



Australian Government
Department of Industry, Science,
Energy and Resources



Planning,
Industry &
Environment

Report of the Liddell Taskforce

An assessment on the impacts of a Liddell closure on system reliability, electricity prices, industry, and the local region

Prepared for public release

24 April 2020



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The Department of Industry, Science, Energy and Resources and the NSW Department of Planning, Industry and Environment acknowledge the traditional owners of country throughout Australia and their continuing connection to land, sea and community. We pay our respects to them and their cultures and to their elders both past and present.

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Context

Australia's access to abundant energy reserves and its fleet of coal-fired power stations has ensured homes and businesses have been supplied with affordable, reliable and secure electricity. However the large baseload generators that have long powered the system are beginning to reach the end of their operational lives and exit the system. As these generators close, they take with them a significant volume of capacity as well as system services essential to maintaining frequency, voltage and inertia.

It is important that the changes to Australia's energy system are managed effectively to limit any negative impacts, such as the significant price and reliability impacts that followed the closure of Northern and Hazelwood power stations and caught governments and energy consumers unprepared. Effective management will ensure that closures occur in an orderly manner so that electricity remains reliable, secure and affordable. This is particularly important for those industries that use large amounts of electricity or depend on a reliable supply.

A closure of Liddell Power Station (Liddell) would be the next in a series of expected coal closures that have removed over 5000 MW of baseload capacity from the NEM in the last 10 years, and which will potentially see the further withdrawal of more than 10000 MW of coal capacity from the NEM by 2040. The experience of Liddell will be informative in the effective policy responses to future closures.

Report

AGL has announced it will close Liddell gradually over 2022 and 2023. Liddell, as part of Australia's coal-fired generation fleet, has played an important role in maintaining the reliability of electricity supply in NSW for nearly 50 years.

Owned by AGL, the 2000 megawatt (MW) nameplate capacity coal power station is due to close over 2022 and 2023.¹ A Liddell closure would represent a withdrawal of a substantial volume of generation capacity—Liddell provides around 13 per cent of NSW's electricity supply—and other power system services. Governments want to ensure NSW's electricity supply remains affordable, reliable and secure in the context of the announced closure.

Some recent withdrawals of coal power stations, such as Northern's closure in 2015 in South Australia and Hazelwood's closure in 2017 in Victoria, contributed to price increases in the National Electricity Market (NEM) and reliability issues in those NEM regions. Hazelwood's closure coincided with increases in both gas and coal prices², and was followed by unanticipated electricity price rises across the NEM. Despite high prices, there has been limited investment in new dispatchable generation, which has contributed to ongoing challenges in maintaining reliability in both jurisdictions.

The Liddell Taskforce

Recognising the importance of a collaborative approach, the Commonwealth and NSW Governments established the Liddell Taskforce (Taskforce) in August 2019 to assess the impacts of AGL's announced closure of Liddell on electricity prices, reliability and security, the regional economy and dependent industries. The Terms of Reference require the Taskforce to investigate the impact of a Liddell closure on reliability in the NEM, power prices, dependent facilities and the local region. The Terms of Reference also require the Taskforce to produce recommendations, which are presented along with findings throughout this report.

The Taskforce delivered its report to the Minister for Energy and Emissions Reduction, the Hon. Angus Taylor MP on 24 April 2020. The report was also provided to the NSW Minister for Energy and Environment, the Hon. Matthew Kean MP. This work is part of the Commonwealth and NSW Governments' continued commitment to improve the affordability, reliability and security of the NEM.

This report includes attachments:

- The Liddell Taskforce Terms of Reference
- Liddell Taskforce members
- Consultation

¹ One unit is scheduled to close in April 2022, and the remaining three units are scheduled to close in April 2023

² Australian Energy Regulator, 2018, *Electricity Wholesale Performance Monitoring: Hazelwood advice*, accessed at https://www.aer.gov.au/system/files/AER%20electricity%20wholesale%20performance%20monitoring%20-%20Hazelwood%20advice%20-%20March%202018_0.PDF

- The Australian Energy Market Operator – Generation Replacement Study – A Public Summary Report for the Liddell Taskforce
- Frontier Economics – Modelling of Liddell Power Station Closure Final Report

The Taskforce has drawn on the expertise of Commonwealth agencies, the NSW Government and other relevant stakeholders (listed in the consultation attachment) to help assess the impacts of a Liddell closure. The Taskforce has met with organisations within both the energy sector (including energy market bodies) and industry sector, regional entities (including local governments), and research institutions.

The Taskforce assessed the impact of a Liddell closure and identified options to maintain a similar reliability, price and security outcome in NSW and the broader NEM. To inform this analysis, the Taskforce sought advice from the Australian Energy Market Operator (AEMO) on reliability and security and commissioned market modelling from Frontier Economics to inform potential price outcomes. AEMO advised on what system services are provided by Liddell, if there is likely to be a gap in the provision of system needs between the scheduled closure and 2025 (when Snowy 2.0 is expected to come online), and the extent to which options to address a Liddell closure provide these services. The modelling by Frontier Economics informed the Taskforce's views on the relative price impacts of a Liddell closure both with and without any replacement capacity, compared to a life extension of part of the plant.

The Taskforce is cognisant of the limitations of the modelling it has commissioned. For example, while Frontier's modelling factors in strategic bidding it does not try to emulate the strategic investment decisions made by players in the market.

Previous modelling exercises have not always accurately predicted the impact of generator closures. For example, in 2016 the Australian Energy Market Commission (AEMC) commissioned modelling to inform the market of the consequences of Hazelwood's closure. It forecast a wholesale cost in Victoria of \$60 per megawatt hour (MWh) in 2016–17 (pre-Hazelwood closure) and an increase of \$22 per MWh to \$82 per MWh in 2017–18.³ The actual wholesale price in 2017–18 was \$100 per MWh⁴, in part reflecting prevailing fuel costs higher than those assumed in the modelling.

These observations are not meant to be critical of the modelling. Rather, it is a reflection of the challenges in modelling electricity price outcomes in markets with imperfect competition, where both strategic bidding behaviour and strategic investment decisions will determine prices, along with the genuine costs, such as fuel prices, incurred by generators. This uncertainty around modelling exercises should be kept in mind when evaluating Frontier's modelling work for the Taskforce.

³ AEMC Final Report, 2016 Residential Electricity Price Trends, 14 December 2016, <https://www.aemc.gov.au/sites/default/files/content/be91ba47-45df-48ee-9dde-e67d68d2e4d4/FINAL-REPORT%C2%A02016-RESIDENTIAL-ELECTRICITY-PRICE-TRENDS.pdf>, Accessed 15 November 2019

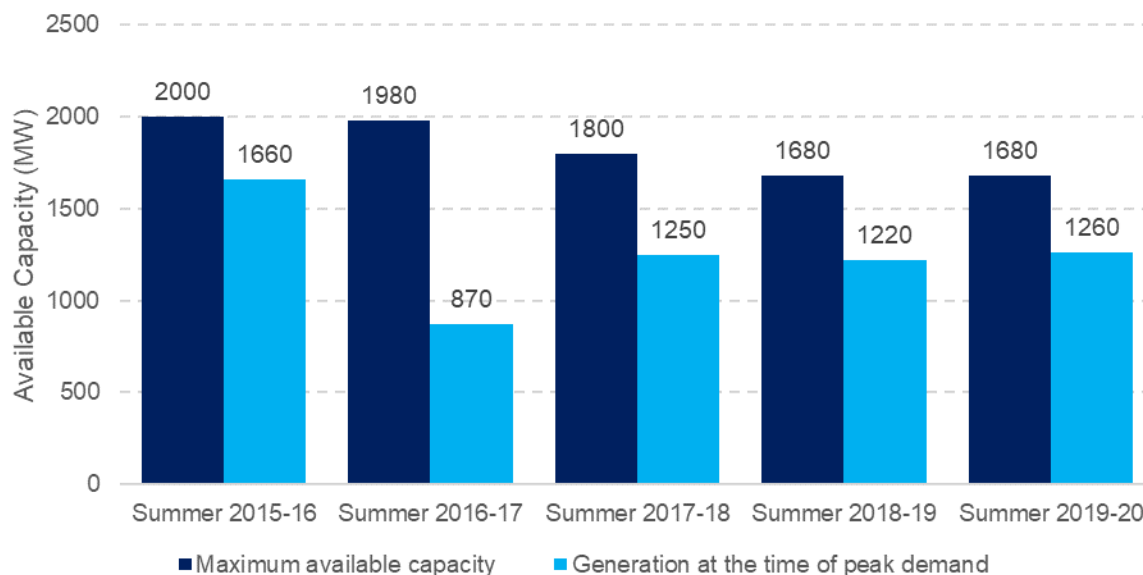
⁴ Based on volume weighted average prices in Victoria for FY2017–18 sourced from <http://v6.nem-review.info/>. Accessed 15 November 2019

The Liddell Power Station

Liddell is currently the oldest operating black coal power station in the NEM, and as would be expected its performance has degraded over time, with its forced outage rates increasing to above 20% of the year and availability reducing to around 60% of the year. This means that over time Liddell has been offline unexpectedly for longer and less of its capacity has been made available to the market. The Taskforce was advised each of Liddell's four units are performing at different levels, with one unit presenting particular problems.

Since 2017, AGL has operated Liddell below its nameplate capacity of 2000 MW, with 1680 MW available to the electricity market. AGL has been bidding Liddell's capacity on the spot market with prices low enough to ensure dispatch thereby allowing it to run relatively consistently to reduce stress involved with ramping. Liddell's performance has improved in this time with fewer forced outages during summer peak demand events.

Figure 1: Liddell Power Station's recent availability in summer months and output during peak demand⁵



In 2019, AGL formally notified AEMO of the schedule for closing Liddell including the first unit in April 2022 with the remaining three units closing in April 2023. This followed an announcement in 2015 that Liddell would close in 2022.

Liddell's announced closure comes in the context of an electricity sector in transition. Liddell would be the next in a series of coal power station closures that have removed over 5000 MW of capacity from the NEM in the last 10 years. The earlier closures represented rationalisation of excess generation capacity in the context of unanticipated stable demand. The more recent ones, particularly Northern and Hazelwood, required replacement capacity. This is largely happening through rapid growth in variable renewable energy and distributed energy resources,

⁵ NSW Department of Planning, Industry & Environment analysis of Liddell Power Station using NEM-Review

rather than new dispatchable generation. In addition, Transmission Network Service Providers (TNSPs) are increasingly being required to provide security services.

Finding 1: The effect of coal closures on price, reliability and security depends on broader market conditions and the willingness and ability of market participants to invest in replacement capacity.

Concern about the potential price and reliability effects of coal closures has been informed by recent experience. The sustained increase in prices and several load-shedding events following Hazelwood's closure are front of mind. Stakeholders the Taskforce consulted were clear that each coal closure will have a different impact on the market, influenced by its size, role in the power system, and the state of the market when it exits. The key issue will be whether there will be sufficient closure notice, capacity and appropriate commercial incentives for the power system to function optimally for consumers.

Compared with the Hazelwood closure, the case of Liddell's announced closure is different. However, the commercial, regulatory and policy drivers behind strategic investment and bidding decisions remain. These may limit or alter the market response to a Liddell closure.

There will have been a longer closure notice period for Liddell and there are more dispatchable generation projects on the horizon now in NSW than in Victoria when Hazelwood closed (though few have reached a Final Investment Decision). For example, Bayswater is undergoing a 100 MW upgrade and there is a planned 60 MW upgrade to Mt Piper.⁶ There were market incentives in place at the time of Hazelwood that drove investment in wind and solar in preference to other types of generation.

If Liddell exits the market in 2023 there is likely to be relatively more surplus capacity available in the market than was the case for Hazelwood. Brown coal generators in Victoria were operating around 80 per cent capacity in 2016, which limited their further contribution after Hazelwood closed and meant replacement generation included a shift to higher cost black coal and gas. Before Liddell's scheduled exit, black coal plants in NSW could be operating below 60 per cent capacity and could increase their output after a Liddell closure if other sources of new generation are not available and there are appropriate commercial incentives to do so. As a result, the difference between fuel costs for Liddell and replacement generation may be less than was the case for Hazelwood, meaning the price impacts may also be less.

Finding 2: Governments have made commitments that may improve price, reliability and security outcomes, including support for upgrades to interconnectors, Snowy 2.0, NSW's Emerging Energy Program, NSW's energy retailer procurement process and both governments' commitment to establish the Central West NSW Energy Zone.

There are specific plans in train or recently implemented that are intended to help mitigate reliability and price impacts from coal closures. They include interconnector upgrades, Snowy 2.0, Renewable Energy Zones, UNGI, the Retailer Reliability Obligation, Grid Reliability Fund, NSW Emerging Energy Program, Converting the Integrated System Plan (ISP) into Action, the NSW Electricity Strategy and the Wholesale Demand Response Mechanism. There may be

⁶ EnergyAustralia has announced the upgrade and planned the outage schedule but AEMO has not yet classified the project as committed.

challenges implementing some of these plans at scale and in time for Liddell's scheduled closure. For example, the proposed Wholesale Demand Response Mechanism is untested in its ability to incentivise businesses to engage in demand response and will initially be targeted exclusively at commercial and industrial customers. Without additional support, these potential participants may not want to engage in demand response because it is outside their core business and requires additional systems and understanding.

Impacts of a Liddell closure on the electricity system

Price impact

Finding 3: The modelling suggests Liddell's planned closure could lead to a NSW wholesale price increase from the low \$60s per MWh in 2022 to between \$75 and \$80 per MWh in 2023–24, depending on the market response to deliver new capacity. The modelling further suggests some price rise irrespective of a Liddell extension.

The Taskforce's modelling forecasts wholesale prices in the mainland NEM regions falling to the low \$60s per MWh by 2022 under all scenarios modelled, as already committed projects come online.

Where the market operates efficiently and there are no barriers to investment (such as large upfront capital costs for new entrants) the modelling found new capacity could replace Liddell before it closes. Under the modelled *with replacement scenario*, where the model was allowed to add new generation, average NSW wholesale prices rise as Liddell exits to around \$75 per MWh in 2024. The price moderates over the following years as Snowy 2.0 and more renewable energy capacity is built, to average \$71 over the five years to 2027–28. These modelled price levels should be treated as indicative given the modelling limitations and uncertainties discussed above.

If Liddell closes as announced, the market is not able or willing to respond to build new capacity, and other major investments, such as Snowy 2.0 and transmission upgrades, are delayed, the Taskforce's modelling suggests NSW average wholesale prices could rise to around \$80 per MWh in 2023–24 as Liddell exits. In this '*no replacement*' scenario, annual average NSW wholesale prices remain close to or above \$80 per MWh for the remainder of the decade as other plants close.⁷

In addition to the market modelling, the Taskforce analysed historical generator bidding data. This analysis supported the findings of the modelling, suggesting only a portion of the capacity offered by Liddell can be replaced by committed projects in the NSW NEM region. If interconnectors are constrained (i.e. in relatively high demand periods) and generators do not change their bidding behaviour, NSW NEM Region wholesale electricity prices would be significantly higher without Liddell if there is no further investment beyond currently fully committed projects or Snowy 2.0.

⁷ The Taskforce's modelling included generation projects that met AEMO's commitment criteria as at 1 August 2019, including the 100 MW Bayswater upgrade. It also included the 60 MW Mt Piper upgrade. However, it did not include AGL and Maoneng's offtake agreement for four 50 MW batteries.

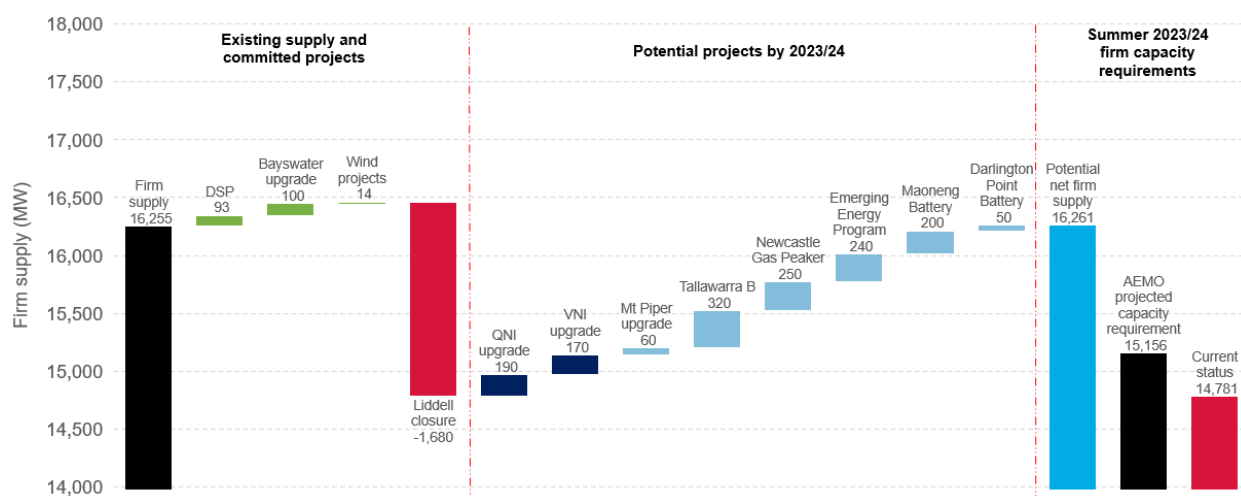
Reliability impact

Finding 4: Liddell contributes to system reliability by providing a significant amount of relatively consistent output. If implemented on schedule, committed projects (including upgrades to QNI and VNI, and AGL's 100 MW Bayswater upgrade) and probable projects (including EnergyAustralia's turbine upgrade at Mount Piper power station⁸, AGL and Maoneng's offtake agreement for four 50 MW batteries in NSW, AGL's Newcastle gas peaking plant, EnergyAustralia's Tallawarra B gas peaking plant, and projects supported by the NSW Emerging Energy Program) would be more than sufficient to maintain a high level of reliability as Liddell exits. These 'probable' projects have been publicly announced and are in advanced stages of planning but have not yet reached Final Investment Decision.

Although AEMO's 2019 Electricity Statement of Opportunities (ESOO) did not forecast a breach of the existing reliability standard after a Liddell exit, it did forecast an increased risk of supply shortfalls, and AEMO and TransGrid⁹ are concerned about an increasing risk of unserved energy following Liddell's scheduled closure. The 2019 ESOO indicates that with committed projects and the QNI and VNI 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. There are further publicly announced projects from the private sector not included in AEMO and TransGrid's analysis, which could provide up to 1120 MW of firm capacity by 2023–24 if all were to proceed.¹⁰

Figure 2 shows that if these projects come online as proposed they would reduce the risk of reliability gaps emerging when Liddell closes.

Figure 2: Potential projects in NSW that could provide firm capacity in replacement of Liddell¹¹



⁸ EnergyAustralia has approved funds and appointed contractors to perform this upgrade, but at the time of preparing this report AEMO had not yet classified the project as committed.

⁹ TransGrid is the TNSP for NSW

¹⁰ These 'probable' projects have been publicly announced and are in advanced stages of planning but have not yet reached Final Investment Decision.

¹¹ Chart created by the NSW Department of Planning, Industry and Environment

- Firm supply is based on November 2019 AEMO Generation Information Page, adjusted for Liddell's available capacity (1680 MW). It includes existing firm scheduled and semi-scheduled generation capacity and imports from Victoria and Queensland using the lowest nominal capacity of interconnectors.
- Committed projects includes demand side participation, AGL's 100 MW Bayswater upgrade, and the Crudine Ridge wind farm project (138 MW de-rated by AEMO's wind peak contribution factor of 9.94 per cent)
- Tallawarra B has approval for 450 MW but the NSW Department of Planning, Industry and Environment understands it is only considering a single 320 MW open cycle gas turbine
- AEMO projected capacity requirement is based on the net existing & committed capacity with an additional 375 MW. AEMO's 2019 ESOO showed this would limit unserved energy to below the NEM Reliability Standard in a 1-in-10 year demand event.
- The EEP does not specifically target firm capacity availability by end-2023. The firm capacity included for this purpose is an indicative estimate only and will be subject to change

The Energy Security Board (ESB) and others are working on how best to address the transition and better equip the market for future coal closures. One of the key processes is the ESB's upcoming advice on implementing interim measures to preserve reliability and system security, including a review into the reliability standard. In addition, ESB's Post-2025 Market Design project is looking to develop a long-term framework that will preserve reliability and security at least cost as the system transitions. Such reforms aim to ensure a smoother transition for future coal closures.

Recommendation 1: If governments consider more needs to be done to ensure grid reliability, the Taskforce recommends they continue to work through the COAG Energy Council to develop an enduring policy framework to address reliability impacts of coal closures.

Security impact

Finding 5: Liddell provides system security services like frequency control, inertia and grid forming. With committed projects there is likely to be enough frequency and voltage management services and inertia to meet power system requirements in NSW without Liddell. However, without more inertia NSW will be less resilient to high impact but low probability events. Liddell does not have the flexibility and level of availability that will be increasingly important to maintain system security in future.

Advice from TransGrid suggests there will be sufficient system strength to maintain a secure system when Liddell exits, under normal operations. This view was supported by advice from AEMO, which found there will be enough frequency/active power, inertia and voltage/reactive power services in the system. AEMO also advised that they may be required to intervene through directions to ensure enough system services are available, in the absence of alternative provision of these services. However both TransGrid and AEMO advised if there is not sufficient new generation, there will be lower resilience to high-impact low-probability events due to the loss of grid forming and system restart capabilities. It remains a matter of concern that the probability of such events may increase in the coming years.

The energy transition means the services the system needs to remain secure are also changing. AEMO's assessment of anticipated system needs from 2025 highlights the increasing importance of flexible, dispatchable generators or demand response with fast ramp rates that can follow load changes and fluctuations from generators with more variable output, and frequency services to respond in the event of loss of generation or other disturbances. This view was supported by other energy sector stakeholders that the Taskforce consulted.

Addressing the impacts on price, reliability and security

The Taskforce's Terms of Reference require it to advise on options to maintain price, reliability and security and produce a full suite of options for the Commonwealth and its partners to address the impacts of a Liddell closure.

Finding 6: Maintaining price, reliability and security outcomes could be achieved through a combination of options. This combination could include a mix of Liddell extension; increased contributions from existing generators; new gas, renewables and storage; demand response, or transmission infrastructure. None of these options would stand alone and none come without issues, with each facing market and/or non-market barriers.

AEMO's advice shows that the system needs gap between when Liddell is expected to close in 2023 and when Snowy 2.0 is expected to come online in 2025, cannot be filled by a single replacement option examined. Liddell's current operations and its life extended option fall short of some anticipated 2025 system needs. To avoid any system needs gap, a combination of projects should be delivered prior to any closure of Liddell that would also meet the anticipated 2025 system needs.

Like-for-like replacement

Finding 7: While modelling suggests Liddell would be replaced by a combination of investment by market participants, this level of market driven investment may not deliver the same price outcomes for consumers.

Finding 8: In relation to price, the Taskforce modelling found prices under a 'Liddell exit with replacement' scenario would be consistently lower than under the 'no replacement' scenario but could be higher than a 'Liddell extension' scenario from 2023–24 to 2025–26. However, the AEMO advice identified other significant and material risks and impacts in relation to the various replacement and extension options, and that each replacement or extension option makes a different contribution to system needs and for varying periods of time.

The Taskforce took a system-wide view, interpreting 'like-for-like' as technology or other changes that would ensure similar outcomes with or without Liddell. The Taskforce considered both system services and price impacts in its assessment of like-for-like replacement options. To inform whether potential options meet system services requirements, the Taskforce sought advice from AEMO. The Taskforce also commissioned modelling by Frontier Economics to inform its views on the relative price impacts.

AEMO's assessment assumed the transmission upgrades to QNI and VNI recommended in the ISP will proceed. These projects are well advanced, with the QNI upgrade having been recently brought forward by joint State and Commonwealth government underwriting.

AEMO advised each option they examined can contribute some of the necessary system services. In the longer-term, AEMO's assessment showed that having Snowy 2.0 and HumeLink in the system is an improvement on Liddell's current operations and meets the anticipated future

system needs. Other pumped hydro and battery assets can make contributions to system needs but scale is an issue.

To assist the Taskforce, AEMO examined combinations of solutions that could address like-for-like characteristics, scale and timing where the replacement would be operational by the scheduled 2023 Liddell closure. These combinations, where planning is already underway, were large scale solar arrays with battery storage and also a gas peaking plant. In addition, AGL's announced offtake agreement with Maoneng for four 50 MW / 100 MWh battery projects coupled with proposed gas generation projects could meet the anticipated 2025 reliability and security system needs, and could be operational prior to the scheduled closure of Liddell.

Frontier's modelled '*with replacement*' scenario provides an indication of the extent to which a combination of replacement options would deliver 'like-for-like' price outcomes. In that scenario the model assumes sufficient new investment to meet the reliability standard. The modelling suggests a combination of increased contributions from existing generators, more flexible dispatchable capacity in the form of gas and storage, and more low marginal cost renewables could maintain similar price outcomes. However, price outcomes are higher in the '*with replacement*' scenario than in the '*Liddell extension*' scenario.

The Taskforce has not modelled a scenario with more surplus capacity than is needed to meet the current reliability standard, so cannot conclude whether this would deliver improved price outcomes. Demand response was also considered to have a central role in replacing Liddell's dispatchable capacity and reducing peak demand.

The Taskforce explored a range of policy measures that could support like-for-like replacement capacity. These policy options fall into three broad categories: removing non-market barriers, market reform, and direct intervention to support replacement capacity.

Recommendation 2: Governments should provide as much certainty as possible and address other non-market barriers to enable replacement projects to be delivered on time. This could include encouraging regulators to work proactively with proponents of new investments.

Recommendation 3: Governments could focus on developing demand-side measures as one part of the solution, through promoting uptake of demand response, distributed energy resources integration, and energy efficiency as a low-cost, short-term response to a Liddell exit, and to facilitate the longer term transition.

Recommendation 4: If considering support for like-for-like replacement options, governments should evaluate the most appropriate projects, taking into account future system needs based on AEMO advice, costs and timing. If direct support is warranted, government could underwrite or procure new capacity through existing programs or through offtake agreements but should consider the effect on the business case for other investments.

Liddell extension

Finding 9: The Taskforce was informed it may be possible to extend two of Liddell's four units beyond 2023. Modelling forecasts this could result in an increase in the wholesale price in NSW by 15 per cent from 2022 to 2024 to around \$70 per MWh, compared with around \$75 to \$80 per MWh if Liddell exits. The feasibility of an extension would depend on overcoming engineering, safety, commercial and regulatory challenges and managing the outage schedule for upgrades to avoid reliability risks during peak periods. Additional like-for-like replacement may be needed alongside a Liddell extension to meet anticipated system needs. The time needed to take a final decision may delay other investments. A detailed engineering assessment would be required as soon as possible to accurately determine the capital and other costs associated with an extension.

The Taskforce was informed it may be possible to extend two units of Liddell beyond 2023. An extension until 2026, for example, would bridge the gap to Snowy 2.0's completion. Under this 'Liddell extension' scenario, the Taskforce's modelling suggested the average NSW wholesale price could rise by around 15 per cent from 2022 to 2024 to \$70 per MWh, compared to around 22 per cent (to \$75 per MWh) in the 'with replacement' scenario and around 29 per cent (to \$80 per MWh) in the 'no replacement' scenario. The Taskforce is cognisant of the modelling limitations and uncertainties discussed above when comparing the modelled price outcomes under the different scenarios.

Over the five year period from 2024, average NSW wholesale prices are around \$70 per MWh in the 'Liddell extension' scenario, compared to around \$71 per MWh and \$82 per MWh in the 'with replacement' and 'without replacement' scenarios respectively. Compared with the 'with replacement' scenario, Liddell's extension crowds out investment in new gas and pumped hydro capacity in NSW and Queensland respectively.

When considering anticipated 2025 system needs, a Liddell extension meets the maximum power output requirement. This means it could provide sufficient capacity to maintain current levels of reliability in NSW as long as it is actually available during peak demand conditions. However the increasing risk of outages as the plant ages gives rise to an increasing possibility those outages would lead to supply shortfalls. Liddell already has a high outage rate compared with other NSW coal generators. AEMO ranked different options to replace the services currently provided by Liddell against future system needs, the outcomes of this ranking are available in the attached AEMO analysis. AEMO noted '*Liddell's current operations and its life extension option were found to fall short of some 2025 system needs and represents one of the lowest ranked replacement options.*' AEMO's advice suggests additional like-for-like replacement could still be needed to achieve the system needs even if Liddell is extended.

A detailed engineering assessment would be required to accurately determine the capital cost of a three year extension of two units. There is a risk that upgrades to make the plant compliant with safety and other regulation would not alter its upward trajectory of faults and unplanned outages. Any upgrades would also need to comply with conditions for planning and environmental approvals which would need to be sought, and could add further costs. Commercial and operating costs and conditions would also need to be negotiated. Delaying a decision on Liddell's extension until after the results of a detailed engineering assessment are

known would result in further uncertainty for other potential investments and could lead to challenges (financial viability and timing) in commissioning alternatives.

The Taskforce notes many consulted stakeholders counselled against governments providing support for life extension of Liddell, arguing there was no need for the extension, as it would displace investment in newer more dependable generation and would create further uncertainty in the market. Some stakeholders also expressed the view it could delay transition plans for the region and the wider NEM. Conversely, some stakeholders were in favour of an extension, with a view that it may help keep prices lower and maintain reliability.

Finding 10: Extending Liddell under different ownership may be possible but may lead to further cost, complexity and time delays relative to continued operation by AGL. These could arise from the need to separate coal and water supply arrangements currently shared between Liddell and Bayswater power stations.

Finding 11: Extending Liddell is not likely to be commercially viable due to the upfront investment needed, new coal purchase costs and difficulty in selling hedge contracts for an increasingly unreliable power station. Government support would likely be needed for any extension. An extension could undermine the business case for other investments.

Operating Liddell independently of AGL's portfolio made no material difference to the modelled price outcomes. Research completed by WorleyParsons found that it would be possible to contractually separate the assets, but this would bring a range of challenges and would be time consuming. However, this would be easier than trying to physically separate them.

Recommendation 5: If governments see fit to pursue extending Liddell, they could de-risk the investment in upgrades by underwriting returns or limiting liabilities, and should seek advice from an independent expert as soon as possible on the technical and commercial feasibility of an extension before making any commitments.

- *This would include a thorough engineering and safety audit of the plant, ash dam and other infrastructure,*
- *Assessment would also be needed of associated costs, environmental and other regulatory issues to be addressed, additional outages required and risks of those outages for the market.*

Impacts on dependent industries and the local region

The Taskforce was asked to consider the impacts of a Liddell closure on dependent industries and the local region.

Impacts on the local region

Finding 12: A range of organisations have plans in place or under development to assist the local region to adjust based on AGL's announced 2023 closure of Liddell. Examples include AGL forming the Hunter Energy Transition Alliance to work with the community to identify opportunities for new energy investment, future jobs and the Liddell site; AGL's Liddell Innovation Project to repurpose the Liddell site, reskill workers and diversify the local economy; and local governments working with industry and academia to guide the transition, including measures to support diversifying the local economy and upskilling the workforce.

Finding 13: The transition in the Hunter region may be more efficient and effective with a local body leading, coordinating and facilitating cooperation among the various organisations working towards the transition.

A significant amount of work is already underway by a range of stakeholders to support the region through the Liddell closure and the transition away from coal more generally. Key organisations providing leadership and funding as the Hunter makes this transition include:

- AGL
- NSW Government
- the Hunter Joint Organisation of Councils
- Muswellbrook Shire Council, Singleton Shire Council and the Upper Hunter Shire Council
- joint business, government and community affiliations such as the Upper Hunter Mining Dialogue and the Hunter Energy Transition Alliance
- the Hunter Economic Development Corporation
- the University of Newcastle and Monash University
- the Hunter Research Foundation
- Regional Development Australia – Hunter.

In 2016, AGL formed the Hunter Energy Transition Alliance to work with the community to identify opportunities for new energy investment and future jobs at the Liddell and Bayswater site. The two power stations and buffer zones occupy around 10,000 hectares and AGL has significant water entitlements which may become excess to requirements. AGL has committed to no forced redundancies when it closes Liddell and repurposes the site.

In 2017, AGL released its NSW Generation Plan outlining a range of investments which could replace both the energy and firm capacity then provided by Liddell. AGL has also launched the

Liddell Innovation Project, which focusses on repurposing the Liddell site, reskilling workers, and diversifying the local economy.

Local governments are working with industry and academia to guide the transition, including measures to support the diversifying the local economy and upskilling the workforce. Stakeholders told the Taskforce the Hunter region wants to remain an energy provider, however there will be a need to provide other energy solutions using the infrastructure and resources available within the region.

The long notice period for Liddell's closure has helped the local region prepare to transition to new industries. Those consulted felt prepared for the transition, and many were looking forward to new opportunities. Stakeholders also acknowledged the significant work already underway to prepare for the transition. The Taskforce found there may be an opportunity to better coordinate the work underway in the region, which could be achieved by clearly identifying and resourcing an existing body to provide a locally driven leadership role.

Impacts on dependent industries

All industries and businesses that consume grid-connected electricity are impacted by changes to the cost, reliability and security of the electricity system. To the extent a closure of Liddell impacts prices and reliability in the NEM, the impact will be felt most in the NEM region where Liddell is located (NSW), and by those industries that use large amounts of electricity or depend on a reliable supply. Many energy-intensive producers have long-term electricity contracts so are unlikely to be affected by incremental changes in the market, though this depends on the detail of the contract. Some energy-intensive industries, such as aluminium smelting and steel production, place a particularly high value on a low-cost reliable energy supply. The Taskforce focused in particular on the Tomago Aluminium smelter.

Tomago Aluminium's smelter (Tomago) is an independently operated joint venture owned by Hydro Aluminium, Rio Tinto and Gove Aluminium Finance (owned by CSR and AMP capital). Tomago advised the Taskforce it has 1,804 Full Time Equivalent employees. It has three potlines with a total of 840 cells and has a capacity of ~595,000 tonnes/year or around 25 per cent of Australia's aluminium.

Finding 14: The Tomago Aluminium smelter is facing commercial pressures arising from historically low aluminium prices and high electricity costs through its hedge contract with AGL relative to its previous contracts and international competitors.

Aluminium smelters are facing historically low aluminium prices and the owners of several smelters in Australia have signalled their continued operation is not guaranteed.

Tomago advised the Taskforce it is under pressure from current low aluminium prices and high delivered energy costs relative to its previous contracts and aluminium smelters in other countries.

Tomago has an electricity hedge contract with AGL that determines the price it pays for electricity. The contract was executed by Tomago and the then state-owned Macquarie Generation in 2010 and it came into effect in November 2017. The Taskforce is not in a position to comment on the details of contractual arrangements.

Finding 15: Any increase in the frequency of load-shedding for Tomago would result in an increase in the costs and risks to Tomago associated with shutting down and restarting potlines.

Power system reliability and security is an issue for Tomago—for plant integrity risk reasons, as well as for financial reasons. Tomago advised a reliable electricity supply is critical because interruptions that are not resolved within three hours will result in the irreversible freezing of potlines. With each shutdown, Tomago advises there is a risk a potline will not be able to be restarted in time to avoid freezing.

Tomago expressed a concern that as the electricity market transitions, it may be directed by AEMO to shut down potlines more frequently to avoid more widespread load shedding of other businesses and households. Tomago is currently not compensated for these events and is seeking to minimise them in order to minimise the direct costs and risks associated with providing this demand response service. Tomago is also concerned it may see an increase in events where it chooses to reduce load when provisions in the hedge contract allow AGL to set aside the agreement and expose Tomago to high spot prices (unhedged electricity purchases outside its contract with AGL).

Any increase in shutdown events, whether from AEMO or through the contract with AGL, would increase the costs associated with these shutdowns and the risk that Tomago will be unable to restart a potline. The impact on Tomago will depend on whether reliability can be maintained through the transition. In discussions with Tomago, it was made clear it felt the choices for dealing with the scheduled closure of Liddell should maximise system reliability and security outcomes to reduce the likelihood of unanticipated system outages.

Finding 16: AGL and Tomago are in discussions regarding their electricity hedge contract in an attempt to relieve some of the commercial pressure facing Tomago.

Tomago may be able to renegotiate its contract with AGL to address its increasing costs and explore opportunities to receive appropriate compensation for being available to interrupt its large load at short notice to support the reliability of the grid. Governments can play a role in facilitating negotiations for Tomago's electricity supply and enabling market frameworks that compensate Tomago for grid services. Developing alternative suppliers of demand response and support for pumped hydro or other dispatchable capacity projects in NSW to underpin future grid reliability and security in the region would support all industries that need a reliable supply of electricity, including the aluminium industry.

Recommendation 6: If governments are willing to support Tomago's continued operations they could support the renegotiation of Tomago's electricity hedge contract and explore opportunities for Tomago to be compensated for demand response to avoid load shedding other customers.

In line with the Terms of Reference, the Taskforce has collated information on power and price requirements for dependent industries. Due to the highly sensitive nature of this information, the Taskforce has not included details in this report.

A framework for assessing future coal closures

The Terms of Reference required the Taskforce to articulate conditions under which government intervention should be considered and develop a framework for assessing future power station closures. In developing the framework, the Taskforce has drawn on lessons learned from its own process.

The guiding principles the Taskforce proposes for managing future coal power station closures are:

- **Affordability and reliability:** ensure prices are kept at a reasonable level (particularly for energy-intensive industries) and reliability is maintained.
- **Market first:** governments should prioritise market-based solutions, preferring **private sector investment and cost burden** over transfers to taxpayers or consumers, and intervene only where there is a market failure the market is unlikely to resolve.
- **Do no harm:** government intervention should avoid raising investment risk and take into account potential impacts on other investments. Interventions should be consistent with the National Electricity Objective.
- **Evidence-based, efficient and effective:** Any intervention decision should be informed by evidence, including advice from market bodies, and be feasible, technology neutral, well designed, timely, avoid duplication and deliver value for money.
- **Test and consult:** Proposed actions should be tested through electricity market modelling and consultation.

With these principles in mind, the Taskforce considered conditions under which government intervention could be considered. The conditions articulated relate to expected reliability, security and price outcomes that may justify government intervention. In making any decision to intervene, governments should identify whether the following conditions are likely to be met following the closure, and assess the need for intervention by reference to the guiding principles:

- **Reliability:** There is projected to be a 1-in-10 year reliability gap following the closure, the Reliability and Emergency Reserve Trader cannot cost-effectively bring on necessary reserves, and market bodies cannot respond in other ways to adequately address the projected reliability gap.
- **Security:** AEMO or network operators anticipate a material deficit in important grid services, existing measures and anticipated market changes are unlikely to address the deficit, and there is not an existing market-based mechanism to address the deficit.
- **Price:** The closure is expected to result in sustained high wholesale prices, the high prices are not expected to bring on sufficient new capacity, and government intervention is not likely to have perverse outcomes.

The Taskforce recommends a consistent and measured process to assess the impact of future closures similar to that undertaken by this Taskforce. Drawing on the experience of its own process, the Taskforce recommends a joint taskforce be established at least 3.5 years before an expected closure, comprising the Commonwealth and relevant state government and the

Energy Security Board. In the case of an unexpected closure with short notice, the taskforce may need to support governments to take action at short notice.

Future taskforces should have six months to model and gather stakeholder views on the impacts of the closure, consider whether conditions for government intervention are met and recommend a narrow set of interventions for further consideration with reference to the guiding principles. Governments can then consider those options and seek consensus on the appropriate way forward.

The Taskforce has identified a number of potential market reforms that could minimise the need for interventions in each future closure. These include providing AEMO additional powers to manage coal plant end of life and ensure minimum returns to generators, lengthening or strengthening the current notice of closure requirements, strengthening existing mechanisms such as the Retailer Reliability Obligation and new markets for power system services. The Taskforce also notes the importance of Regional Deals—building on the success of the City Deals, the regional deals are tailored to each region’s comparative advantages, assets and challenges and reflect the unique needs of regional Australia.

Aspects of these potential reforms may be addressed in the Energy Security Board’s advice on a post-2025 market design for the NEM, and their advice on measures that could be implemented in the interim.

Next steps

The Taskforce has not recommended specific policy responses, but rather options, steps to progress those options, and a framework for deciding on action. Governments will need to evaluate the options available to them in light of their appetite for risk—both the risk of sub-optimal outcomes in the electricity system and the transfer of risk to taxpayers. This will be influenced by the timing of decisions as well as governments' views on the likelihood of different outcomes and trust in the market. Further, additional work would be needed by those with appropriate expertise to understand in detail the feasibility of each option. In particular, further consideration of Tomago's situation could take into account options and impacts that fall outside the electricity sphere.

As governments consider their responses to this report's recommendations and undertake further work, continued collaboration can ensure a measured, considered and effective approach.

In this context it is incumbent on the Taskforce to note an in-principle decision on life extension is needed soon. This is because should governments wish to pursue a life extension option that will deliver the continued operation of Liddell Power Station in the way it has been modelled for this report the time available to do this will pass. However, the full cost of such a life extension would not be known for at least 12 months from now – after allowing for a thorough engineering and safety assessment, time to understand and cost any additional environmental requirements and the negotiation of commercial and operational terms between AGL and whoever is to operate an extended Liddell.

Since preparing this report there have been a number of policy, regulatory and market developments which are relevant to its underlying context. These include:

- COAG Energy Council Ministers agreed to establish an out-of-market capacity reserve and amend triggering arrangements for the Retailer Reliability Obligation.
- AEMC published a second draft determination on the Wholesale Demand Response Mechanism.
- The AER approved the regulatory investment test for transmission for TransGrid's proposed upgrade to the Queensland to NSW interconnector.
- The NSW Department of Planning, Industry & Environment and the Civil Aviation Safety Authority both determined that aviation risks from EnergyAustralia's proposed Tallawarra B can be managed to an acceptable level, meaning that project now has planning approval.

The Taskforce's recommendations should be considered in this evolving context.

Further, at the time this report was finalised the full implications of the COVID-19 crisis for the economy and therefore NEM energy demand are unclear. What seems likely is there will be significant impacts on economic activity and energy demand. To what extent and over what timeframes demand will be impacted is uncertain. The Taskforce recommends that AEMO gives high priority to updating its forecast supply-demand balance for all NEM regions as better information becomes available. This will indicate whether the outlook has changed for the NSW region following the scheduled closure of Liddell.

In addition to impacts on demand, the electricity sector will need to manage the impacts of the COVID-19 crisis on supply chains and human resources in order to continue to supply electricity through the crisis. This could have flow-on implications for the sector's ability to proceed with either new generation and storage projects, or a potential extension of Liddell, in the timeframes outlined in this document.

Recommendation 7: Governments should continue to work closely together on a response to Liddell's planned closure, and in the longer term options to address Tomago's viability and manage future coal closures, based on updated projections from the market operator.

Attachment A: Liddell Taskforce Terms of Reference

In 2015, AGL announced the Liddell Power Station (Liddell) would close in 2022. However, following an engineering assessment, AGL announced in August 2019 it will close one unit in April 2022 and the remaining three units in April 2023. This will allow Liddell to support system reliability for the 2022–23 summer.

Liddell has played an important role in ensuring the reliability of electricity supply in NSW, providing up to 1800 MW of dispatchable power in 2018. The Australian Energy Market Operator (AEMO) has projected a reliability gap of up to 640 MW in NSW in 2023–24 in the event of no further investment in supply. A failure to replace like-for-like capacity in the market will also put upward pressure on electricity prices, as was seen after Hazelwood's closure in 2017.

Liddell's closure will also affect the local community and its economy. In addition to the 300 staff that work at Liddell there are a number of dependent industries and facilities that employ over 1000 Australians.

To understand the full potential impacts of Liddell's closure, the Taskforce will investigate the impact of the closure on reliability in the National Energy Market (NEM), power prices, dependent facilities and the local region. A final report will include detailed information and recommend any necessary policy proposals. In developing policy proposals, the Taskforce must have due regard to limiting unnecessary financial exposure of taxpayers.

The Taskforce will:

- develop options to maintain a similar reliability, price and security outcome in NSW and the broader NEM. This will take into account and complement other Commonwealth and NSW government initiatives, work on implementing AEMO's Integrated System Plan, and committed investment
- model the impact on wholesale and retail power prices from Liddell's closure and the other options identified to maintain similar reliability and security outcomes
- collate detailed power and price requirements for dependent industries
- develop a full suite of options for the Commonwealth and its partners to address the impacts of the announced closure
- articulate conditions under which government intervention could be considered
- develop a framework for assessing future power station closures.

The Commonwealth element of the Taskforce will report to the Minister for Energy and Emissions Reduction, the Hon. Angus Taylor MP on a monthly basis.

The Taskforce will draw on the expertise of other Commonwealth agencies, the NSW State Government, AGL and other relevant stakeholders, to produce a final report, recommendations and proposals by late 2019.

Attachment B: Liddell Taskforce members

The Commonwealth-led Taskforce comprised senior representatives from the former Commonwealth Department of Environment and Energy, now the Department of Industry, Science, Energy and Resources, and the New South Wales Government.

Commonwealth members (Department of Industry, Science, Energy and Resources)

Sean Sullivan, Deputy Secretary, Energy Group (Chair)

Rachel Parry, Head of Division, Energy Division

James White, General Manager, Energy Transition Branch

Paul Johnson, Principal Advisor, Electricity Branch

NSW members

James Hay, Deputy Secretary, Climate Change and Sustainability, Department of Planning Industry and Environment

Cameron O'Reilly, Executive Director, Energy Reform and Investment, Department of Planning Industry and Environment

Dr Chris Armstrong, NSW Deputy Chief Scientist and Engineer

Liam Ryan, Director, Energy Data & Analytics, Department of Planning Industry and Environment

In addition, other senior executives from the former Commonwealth Department of the Environment and Energy assisted, including Rob Heferen who chaired the Taskforce until 22 November 2019.

The Taskforce was supported by a secretariat in the former Commonwealth Department of Environment and Energy, now the Department of Industry, Science, Energy and Resources, with advice from NSW Department of Planning, Industry and Environment.

Attachment C: Consultation

In order to produce its report the Taskforce has drawn on the expertise of other Commonwealth agencies, the NSW State Government, AGL and other relevant stakeholders.

The Liddell Taskforce has benefitted greatly from the engagement and feedback from these stakeholders on the impacts of the announced Liddell closure. Their input has provided the Taskforce with a holistic view of the issues. Engagement with Commonwealth agencies and the NSW State Government has been crucial to ensuring the Taskforce did not work in a silo and shared information and knowledge on policy processes underway.

Stakeholder meetings were held across September and October in the Hunter region, Sydney, Melbourne, Canberra, and via teleconference. A full stakeholder list is below. Feedback was received in person and in some cases through formal submissions.

The Taskforce thanks stakeholders for their participation in the consultation process.

Stakeholders that participated in the consultation process

Energy sector	Industry sector	Regional entities	Research and advisory bodies
AGL Macquarie	Australian Industry Group	Joint Organisation of the Hunter Valley Councils	Australian National University
Energy Consumers Australia	CSR Limited (part owner of Tomago)	Hunter Development Corporation	Bloomberg New Energy Finance
Australian Energy Council	Molycop	Hunter Employment Facilitator	Grattan Institute
Australian Energy Market Commission	Rio Tinto (part owner of Tomago)	Latrobe Valley Authority	
Australian Energy Market Operator	Tomago Aluminium (smelter operator)	Muswellbrook Shire Council	
Australian Energy Regulator		Regional Development Australia – Hunter	
Bayswater power station operators		Singleton Council	
Energy Efficiency Council		Upper Hunter Council	
Energy Security Board			

Energy Users Association of Australia			
EnergyAustralia			
A large electrical and generation equipment manufacturer			
Liddell Power Station operators			
Squadron Energy			
TransGrid			

Attachment D: AEMO – Generation Replacement Study

To inform its analysis of what would constitute 'like-for-like' replacement in terms of maintaining grid reliability and security, the Liddell Taskforce sought advice from AEMO. AEMO provided a confidential Generation Replacement Study, which examines the system services Liddell provides, what the system will need following a Liddell exit, and the extent to which specific projects could provide those services.

As AEMO's report contains sensitive business information, for the purpose of this public report AEMO has provided a public version of the Generation Replacement Study. This is attached below.

For its public report AEMO assessed generic power generation and storage technology options rather than specific projects. AEMO compared generator performance (such as maximum power outputs and ramp rates) and the ability to provide ancillary services (such as frequency and fault current) of these options, against two references: 1: Liddell's current operations (slide 5), and 2: anticipated 2025 system needs, which reflects the gap between when Liddell is scheduled to close and when Snowy 2.0 and HumeLink are expected to come online (slide 6). In assessing anticipated system needs, AEMO's assessment assumed transmission upgrades to QNI and VNI, recommended in the Integrated System Plan, will proceed. These projects are well advanced, with the QNI upgrade having been recently brought forward by joint State and Commonwealth government underwriting.

Attachment E: Frontier Economics Modelling Report

The Liddell Taskforce was required by its Terms of Reference to model the impact on wholesale and retail power prices from Liddell's closure and the options identified to maintain similar reliability and security outcomes. The former Commonwealth Department of the Environment and Energy commissioned Frontier Economics to complete modelling for the Taskforce. The full modelling report is attached below.

The purpose of this modelling is to provide insights and quantitative analysis of the relative merits of different potential policy options to help inform future decisions. The modelling does not predict the future, rather it provides an indication of how the world may differ under a range of plausible scenarios. Taken together, the modelling results can provide guidance for decision-makers, but many factors not considered by models must also be taken into account in any policy decision.

The Taskforce is cognisant of the limitations of the modelling it has commissioned. Future market development is inherently uncertain and all models make approximations, which limit their ability to capture real world market conditions. For example, pricing effects are highly dependent on multiple factors not captured by modelling. Prices can be higher or lower due to weather conditions or forced outages, and decisions by large market players can materially affect future prices.

Due to this inherent uncertainty, this modelling exercise has considered a range of scenarios, each with different assumptions about the closure date of Liddell and other developments in the NEM over the period to 2030. None of these scenarios should be considered "business-as-usual". Rather, each scenario provides insights as to the possible outcomes under a particular set of assumptions.

Full details of each modelled scenario, modelling scenarios and results are can be found in Frontier's modelling report below.