

There is no place for constructing infrastructure that emits any greenhouse gasses, no matter how infrequently it is expected to operate.

12 Another senseless Commonwealth/Snowy Hydro intervention in the NEM

There are many parallels between KKPS and Snowy 2.0. In both cases there are cheaper, more efficient, and less environmentally damaging alternatives.

	Kurri Kurri Power Station	**Snowy 2.0 Pumped Hydro Storage**
Not needed	No need for additional 'dispatchable' gas peaking plant this decade	No need for Snowy 2.0 storage, or its equivalent, till the end of this decade
Business Case	Expected to be released in July	Not published, but flawed with underestimated costs and overestimated revenues
Cost exclusions	Spur pipeline/storage, financing	Transmission, financing, project management, planning, offsets etc
Understated capital cost	Would cost much more than $600 million	Initial estimate of $2 billion is likely to end up around $10 billion
High operating cost	Much higher operating cost than batteries	Loses 25% of energy in the pumping/ generation cycle
Uneconomic	Five times the Colongra purchase price. Run time overstated. Cannot possibly pay for itself	Revenue less than half that assumed. Cannot possibly pay for itself
Taxpayer subsidy	Full cost of KKPS - around $1+ billion	$1.38 billion already, with more likely
'Cannibalising' existing Snowy Hydro plant	Reduces operation of underutilised Colongra Power Station (724 MW)	Reduces operation of Tumut 3 Pumped Storage Station (1,800 MW)
Inappropriate location	Severely limited gas supply	In the middle of Kosciuszko National Park, hundreds of kilometres from load centres, needing extensive transmission connections

[11] Whole of Life Greenhouse Gas Emissions Assessment of a Coal Seam Gas to Liquefied Natural Gas Project in the Surat Basin, Queensland, Australia, CSIRO July 2019 https://gisera.csiro.au/wp-content/uploads/2019/07/GISERA_G2_Final_Report-whole-of-life-GHG-assessment.pdf

Separate connection EIS after Main Works EIS	The spur pipeline, to be constructed by Jemena, is to be the subject of a separate EIS, yet to be released	The transmission connection, to be constructed by TransGrid, is the subject of a separate EIS, issued 17 months after the Main Works EIS
Push prices up	Places upward pressure on gas	Will result in electricity prices higher than they otherwise would be (Snowy Hydro modelling)
Environmental impacts	Greenhouse gas and pollutant emissions	Permanent damage to large tracts of Kosciuszko National Park; spreading pest fish throughout the Snowy Mountains
Better alternatives	Batteries; gas power stations with adequate gas supply, if at all	Other pumped storage; or, better still, batteries

If approved, KKPS will be another Snowy White Elephant, following the same path as the taxpayer-funded, uneconomic, inefficient and environmentally destructive Snowy 2.0.

Appendix A – 'Justification' for KKPS

The EIS attempts to justify the project by highlighting out-of-date forecasts of a supply shortfall in the NEM when the 1,680 MW Liddell coal-fired power station closes in 2023. A 2017 forecast of a shortfall 'of as much as 1,000 MW' is quoted, followed by a revised shortfall estimate of 215 MW, concluding that there is 'therefore a clear need to fill this gap [by KKPS]':

> *"In its Advice to Commonwealth Government on Dispatchable Capability (AEMO, September 2017), AEMO reported that the NEM will need as much as 1,000 megawatts of additional new flexible and dispatchable resources to replace the contribution of Liddell. However, the reserve requirement would increase if either projected new resources (e.g. Queensland-NSW Interconnector and Victoria-NSW Interconnector upgrades) do not come online as currently forecast, more generation is retired, or any existing generators were to suffer catastrophic failure or sustained long term outages.*
>
> *The AEMO's 2019 Electricity Statement of Opportunities (ESOO) indicated that with committed projects and the interconnector upgrades, around 215 MW of new dispatchable supply would be required to ensure NSW only has a one-in-ten year risk of a significant involuntary load shed event in summer 2023–24, following a Liddell closure (Liddell Taskforce, 2020, op.cit).*
>
> *There is therefore a clear need to fill this gap in dispatchable capacity, and to provide the firming capacity that will achieve the necessary reliability in the overall energy supply system. The Proposal's primary aim is to meet this need."*

The AEMO 2019 ESOO actually forecast no gap to meet the 'reliability standard' and a 375 MW gap to meet the more stringent 'Interim Reliability Measure (IRM)'.

Reliability forecast components (AEMO 2020 ESOO)

The NEM **reliability standard** is set to ensure that sufficient supply resources exist to meet 99.998% of annual demand for electricity in each region. The standard allows for a maximum expectation of 0.002% of energy demand to be unmet in a given region per financial year.

Unserved energy (USE)[12] is the amount of energy that cannot be supplied to consumers, resulting in involuntary load shedding (loss of customer supply). This may be caused by factors such as insufficient levels of generation capacity, demand response, or network capability to meet demand.

The **Interim Reliability Measure (IRM)**, introduced by the National Electricity Amendment (Interim Reliability Measure) Rule 2020 (IRM Rule) is intended to reduce the risk of load shedding across the NEM by helping keep USE in each region to no more than 0.0006%. This interim measure is intended to support reliability in the system while more fundamental reforms are designed and implemented.

[12] The USE that contributes to the reliability standard excludes power system security incidents resulting from events such as multiple or non-credible generation and transmission events, network outages not associated with inter-regional flows, or industrial action (NER 3.9.3C(b)(2)). 'Expected' in this ESOO refers to the mathematical definition of the word, which describes the weighted-average USE outcome.

After highlighting these outdated forecasts, the EIS then refers to the latest AEMO 2020 ESOO, avoiding any mention of its further reduced supply shortfall in 2023 of IRM to 154 MW (Figure 4), and only referring to a 1,480 MW shortfall in the reliability standard by the end of this decade:

> *"In NSW, the major influencing factor on forecast reliability is the planned retirement of the Liddell power station in 2023. The ESOO acknowledges that the reliability outlook has improved with the planned augmentation of the Queensland to New South Wales Interconnector (QNI) in 2022-23 and the development of 900 MW of local new renewable generation. However, it also highlights risks to reliability posed by extreme climate induced weather events such as the 2019-20 summer bushfires and the COVID-19 pandemic.*
>
> *In NSW there is a need for 1,480 MW of generation this decade to meet the reliability standard and to meet the more stringent IRM capacity, which is expected to be called for from 2023-24. This corresponds to the announced timing for the closure of the Liddell Power Station, which has a capacity of approximately 2,000 MW.*
>
> *The Proposal as planned would assist in maintaining the supply-demand balance and in satisfying the reliability standard and the IRM."*

The EIS incorrectly conflates the 'gap to meet the reliability standard' and the 'gap to meet the IRM'. It also overstates the capacity of Liddell, which was formally downgraded to 1,680 MW and has only had about 1,000 MW available for the past year (Figure 6).

	Gap to meet reliability standard			Gap to meet IRM		
	Victoria	South Australia	New South Wales	Victoria	South Australia	New South Wales
2020-21	0	0	0	0	0	0
2021-22	0	0	0	0	0	0
2022-23	0	0	0	0	0	0
2023-24	0	0	0	0	0	154
2024-25	0	0	0	0	0	305
2025-26	0	0	0	0	0	525
2026-27	0	0	0	0	0	472
2027-28	0	0	0	0	0	895
2028-29	0	0	0	0	0	1,001
2029-30	0	0	1,480	166	148	2,045

Figure 4 - Forecast reliability gap (in MW) to meet the reliability standard and IRM (2020 ESOO)

The very modest 154 MW IRM gap in 2023 has in fact already been closed with the recent announcement of the Tallawarra B gas generator (312 MW). Also, if the 600 MW Port Kembla gas generator is committed (it received $30 million by the Commonwealth in the 2021-22 budget) then there will be no shortfall till the end of this decade, or even later if other dispatchable generation is

built (which is inevitable in the case of big batteries).

The EIS then attempts to provide an argument against the do-nothing option (Section 4.4.2), citing power shortages, blackouts and increased electricity prices:

> *"The implications of the 'do-nothing' or base case should the Proposal not proceed could include:*
> - *Power shortages, most likely during times of peak demand such as during extreme weather, which may become more likely following the closure of the Liddell power station, potentially resulting in increased NEM prices and interrupted supply for NSW residents, businesses and the community*
> - *Regional social and economic benefits including improved energy security, employment, and the stimulus created by major infrastructure investment, would not be realised*
> - *The Proposal Site would be subjected to different environmental or social impacts that may arise from an alternative industrial use to the Proposal. These impacts may be an aggregate reduction or increase dependent upon the nature of the alternative industry proposed.*
>
> *The do-nothing option, especially in the context of the impending closure of Liddell, would increase the risk of load-shedding, where peak demand is unable to be met. While the likelihood of such an event may be small, the economic and social consequences of blackouts can be significant and it is the mitigation of this risk that is a high priority of current government policy settings. Therefore, the do-nothing option would not be consistent with government policy."*

Clearly, there is no justification for a 660 MW gas/diesel generator to be built, at taxpayer expense, by 2023 or beyond.

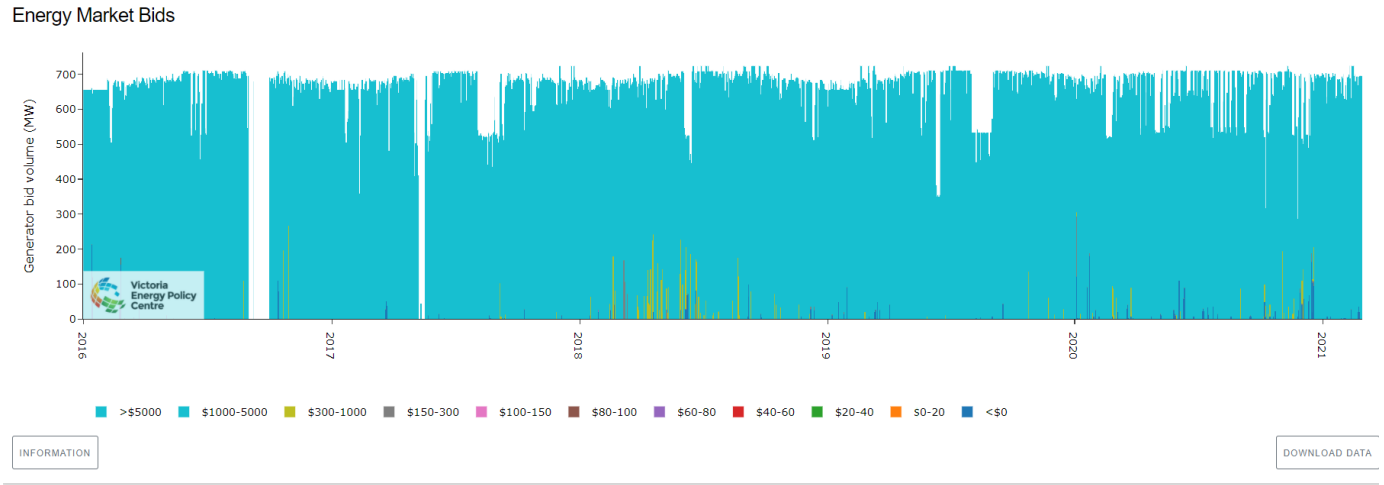
Appendix B – AEMO ISP 2019 Input and Assumptions Workbook v1.5 Jul 20 ($/kW)

Build costs - Central	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
Black Coal (supercritical PC)	3314	3308	3303	3298	3293	3287	3282	3277	3272	3266	3261
Brown Coal (supercritical PC)	5115	5106	5098	5090	5082	5074	5066	5058	5049	5041	5033
OCGT	1416	1416	1413	1411	1409	1407	1404	1402	1400	1398	1395
CCGT	1696	1696	1693	1690	1688	1685	1682	1680	1677	1674	1672
Biomass	12834	12834	12826	12815	12815	12815	12815	12815	12815	12815	12815
Large scale Solar PV	1463	1284	1227	1125	1096	1071	943	909	885	864	837
Solar Thermal (8hrs Storage)	6670	6572	6572	6572	6572	6572	6572	6572	6536	6455	6187
Battery storage (2hrs storage)	1244	1146	1109	1087	1072	1054	854	737	663	614	584
Battery storage (4hrs storage)	1964	1809	1751	1716	1693	1665	1348	1163	1047	969	922
Wind	1781	1761	1741	1726	1716	1706	1696	1683	1671	1635	1627
Wind - offshore	6070	6088	6067	6011	5966	5918	5872	5872	5850	5758	5675

By the end of this decade battery build costs are expected to be two-thirds the cost of KKPS; $922/kW versus $1,400/kW. Also, the operating and maintenance costs of batteries are substantially less than gas/diesel generators.

Appendix C – Colongra and Liddell Power Stations Operation[4]

Historically, Colongra has bid into the market at consistently over $1,000/MWh (Figure 5), explaining why it rarely runs. By way of contrast, Liddell Power Station typically bids $0/MWh or less, to ensure it is dispatched (Figure 6). Colongra could be viewed (simplistically) as 'replacing' $0/MWh power with >$1,000/MWh power.



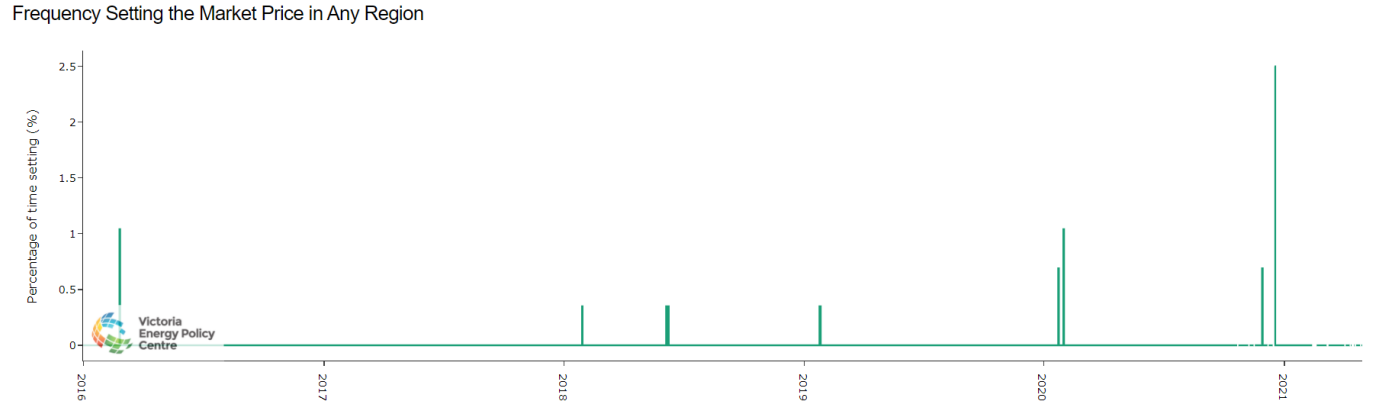


Figure 5 – Colongra Energy Market Bids and Times when it Set the Market Price

As shown in Figure 5, over the past five years, Colongra has set the market price just nine times (i.e. it was the marginally priced generator on the NEM).

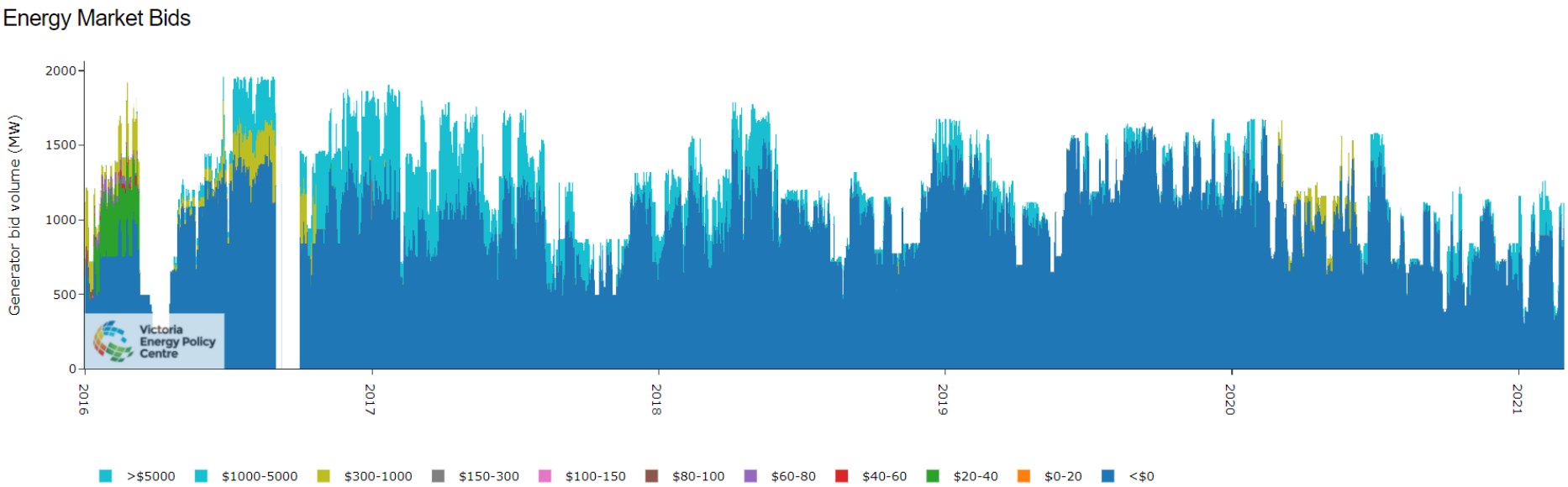


Figure 6 – Liddell Energy Market Bids

Figure 6 shows that the recent availability of Liddell has dropped to around 1,000 MW. This means that the amount of capacity that needs to be 'replaced' in 2023 when Liddell is closed is significantly less than its nameplate rating of 2,000 MW.