16 March 2018

Hon. Josh Frydenberg MP
Minister for the Environment & Energy
PO Box 6022
House of Representatives
Parliament House
Canberra ACT 2600

Level 22
530 Collins Street
Melbourne VIC 3000

Postal Address:
GPO Box 2008
Melbourne VIC 3001

T 1300 858724
F 03 9609 8010

Dear Minister Frydenberg,

Advice to the Commonwealth relating to AGL's proposal to replace Liddell

This analysis is provided in response to your request for the Australian Energy Market Operator (AEMO) to assess AGL's plan to replace the energy and capacity currently delivered by the Liddell Power Station (Liddell) following its retirement in 2022.

Background

In April 2015 as part of its Greenhouse Gas Policy, AGL committed to the closure of its coal-fired power stations at the end of their operating life. AEMO included this announcement within its 2016 Electricity Statement of Opportunities (ESOO) released in September 2016. AEMO's analysis projected that under a neutral economic and consumer outlook (and in the absence of new generation, network or non-network development) coal-fired generation withdrawals at the levels assumed, may lead to reliability standard breaches in New South Wales by 2025–26, after the announced withdrawal of Liddell.

The 2016 report warned that additional intermittent generation alone may not materially improve the reliability of the system during peak demand periods. It stated that network or non-network developments, potentially including generation, storage, and demand side management services, may reduce the risk of supply interruptions if they can increase available supply or decrease demand at the required peak demand times.

On 5 September 2017, AEMO released the 2017 ESOO outlining a heightened risk that the current NEM reliability standard will not be met, and confirmed that for peak summer periods, targeted actions to provide additional firming capability were necessary to reduce the risk of supply interruptions.

The short term risk was identified in Victoria and South Australia, with the potential for unserved energy (USE) and the likelihood of not meeting the current reliability standard projected to increase in New South Wales after Liddell closes. This same analysis was echoed in AEMO's advice to the Commonwealth government on dispatchable capability in mid-September 2017. Specifically, AEMO identified that under certain conditions, such as coincidental high demand, dispatchable plant failures and low variable renewable energy, the NEM could see a need for an additional 1,000 MW of dispatchable resources.

Following this document, AGL again reconfirmed its commitment to the closure of Liddell in 2022 - the end of its operating life. At the Prime Minister's request, AGL committed to the Prime Minister to deliver a plan in 90 days of the actions AGL will take to avoid a market

shortfall once Liddell retires. On 9 December 2017, AGL outlined plans for Liddell beyond its announced retirement. This letter reviews the AGL plans post Liddell.

About Liddell

Liddell was commissioned in 1973 and has a maximum design capacity of 2000 MW. However, while Liddell has a nameplate capacity of 2000 MW, because of its age, Liddell is operating at a lower level of output. At the end of 2017, Liddell's nameplate capacity during summer had reduced to approximately 1800 MW.

AGL's proposed Liddell replacement plan

AGL proposes a three-staged approach to replace Liddell and address the 1000 MW gap in flexible and dispatchable resources that AEMO had identified.

AGL has proposed to invest in the generation required to meet reliability and emissions standards for their current residential customer load (Stage 1). AGL also advised that they would potentially invest to meet uncontracted commercial and industrial load (Stage 2). AGL also identified a willingness to consider investment to close any gap of any remaining capacity shortfall if the market had not already invested to cover it (Stage 3).

All resources are proposed to be operational by 2022, and while AGL states that it will pursue the entirety of its plan, the Bayswater upgrade[1] is the only committed resource at this point in accordance with the criteria AEMO applies for determining new supply. AGL also notes that it will not pursue new investment identified in Stage 3 of the plan if other participants in the market invest in new resources.

Table 1: Installed capacity within every stage of the AGL plan (MW)

AGL Plan Stage	Technology	Installed Capacity (MW)	Projected capacity at high demand (MW)
Base case	Bayswater upgrade (fully committed)	100	100
Stage 1	Solar	300	0-250
Stage 1	Gas	250	250
Stage 1	Demand response	20	20
Stage 2	Gas	500	500
Stages 2+3	Demand response	80	80
Stages 2+3	Renewables (wind and solar)	750	40-600
Stage 3	Liddell Battery*	250	0-250
		2,250	**990 - 2,050**

[1] *Publically announced 28 February 2018.*

* Note: for the purpose of AEMO's modelling, the Liddell Battery is withheld to only operate to avoid USE to maximise its impact on reliability.

Review of AGL Plan

There are two components of AEMO's analysis of the Liddell plan:

A) We first updated our projected resource gap following Liddell's closure in 2022. The update was appropriate to take into account any further projected changes in supply and demand profiles in NSW since our analysis published in September. The output of this analysis shows the level and type of capability (MWs) AEMO forecasts to be required to ensure reliability for the period of time following Liddell's closure. AEMO notes that this approach is consistent with the reliability forecast analysis contemplated in the National Energy Guarantee.

B) We compared AGL's proposed output from its plan against the resource gap. In all cases, AEMO has analysed the impact of AGL's projects and its three stage strategy against a Base case, using the following scenarios:

- **Base case** – Committed only[2], Liddell to close end of 2022. The Base Case includes the 100 MW Bayswater upgrade and 810 MW's of other resources (primarily variable renewable generation) that have reached the stage of the commitment that AEMO relies on to determine new supply arrangements, are scheduled to be available prior to Liddell's closure and can serve NSW. The new resources that have committed since AEMO's September analysis are included in Table 2.
- **Scenario 1** – Base case plus AGL Stage 1 implemented to capacity and on time.
- **Scenario 2** – Base case plus AGL Stage 1 - 3 implemented to capacity and on time.

A. Updated analysis of resource gap

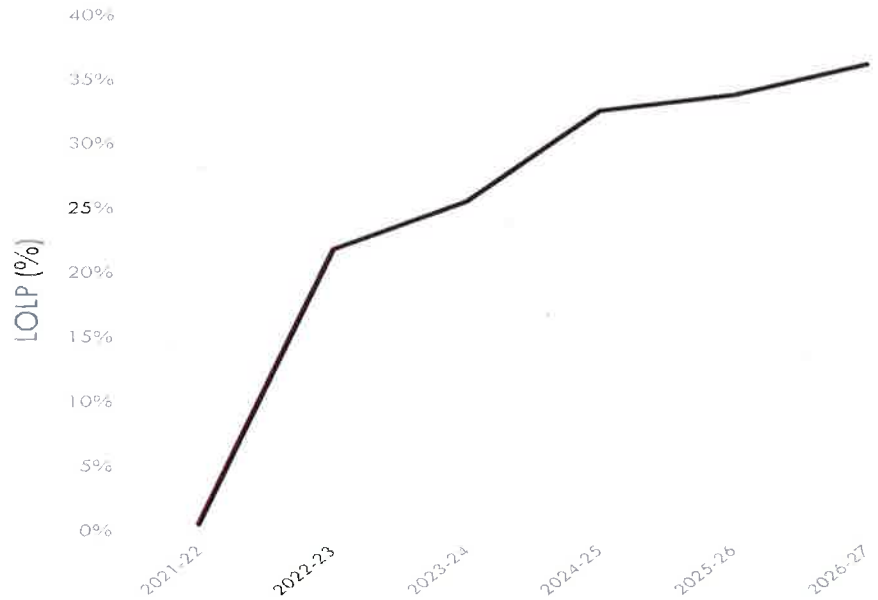
AEMO's analysis of the Base case demonstrates that, without the entirety of AGL's plan or comparable investment in resources by others, there remains a high risk of load shedding following the closure of Liddell. Specifically, the analysis shows that once in every three years, approximately 200,000[3] households in NSW may experience power outages lasting five hours.

The expected loss of load probability (LOLP) for NSW from 2021-22 onwards is shown in Figure 1 below, and highlights that unless a combination of more generation, demand side participation, storage or transmission capacity is built, there is a significant risk of load shedding over peak periods after Liddell's retirement. The risk grows every year due to projected increases in NSW electricity demand, driven largely by continued population and economic growth forecasts.

[2] *Includes AGL's Bayswater upgrade and other proponents' generation that have reached committed status including those shown in Table 2. As such, this does not include AGL's solar off-take agreement.*

[3] *Assuming average household demand of 2kW during peak periods.*

Figure 1: Expected loss of load probability (LOLP) for NSW from 2021-22 onwards



To minimise this risk, AEMO's latest analysis using updated supply and demand information, shows approximately 850 MW of additional dispatchable resources are needed by 2026-27. This additional capacity will reduce the risk of load shedding to a 1-in-10 year likelihood after the closure of Liddell.

AEMO's analysis acknowledges the proposed addition of 3,700 MW of committed capacity in the NEM, of which 2,600 MW of new investment in renewable generation capacity has been committed since September 2017. However, as there is insufficient interconnector capability for reliable delivery of additional new supply into NSW from other regions during peak periods, only the NSW committed generation totaling 910 MW of nameplate capacity contributes to NSW resource requirements in the Base Case. These committed resources include AGL's 100 MW Bayswater upgrade and 200 MW Silverton wind farm. See Figure 2 below:

Figure 2: New resources soon to be available in NSW

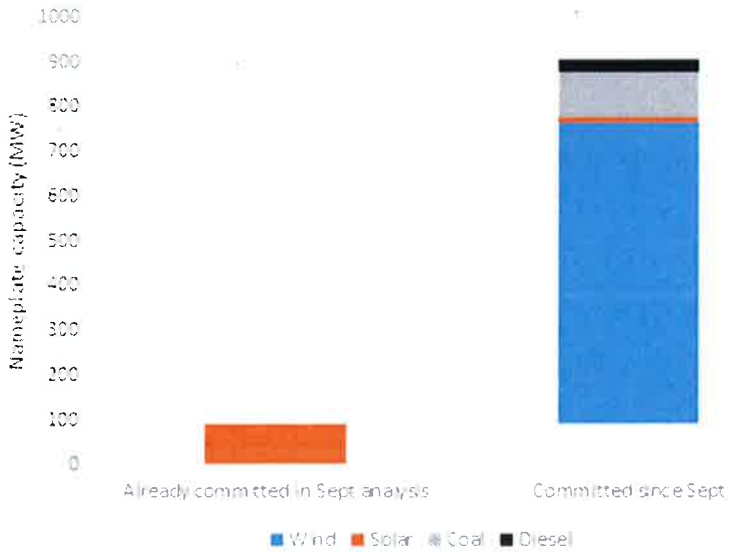


Table 2: Increase in committed renewable MWs since AEMO's September report

Region	Fuel type	Increase in committed MWs since AEMO's September report
QLD	Solar	863
	Wind	496 (including AGL's 450 MW Coopers Gap wind farm)
NSW	Solar	12
	Wind	673 (including AGL's 200 MW Silverton wind farm)
VIC	Solar	169
	Wind	177
SA	Solar	0
	Wind	245
TAS	Solar	0
	Wind	0

The 850 MW reliability gap in resources available to serve NSW reflects the risk of non-performance of generators under high demand conditions (based on recent observed performance constraints), updated consumption forecasts, the lack of predictability around the contribution of renewable generation at times of peak demand, and limitations on interconnector support.

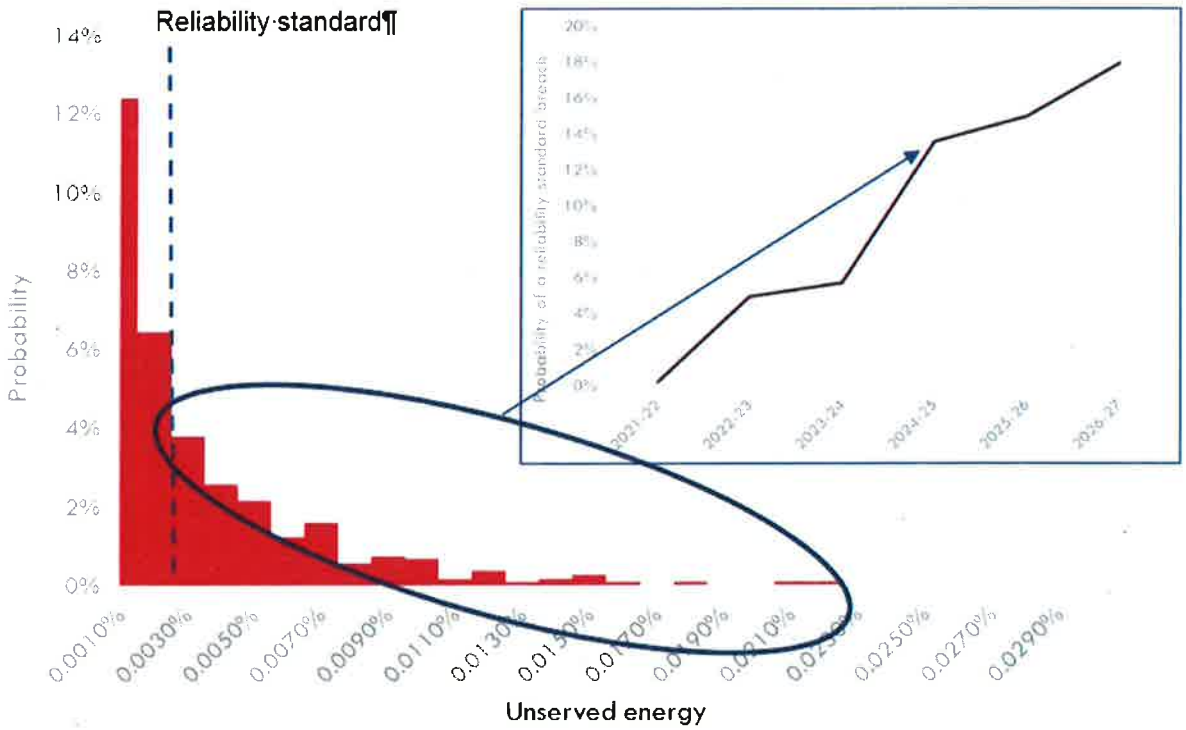
Specifically, temperatures of 40 degrees or more in Sydney could be the catalyst for extreme 1-in-10 year electricity demand conditions, particularly when these temperatures are experienced towards the end of the day when business demand is still relatively high, residential demand is increasing and rooftop solar generation is declining. In short, under the Base Case scenario, when Liddell retires there is a significant potential for involuntary load shedding during these hot summer days, without additional investment in dispatchable resources.

Evaluation under the NEM Unserved Energy Reliability Standard

AEMO also assessed AGL's plan and supporting modelling by applying the NEM Reliability Standard – an economic planning benchmark that requires expected unserved energy (USE) to not exceed 0.002% of consumption per region in any financial year. The USE analysis applies a statistical expectation of a future state, using averages across a range of future outcomes, weighted for probability of occurrence. Because the USE reliability standard is an annual statistical forecast, the actual occurrence of load shedding in a given year over a particular combination of weather events could be much higher than the expected level. We noted that in all scenarios of this analysis AGL's proposed plan (which also includes the addition of other proponents' generation that have reached committed status), the economic planning standard is forecast to be met.

As the September analysis identified, the fact that NSW would meet the probabilistic 0.002% USE reliability standard while simultaneously showing a high risk of insufficient supply to meet demand under plausible extreme weather conditions reflects the changing nature of our Australia's weather patterns and energy usage. Changes in the make-up and operating complexity of the NEM, including a growing proportion of variable renewable energy generation, behind-the-meter and on grid, are contributing to a growing difference in the expected level of statistically averaged incidences of resource insufficiency and exposure to potential supply shortfalls at times of peak demand.

Figure 2: Distribution of annual unserved energy showing probability that standard will be breached, 2024-25[4]



One reason why the statistical analysis shows low expected USE despite a high probability of outages over peak, is the changing load profile. The installation of high levels of embedded solar PV generation across the NEM is leading to a later and shorter peak in the 'operational demand' (i.e. net demand on the system).

Concurrently, the USE measure is becoming more sensitive to weather-driven variations in input assumptions more generally. With increasing growth in variable renewable energy resources, both demand and supply are now exposed to the vagaries of weather, such as wind and solar availability, impacting AEMO's ability to meet demand on extreme peak days.

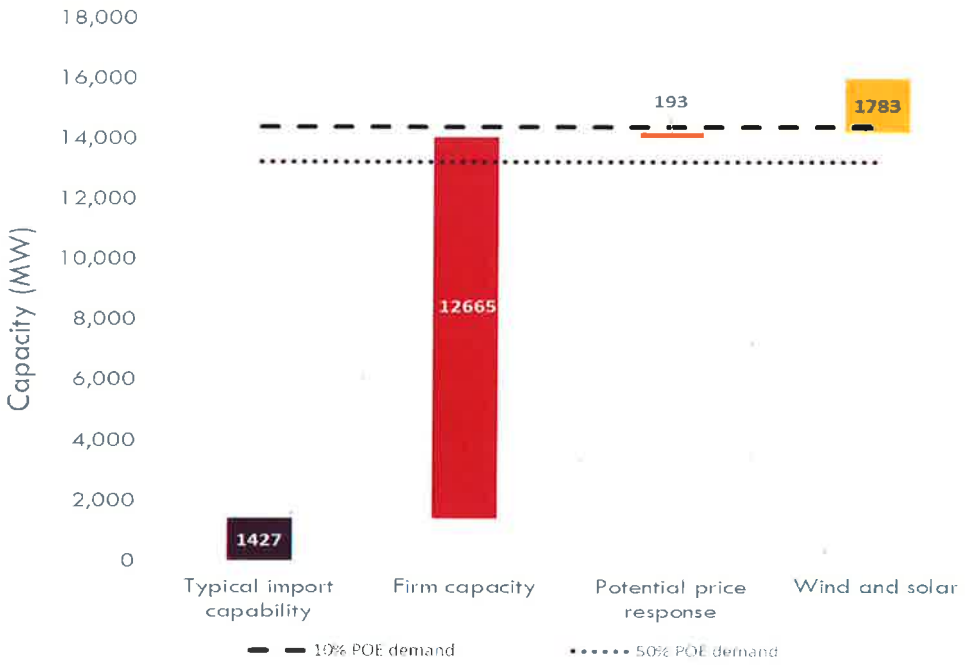
As shown in Figure 3 on the next page, under extreme maximum demand conditions, even with all firm generation (excluding wind and solar) fully available in NSW, AEMO would still expect to rely on:

- Maximum interconnector support into NSW (primarily from Queensland), totaling around 1,500 MW;

[4] *Not shown are the 65% of simulations where no USE was observed, typically under milder summer temperatures.*

- 200 MW of voluntary demand side participation;
- Approximately 150 MW of wind/solar out of a projected total capacity of 1.8 GW (roughly 8% of total capacity)[5].

Figure 3: Supply composition at times of peak demand in NSW



Under these conditions, the unplanned loss of one or more local generators would require some level of involuntary load shedding, unless windy conditions prevailed.

Due to the significant changes occurring in the power system, and particularly the increasing reliance on the weather as a power source, AEMO is reevaluating the method it uses for calculating unserved energy and the reporting of it in the 2018 Electricity Statement of Opportunities. We will engage with the Reliability Panel under the Australian Energy Markets Commission (AEMC) in this review.

Development of a Strategic Reserve

AEMO is recommending that NSW have sufficient resources available to meet demand during a 1-in-10 resource peak. Our recommended additional investment in 850 MW of dispatchable and flexible capability will eliminate this risk under typical historic system conditions. However, as noted in our September advice, AEMO continues to stress that the capability of the power system to meet reliability requirements in all periods of the future are still subject to the risks inherent of our aging generation fleet, weather and climate impacts.

Experiences from both summer 2016/17 and so far in 2017/18 have revealed that there have been a number of events where Lack of Reserve (LOR) conditions have been forecast due to a combination of higher than average temperatures, and unplanned generation outages or loss of generation due to weather conditions.

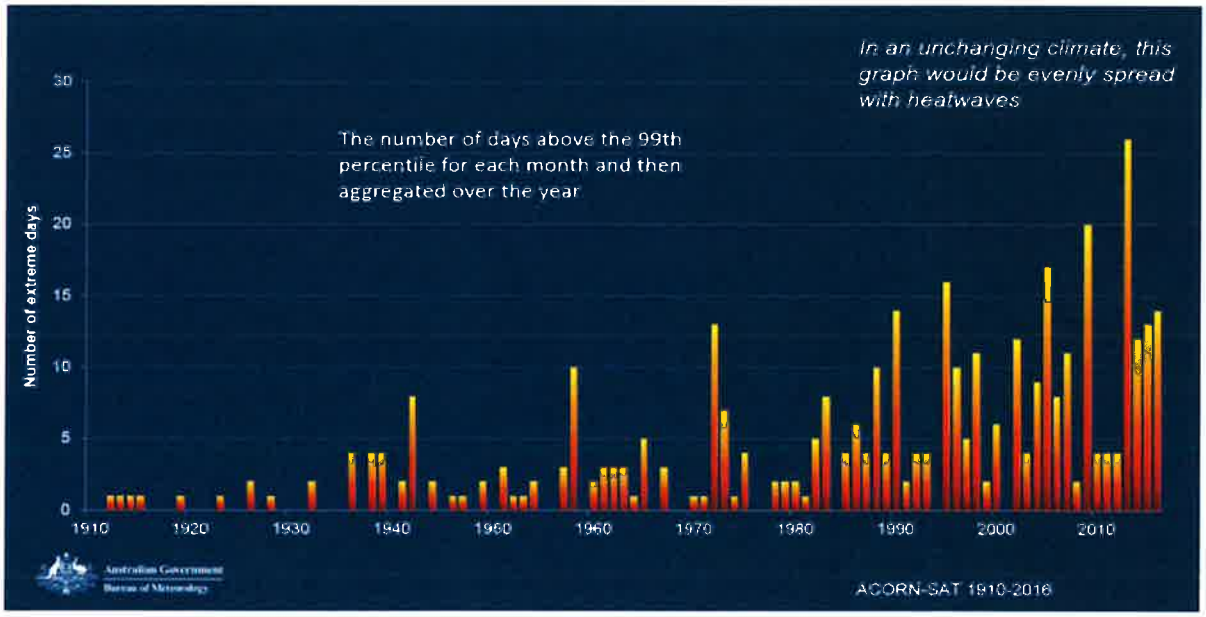
[5] *For 90% of peak demand intervals, NSW renewable output is >15% of total capacity*

The Bureau of Meteorology chart (figure 4) shows, the number of days above the 99th percentile for each month and aggregated over the year is growing. This indicates that the weather is changing and that more extreme peak temperatures and heat waves are more likely. While AEMO's modelling makes some allowance for increasing temperatures due to climate change, we are engaging with the BOM to do more analysis on how best to model the effect of these weather changes in our demand and supply forecasting.

AEMO's view is that optimal approaches towards ensuring an efficient balanced system must target mechanisms that allow the greatest practical level of competition and innovation on both the supply and demand sides of the system. As a result of the changed dynamics of the power system and the increased uncertainty in the many and varied factors that contribute to balancing supply and demand, in its September report AEMO proposed the development of a strategic reserve mechanism, that was also recommended in the Finkel review and accepted by the COAG Energy Council.

In AEMO's view, a standing strategic reserve comprised of resources such as distributed generation and flexible load owned by commercial customers who are not participants in the market, but can be made available to avoid involuntary load shedding during extreme conditions, are a necessary and prudent addition to the current NEM market design. AEMO will be pursuing the development of a strategic reserve with the Energy Security Board (ESB) and AEMC.

Figure 4: The number of days above the 99th percentile for each month, aggregated over the year.



B. Evaluation of AGL's Plan.

AEMO's analysis identifies that with 90% confidence, the output from the AGL Liddell replacement plan (over and above the Bayswater upgrade that is already committed) at time of system peak demand is at least 260 MW for Stage 1 alone, and at least 1,000 MW if all three stages proceed.

In its entirety, all three stages of AGL's plan would deliver sufficient dispatchable resources to fill the identified 850 MW resource gap. However, under Scenario 1, there remains a resource gap of around 590 MW exposing the power system to a high risk of involuntary load shedding, especially in 1-in-10 year maximum demand conditions.

For example, in 2026-27:

- For *Scenario 1*, there is a risk of load shedding every 4 years, resulting in approximately 174,000 households without power for 3.6 hours.
- For *Scenario 2*, this risk of load shedding reduces to 1-in-20 years, resulting in approximately 172,000 households without power for 2.2 hours.

Recommendations and consistency with the proposed National Energy Guarantee.

In conclusion, AEMO's analysis shows that an additional 850 MWs of resource capability are required to ensure reliability in NSW following the closure of Liddell. If all three stages of the AGL plan are completed, the resource gap will be eliminated. However, to ensure adequate resources are available at the time of Liddell's retirements, AEMO can only include those resources for which there is a clear commitment to construct. Given at this stage AGL has only committed to install 100 MW of additional firm generation in its plan, unless AGL or others invest in sufficient replacement resource capability to serve NSW, there remains a significant resource gap of 850MW.

The Commonwealth's request and AEMO's assessment of a reliability gap represent the type of challenge that the National Energy Guarantee is intended to solve. A market approach that allows multiple other participants to compete to invest in a variety of resources that can address the reliability deficit to produce the best overall outcome for consumers. These resources can include new supply, demand-based resources, efficiency gains and transmission investment that increases import capability and better utilises resources in other regions.

Development of alternatives to meet the supply requirements in NSW will take time. The longer amount of time available for parties to respond to the gap will allow greater competition and, as a consequence, improved benefits for consumers. Ideally, an agreed National Energy Guarantee will serve as a market mechanism to address this gap.

If, however, the National Energy Guarantee is not agreed to by December 2018, AEMO recommends that an alternative process to acquire the 850 MW of Liddell be pursued. In this regard, AEMO proposes to work with the ESB and in close consultation with the NSW government, to establish a mechanism to allow the replacement of Liddell to proceed in a manner that is consistent with the pending National Energy Guarantee. AEMO notes that the NSW government is uniquely positioned to have strong visibility of the potential pipeline of projects that may be utilised by the private sector within its jurisdiction.

Due to the volume of the gap, AEMO preference is that either the National Energy Guarantee or a mechanism that can be used for NSW and is consistent with a pending National Energy Guarantee will be agreed to by year end 2018 for use during 2019. In the absence of a timely agreement and implementation of a mechanism that supports the introduction of competitive alternatives, fair opportunities for market participants to compete to close the 850 MW gap may be limited to the detriment of NSW consumers.

AEMO looks forward to continuing to work closely with the Commonwealth, the NSW Government as well as other States, the ESB and the AEMC and AER as members of the ESB and in their individual responsibilities to resolve this significant challenge and to facilitate a secure, reliable and efficient power system transition.

Yours sincerely,

Audrey Zibelman
AEMO Managing Director and Chief Executive Officer