NSW GOVERNMENT | Chief Scientist & Engineer

Assessment of summer preparedness for the NSW energy market: 2019/20

October 2019

NSW GOVERNMENT | Chief Scientist & Engineer

The Hon Matthew Kean MP
Minister for Energy and Environment
52 Martin Place
SYDNEY NSW 2000

Dear Minister

Assessment of 2019/20 summer preparedness for the NSW energy market

In September 2019, you requested that I provide expert advice on the risks within the national electricity market, especially in relation to summer.

This report is submitted in fulfilment of Term of Reference 1, an assessment of summer preparedness of the NSW energy market for 2019/20. The assessment was undertaken by an expert panel chaired by myself and Mr Neville Henderson (former commissioner of the Australian Energy Market Commission) and Professor Joe Dong (UNSW Digital Grid Futures Institute, and School of Electrical Engineering and Telecommunications, UNSW Sydney).

The Panel and secretariat consulted with the Australian Bureau of Meteorology (BOM), the Australian Energy Market Operator (AEMO), the Australian Energy Market Commission (AEMC), Australian Energy Regulator (AER), Energy Security Board (ESB) network operators and generators on their preparedness for summer.

The Panel examined issues including:

- The forecasts accuracy for summer 2018/19 and a review of the Department's post-summer preparedness actions
- Forecasts of unserved energy (USE) and other information sources for 2019/20
- Weather and climate effects that could impact supply and demand over the coming summer
- Summer preparedness actions undertaken by the Department and market participants
- Possible future risks to energy security in NSW

The Panel concluded that the NSW Government is well prepared for the coming summer in regards to the supply of energy, although there are a number of system and climate risks that could impact the security and reliability of energy supply.

The Panel has made several recommendations concerning this and future summers.

Yours sincerely,

H. Durrant-Whyte.

Hugh Durrant-Whyte
Chief Scientist & Engineer

30 October 2019

FINDINGS & RECOMMENDATIONS

FINDINGS

Summary of findings from summer 2018/19

- The AEMO 2018 ESOO forecasts for the summer 2018/19 were accurate regarding supply and demand, with no load shedding occurring in NSW, leading to a good summer reliability outcome.
- For 18 January 2019, the NSW Government (JSSC) enacted both the Government Energy Action Response (GEAR) and Large Energy User Voluntary Demand Response (VDR) protocols, with an estimated demand management reduction of 18.5 MW. However, this demand reduction was not required.
- The NSW Government has improved its response to energy emergencies with information protocols and levers, in particular the NSW Government Summer Readiness Action Plan and the demand management protocols which were in place for the 2018/19 summer.

Summer 2019/20 and beyond

- In terms of energy reliability, AEMO has forecasted that NSW is well placed for summer 2019/20 noting that the overall risk of unserved energy (USE) is well below the reliability standard (0.002%).
- AEMO, TNSP, DNSPs and generators have undertaken a significant amount of work on summer preparedness.
- However, there are a number of system and climate risks that could impact the security and reliability of energy supply in NSW for summer 2019/20. A combination of coincident NSW and/or inter-jurisdictional events, could lead to a tightening or possible shortfall of supply.
- Some risks to energy supply that have been identified include:
    - Reliability of coal-fired power generators: with an increase in the rate of partial or full outage for the NSW fleet (now at 35%), there is a concern from the Panel that the increasing age and retirement schedule will see outages continue to increase.
    - Fuel supply issues: the quantity and quality of coal supply to Mt Piper Power Station is a concern for summer 2019/20 and in the future.
    - Derating of coal-fired power generators: due to water discharge temperature Environmental Protection Licence (EPL) requirements (with the potential for higher inlet water temperatures) and higher ambient air temperatures.
    - Antecedent weather conditions: Australia is in the third year of a significant drought, with record low rainfall conditions, reduced soil moisture and the increased potential for heatwaves (both severity and duration). This will impact the availability of water supplies for hydro generation and has led to an early start to the bushfire season for NSW with reduced availability of water for firefighting in some locations.
    - Bushfire: there is an ongoing and continued high risk of bushfires across NSW over summer that poses a risk to energy infrastructure.
    - Victoria is forecast to exceed the reliability standard and that this may place a strain on supply to and from NSW via the Victoria-NSW Interconnector (VNI).
    - Victorian supply could also be impacted by current outages of Loy Yang A2 and Mortlake 2 generation plants. In discussion with Origin, the Panel noted that their

repair work for Mortlake 2 has been substantially de-risked (as transport of the replacement equipment to site has been completed) and that AEMO's estimates on the generator unit being offline until post-summer 2019/20 (at 60%) is based on similar historical outage scenarios and not this specific outage.

- The Panel notes that communication between the NSW Government (JSSC and EUSFAC) and the various stakeholders (AEMO, TNSP, DNSPs, etc.) has improved over the previous years. This should be built upon with continued and further joint exercises, and in particular exercises across the full NSW NEM energy chain (from AEMO to large energy users).
- NSW expected USE is forecasted to rise with the closure of Liddell (first unit retired in April 2022, and the other three units now pushed back to a post-summer retirement in 2022/23) which may lead to a future tightening of supply.
- The Panel notes that AEMO has highlighted in the 2019 ESOO that the reliability standard may no longer be fit-for-purpose.
- There is an increasing reliance on shoulder period (i.e. prior to summer) to undertake critical maintenance activities on energy infrastructure, in particular coal-fired power generators across the NEM. The Panel notes that the shoulder period is becoming smaller, as summer-like conditions are expanding into spring.
- In a changing climate, the Panel notes that risks to energy security and reliability is not just limited to summer periods but is all year round. Therefore there should be greater emphasis on situational, rather than just summer, preparedness.

RECOMMENDATIONS

Summer 2019/20

Recommendation 1

That the NSW Government continue dialogue with AEMO and NSW coal-fired power generators to further understand:

- the issues and scope to arrest the trend of increasing partial or full unplanned outage rates
- AEMO's assessment of an aging coal-fired power generator fleet and retirement planning
- fuel supplies and to ensure that generators are building redundancy and resilience in these supply chains
- the consequences, in the context of a changing climate, such as derating from increasing water shortages and/or water temperature increases will have on performances.

Recommendation 2

That the JSSC and the EUSFA team develop a skills matrix for future recruitment to ensure expertise is maintained across relevant sectors. This should be developed in consultation with key energy market stakeholders and include experience and in-depth technical knowledge of changes and challenges to networks and power systems across the NEM.

Recommendation 3

That the EUSFAC continue to build relationships and the knowledge base within all NSW Government agencies to ensure that corporate knowledge is maintained (e.g. GEAR protocols and their enactment).

Medium to Longer Term Considerations

Recommendation 4

That the NSW Government:

- continues to undertake joint exercises with market participants and emergency services
- assess procedures and protocols related to the relocation of key personnel (JSSC, EUSFAC and EUSFA) away from other key positions and/or locations (such as the JRO or SEOC)
- undertakes a joint end-to-end exercise (either single or phased) similar to '*Exercise Lumen Tenebris*' that involves key NSW participants in the NEM (such as AEMO, TransGrid, DNSPs, generators and large energy users).

Recommendation 5

That the State Emergency Management Committee considers the development of evacuation sub-plans for an increasing vertical development landscape in Greater Sydney Metropolitan Region.

Recommendation 6

That the NSW Government continues conversations with and provide support to the AEMC's Reliability Panel, AEMC, AEMO, AER, ESB and other market participants to understand and/or contribute to:

- subsequent rule changes on power system security, reliability and strength. This includes, but is not limited to, discussions on and the development of the most appropriate reliability standard for a changing NEM
- the development of AEMO's 2019 Integrated System Plan (draft December 2019, final June 2020)
- AER's checklist of compliance and enforcement regime (due simultaneously to AEMO summer readiness briefing, November 2019)
- AEMO's Australian Energy Sector Cyber Security Framework (December 2019)
- ESB Future Power System Design and Post 2025 Market Design (end of 2020).

CONTENTS

1 INTRODUCTION

In 2017 the (then) Minister for Energy and Utilities established the NSW Energy Security Taskforce, chaired by the (then) NSW Chief Scientist and Engineer (CSE), to examine how NSW manages energy security and resilience, including readiness, planning, preparation and response capability to extreme events such as weather. This was after a load shedding event in NSW during summer 2016/17.[1]

The Initial Report, released in May 2017, found that *"NSW is reasonably well placed to deal with reliability and security risks under 'normal conditions'. However, large spikes in demand and problems with supply that sometimes occur during extreme weather events, such as February's heatwave, pose challenges for our electricity system".* The Final Report, released in December 2017, examined issues that need to be addressed to strengthen the longer-term resilience of the NSW electricity system.

In 2018 the (then) Minister for Energy and Utilities requested that the CSE chair a panel to assess the adequacy of the state's 2018/19 summer preparedness in relation to the energy market and associated departmental emergency management (the '2018/19 Assessment'). The Panel concluded that the NSW Government was well prepared for the summer 2018/19, noting that protocols and exercises by the (then) Department of Planning and Environment (now Department of Planning, Industry and Environment (DPIE), the 'Department'), other NSW Government agencies and industry stakeholders, had improved summer readiness and energy emergency response.

In September 2019, the Minister for Energy and Environment requested that the CSE provide expert advice on the risks within the National Electricity Market (NEM) in relation to summer for the NSW energy market. This advice is to build on the work of national bodies and to focus on opportunities for the NSW Government to take further action to maintain the reliability of energy supply in the State.

This report provides assessment for the 2019/20 summer by 30 October 2019 (as per Term of Reference [TOR] 1) and updates will be provided yearly thereafter to 2023. The full TOR are at Appendix 1. This report builds upon the findings and recommendations from 2017 NSW Energy Security Taskforce report and the 2018/19 Assessment of Summer Preparedness for the NSW Energy Market report.

1.1 BACKGROUND

The National Electricity Market (NEM) is one of the longest electricity systems in the world. It interconnects the six eastern and southern states and territories and delivers around 80% of all electricity consumption in Australia. Created by the Council of Australian Governments (COAG), the NEM is overseen by a governance structure with three national market bodies which are Australian Energy Market Operator (AEMO) as the gas and electricity market operator, the Australian Energy Market Commission (AEMC) as the rule maker and market developer and the Australian Energy Regulator (AER) with responsibility for economic regulation and rules compliance. The Energy Security Board (ESB) has been established to implement recommendations from *the Independent Review into the Future Security of the National Electricity Market 2017* (the 'Finkel Review').

TransGrid, as the NSW Transmission Network Service Provider (TNSP), provides the direct management of the transmission system, coordination of distribution network activities and feedback to the Electricity Incident Controller/Jurisdictional System Security Coordinator

[1] On 10 February 2017, during a heatwave featuring unusually high daily maximum and minimum temperatures over consecutive days, AEMO directed Tomago Aluminium smelter to curtail operations to reduce demand during the peak and the Minister of Energy requested to conserve energy usage.

(JSSC)/Jurisdictional Designated Officer (JDO) during a black system or electricity supply emergency. The role of the Jurisdictional Responsible Officer (JRO), which acts as the emergency contact point for AEMO during electricity supply incidents, is also held by a senior executive of TransGrid.

The Distribution Network Service Providers (DNSP) for NSW are Ausgrid, Essential Energy and Endeavour Energy, and are responsible for operating and maintaining the distribution energy supply network.

1.1.1 Balancing supply and demand and responding to events

Supply and demand in the system are always finely balanced, with AEMO having operational responsibility of managing the NEM to ensure that there is the right amount of electricity supply dispatched to meet demand over a time period, referred to as system reliability. To facilitate this balancing the network operator AEMO maintains forecasts of the predicted demand (based on factors such as time of day, day of the week and forecast weather conditions) and also anticipated capacity available across the generation fleet given the constraints of the network and the status of generators (including derating, scheduled outages, rates of unplanned outage, fuel availability, etc.) and with a buffer (reserves) between the demand and supply capacity.

The summer period has recently been a period of heightened vigilance for the market as excess capacity has been retired, more intermittent renewable generation has been installed, and with summer conditions become gradually more intense. Summers are characterised with increasing heat and use of air conditioning, increased risk of bushfires, and instances of hot dry conditions leading to derating of generators due to issues such as cooling tower water, and lower efficiency of photovoltaics in high temperatures.

The key concern during summer, as demand increases, is for AEMO to have as accurate as possible modelling and predictive capacity for both supply and demand, and to have systems in place and exercised to adjust supply and /or demand through mechanisms to bring on more supply (such as Reliability and Emergency Reserve Trader [RERT] mechanism) or to decrease demand (voluntarily or through load shedding protocols). An example of a load shedding protocol is the requirement of Tomago Aluminium Smelter to shutdown potlines (there are 3 potlines), however there is a limitation to how long a potline can be down for and when this could then be repeated without causing major issues to the potline. The market is designed to encourage enough capacity to be available to address supply with a buffer of, so that system delivers energy across the NSW grid 99.998% of the time, equivalent to reliability standard (unserved energy [USE] <0.002%).

As the difference between the forecast supply and demand narrows, a Lack of Reserve (sequentially LOR1, LOR2, LOR3)[2] may be forecast and then declared which triggers a range of actions by market participants including government. Protocols are also in place to manage a system outage in terms of emergency response, and to restart a system should it 'go black'.

This report looks across these sets of activities, processes and protocols by the NEM participants to develop advice for NSW government on how the electricity market in NSW is placed to manage the upcoming summer period.

[2] 'Lack of Reserve' (LOR) conditions are market notices issued by AEMO designed to elicit a market response to provide more capacity or demand response, and are designated from LOR1 (market signal for more generation, with no impact to power system security or reliability, but there may not be enough reserve capacity to restore contingency capacity), LOR2 (AEMO activates additional resources, including demand response or support generation, whilst there is still not impact to power system security, but it is unlikely the amount of capacity in reserve would be enough to cover involuntary load shedding) and LOR3 (deficit in the supply/demand balance, with involuntary load shedding occurring or about to commence)

1.1.2 Core roles in energy emergency response

During emergency situations, there are a number of key roles that support actions to ensure energy security and reliability and coordinate activities during emergency situations in NSW. This includes the Jurisdictional System Security Coordinator (JSSC) and Energy and Utility Services Functional Area Coordinator (EUSFAC) within the Department, the JRO with TransGrid, the State Emergency Operations Controller (SEOCON) and the Relevant Official (RO).

The JSSC is responsible for the preparation and maintenance of the jurisdictional load shedding guidelines and corresponding procedures, and is vital in a response to a sudden energy event. During an emergency, the JSSC liaises with AEMO and other jurisdictions' JSSCs in relation to voluntary or mandatory restrictions. The JSSC is responsible for developing mandatory restriction schedules and coordinating the declaration of emergency powers of the Minister for Energy by the NSW Premier (as required).

The EUSFAC coordinates the Energy and Utilities Services Functional Area (EUSFA) for the provision of energy and utilities support, and resources for emergency planning, preparation, response and recovery operations. The EUSFAC coordinates information and advice between combat agencies, the SEOCON, the JSSC and functional area participants, depending upon the event type. The EUSFAC may respond to electricity incidents while also responding to gas, water or liquid fuel incidents during the same emergency.

The State Emergency Operations Centre (SEOC) is established by the SEOCON under the *State Emergency and Rescue Management Act 1989.* The primary function of the SEOC during an emergency operation is to:

- support the SEOCON to control or support the emergency operation
- facilitate planning for the ongoing emergency operation
- acquire and allocate resources
- support the development of a coordinated public information strategy.

The EUSFAC is deployed to the SEOC during an event to support the SEOCON. The SEOCON will liaise with the JSSC in the event of an electricity supply emergency to provide specialist advice.

The RO is the individual with the authority to exercise electricity supply emergency powers within a jurisdiction, and in NSW this power sits with the Minister for Energy.

1.2 PROCESS FOR THE PANEL

To undertake the assessment an Expert Panel was established. The Panel was chaired by the CSE, Professor Hugh Durrant-Whyte, and included Mr Neville Henderson (former commissioner of the Australian Energy Market Commission [AEMC]) and Professor Joe Dong (UNSW Digital Grid Futures Institute, and School of Electrical Engineering and Telecommunications, UNSW Sydney). The Panel was supported by secretariat functions drawn from the Office of the NSW Chief Scientist & Engineer.

Additional advice on the Department's emergency procedures and protocols was sought by the Panel from Mr David Owens APM (Managing Director, Risk-e Business Consultants and former Deputy Police Commissioner and SEOCON). Mr Owens was also a member of the 2017 Energy Security Taskforce and a panel member for the 2018/19 Assessment.

In undertaking the work, the Panel received briefings and presentations from national energy market bodies including AEMO, AEMC, AER and ESB, Commonwealth and State government agencies, the Bureau of Meteorology (BOM), network operators, major generators and consumers in NSW on their preparedness for the coming summer. A full list of stakeholders consulted is at Appendix 2.

The Panel drew upon a range of reports prepared by AEMO that are related to NEM summer preparedness, including the 2019 Electricity Statement of Opportunities Report (ESOO), 2018 ESOO, Summer 2019 Forecast Accuracy Update, Forecasting Accuracy Report and 2018 Integrated System Plan (ISP).

The Panel acknowledges that there are reports and activities relevant to the TOR that were still in development and should be considered when released. These include, but are not limited to, the AEMO Summer Readiness briefing and report (November 2019), 2019/20 ISP (draft report December 2019 and final June 2020), 2019 Energy Adequacy Assessment Projection (EAAP) (report in November 2019), the Australian Energy Sector Cyber Security Framework (AESCSF) annual review (December 2019) and the ESB Health of the NEM Report (December 2019).

1.3 STRUCTURE OF THIS REPORT

- Chapter 2 – provide post-summer analysis with forecast accuracy assessment, outcomes and learnings from summer 2018/19
- Chapter 3 – provides an overview of NSW reliability and demand forecasts for the coming summer and other NEM regions, the status of NSW generation and transmission associated infrastructure and climate and weather conditions outlook for summer 2019/20
- Chapter 4 – update on actions have been undertaken by NSW Government, AEMO and major NSW network participants since last summer and/or actions proposed for the coming summer
- Chapter 5 – provides a discussion of potential issues that need to be considered to make NSW better prepared for future summers

2 SUMMER FORECAST ACCURACY 2018/19 AND ACTIONS

The 2018/19 Assessment found that:

- NSW was well placed for summer 2018/19 according to AEMO 2018 ESOO, with the overall expected unserved energy (USE) to be below 0.0002% and a forecasted maximum operational demand of 14,024 MW (10% POE)
- NSW, as part of the NEM, was vulnerable to high impact, simultaneous and/or cross-jurisdictional weather events (such as an east coast heatwave) that could put a strain on supply
- Bushfire was a key risk to network infrastructure, especially in the context of the antecedent drought conditions

The 2018/19 Assessment had a focus on the NSW Government's levers and information protocols, in particular the Summer Readiness Action Plan, the Concept of Operations (ConOps - EUSFAC) and Standard Operating Procedures (SOPs), and the Government Energy Action Response (GEAR) and Voluntary Demand Response (VDR) to manage Lack of Reserve (LOR) conditions and emergency preparations.

This Chapter provide a review of the 2018/19 summer analysis with an assessment of forecast accuracy, outcomes and actions undertaken.

2.1 2018/19 SUMMER ENERGY ANALYSIS

The 2018/19 summer was the warmest on record, with the state experiencing three months of warmer than average temperatures and several heatwave events (BOM, 2019c). There was high demand in most regions of the NEM, with record demand in Queensland (AEMO, 2019h).

Analysis from AEMO concluded that for NSW both summer demand and supply forecast accuracy was good and there was a good overall reliability outcome with no load shedding occurring (AEMO, 2019h).

As shown in Figure 1 and Figure 2, the demand forecast for summer 2018/19 appears to have captured the summer maximum trends well with the maximum falling between the 50% POE and 10% POE forecasts. This is consistent with the warmest summer on record for NSW observed over the period (Figure 2). The demand in NSW has been relatively consistent over the last few years, with expected seasonal patterns (for both summer and winter) and distinctive summer peaks (AEMO, 2019h).

Although no load shedding occurred, there were a number of forecasted LOR conditions and two actual LOR1 conditions declared in NSW over the summer period (17 and 31 January 2019) (AEMO, 2019e). All forecasted and actual LOR conditions were subsequently cancelled, indicating either an appropriate market response or changing conditions.

The 17 January 2019 LOR1 condition was caused by both reduced generation availability and relatively high forecast demand. The 31 January 2019 LOR1 condition was related to relatively high forecast of maximum demand (13,320 MW) associated with high temperatures (38.1°C at the time of maximum demand).

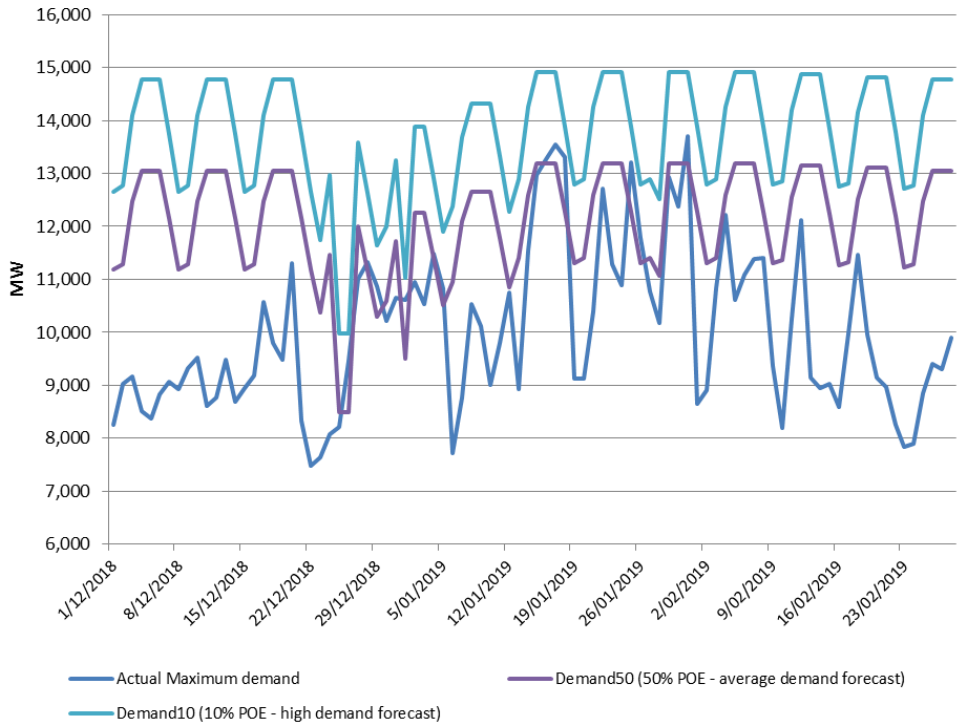

Figure 1: Comparison of forecast 10% and 50% POE demand forecasts with actual operational demand
Data sources: AEMO MT-PASA (AEMO, 2018d) and AEMO Operation Demand – Actual Daily (AEMO, 2019b)

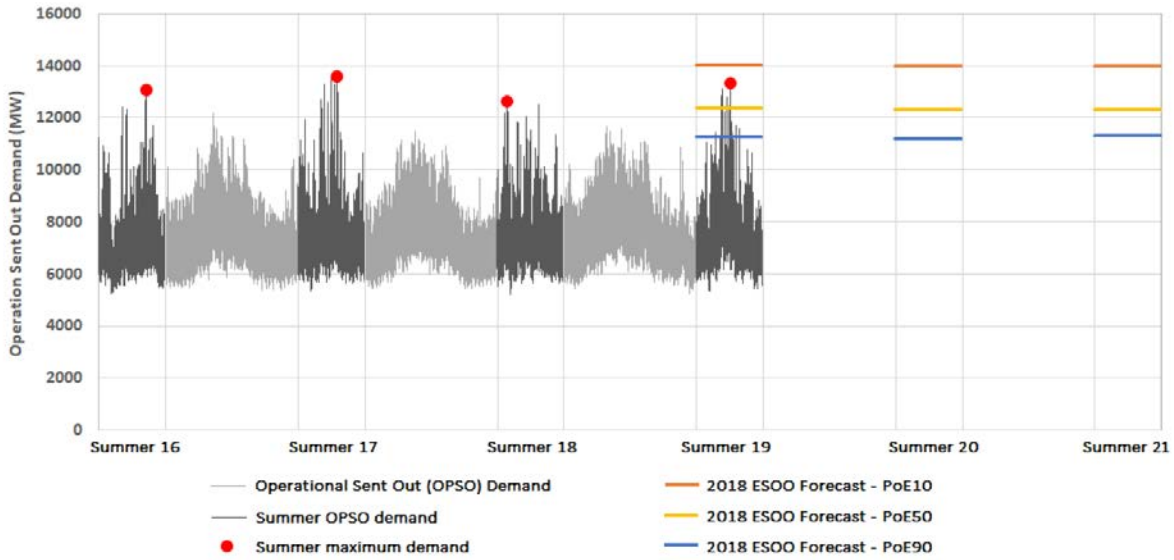

Figure 2: NSW demand history compared to central (previously neutral) scenario forecast, 2016-2021
Source: AEMO (2019h)

LOR2 conditions were forecast for 18 January 2019 and led AEMO to advise the JSSC to activate the demand response levers. The EUSFA team coordinated the activation of both GEAR and Large Energy User VDR protocols between 1300 and 1900 AEDT on 18th January 2019. The LOR 2 conditions were subsequently cancelled.

Specific actions taken during GEAR include, amongst other actions, adjusting employee's workspaces and air conditioning temperature set point. Each participating department was responsible for their own actions, with some buildings achieving 30-40% reduction in building power consumption. The total demand reductions from the activation of GEAR on 18 January was an estimated 7.3 MW. The VDR protocol saw four participants (Sydney Water,

Hunter Water, WaterNSW and the City of Sydney Council) make voluntary adjustments to their operations to reduce their electricity demand during the peak period, with an estimated combined reduction of 11.2 MW on 18 January 2019. It should be noted that the demand reduction via GEAR and VDR is voluntary, and these numbers will fluctuate depending on the event and the response from participants.

Victoria is the only region in the NEM where load shedding occurred over the summer. On 25 January 2019, very high demand associated with high temperatures (42.3°C at the time of maximum demand) and reduced generation availability, led to LOR3 conditions declared on 24 and 25 January with associated load shedding occurring (266 MW and 250 MW respectively). On 24 and 25 January, AEMO activated the RERT, contracting reserves of 365 MW and 575 MW respectively, however load shedding still occurred (AEMO, 2019g).

Generation capacity across NSW was generally as expected. The observed availability of NSW black coal generation was above forecast, but AEMO note that partial unplanned outages have been rising (AEMO, 2019h). The observed output from intermittent generation (large scale grid solar photovoltaic [PV] and wind) was within the simulation range, however due to a facility that was behind schedule for commissioning (according to aggregated data), the total summer intermittent capacity was 100 MW less than the 2018 Electricity Statement of Opportunities (ESOO) forecast (AEMO, 2019h). Hydro-generated power and gas-fired generation availability was also within in the simulated boundaries in NEM.

Over the summer, NSW experienced a number of severe weather events including dust storms, bush fires and severe thunderstorms (which includes damaging winds, hailstones and flash flooding) (BOM, 2019c). Data from NRMA Insurance showed that the summer was the most intense storm season in four years, with 61% of all home insurance claims during 2018-19 triggered by storm damage. December 2018 was the worst month, with 86% of claims resulting from storms including Sydney's worst hailstorm in 20 years (Noyes & Dye, 2019).

Outages across the energy network were related to localised outages in the distribution network. These localised outages were due to storm damage (such as from fallen trees during the December 2018 Sydney hailstorm) and a cable fault (due to overgrown weeds, on 21 January 2019 led to a loss of power for about 45,000 customers in the Eastern Suburbs of Sydney)(Clun, Latimer, & Chung, 2019).

3 SUMMER 2019/20 FORECASTS AND RISKS

This chapter provides an overview of reliability and demand forecasts, the status and risks to generation and transmission infrastructure and the expected climatic conditions for summer 2019/20.

3.1 NSW RELIABILITY AND DEMAND FORECASTS

AEMO has forecasted that for summer 2019/20 NSW will meet the reliability standard (USE <0.002%[3]), resulting in a low likelihood for the need of load shedding in the state (Figure 3)(AEMO, 2019a). As in the 2018/19 Assessment, the expected USE is forecasted to remain steady until 2022/23, after which it is expected to increase based on the announced closure of Liddell Power Station (1,800MW, with one unit at 450MW scheduled to come offline April 2022 and the remaining three units post-summer 2022/23) (Figure 3).

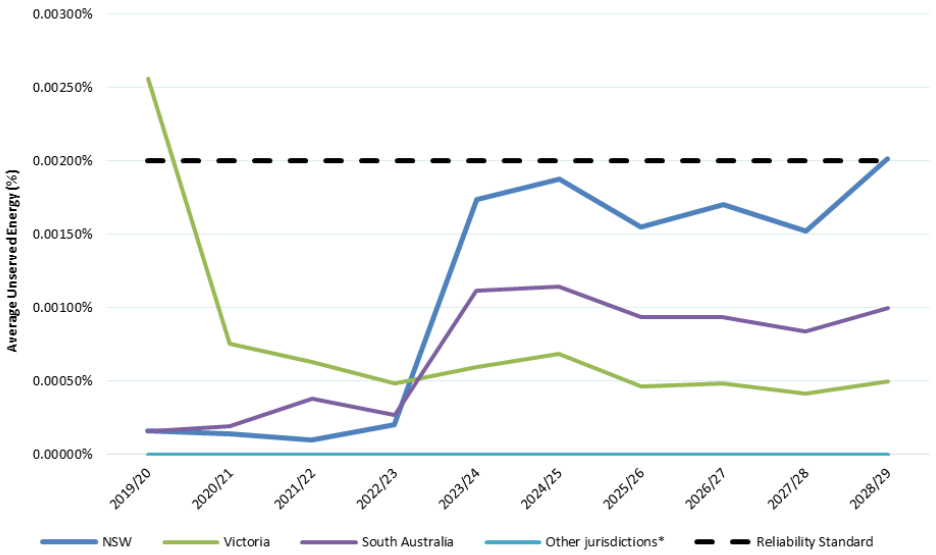

Figure 3: Expected USE for NEM jurisdictions (central scenario)
* Other jurisdictions includes Queensland and Tasmania, both of which exhibit an expected USE of 0.0000% over the forecast period
Source: AEMO (2019a)

AEMO have also forecasted a maximum operational demand (sent out) [4] of 14,293 MW and 13,291 MW for 10% POE and 50% POE respectively[5] for 2019-20. This operational maximum demand is forecasted to occur in NSW between 16:00 – 19:00 (AEDT).

The maximum demand over the summer compared with the forecasted supply is at Figure 4. In the figure, demand (50% POE) falls well below forecasted generation (including intermittent generation at 10%, 50% and 90% of their generation capacity). However, if we were to experience high demand (10% POE) over the coming summer, there could be a tightening of supply – particularly if this coincides on a day with low capacity (low intermittent generation, due to low wind conditions, or derating or loss of coal-fired power generation).

[3] "The reliability standard in the National Electricity Rules (NER) specifies that expected USE should not exceed 0.002% of total energy consumption in any region in any financial year (NER Clause 3.9.3C)"
[4] *"Operational consumption/demand (sent out) unless otherwise stated. This is the consumption to be supplied to the grid by scheduled, semi-scheduled, and significant non-scheduled generators (excluding their auxiliary loads, or electricity used by the generator)"* (AEMO, 2019a)
[5] 50% probability of exceedance (POE), meaning they are expected statistically to be met or exceeded one year in two, and are based on average weather conditions, or a 10% POE (for maximum demand) or 90% POE (for minimum demand), based on more extreme conditions that could be expected one year in 10 (and also called one-in-10).

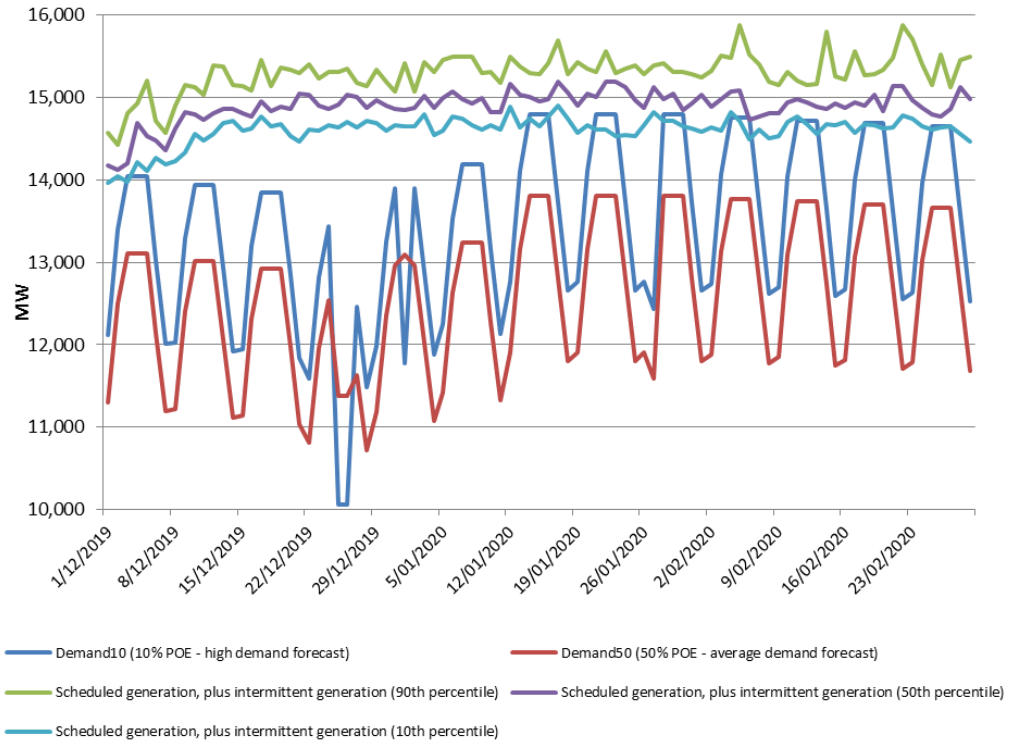

Figure 4: Comparison of NSW demand forecasts (10% and 50% POE) with scheduled and intermittent generation (at 10%, 50% and 90% intermittent)
Source: AEMO (2019d, 2019c)

It is also worth noting that there are two anomalies in the data from the Medium Term - Projected Assessment of System Adequacy (MT-PASA) that occur on 25/26 December 2019 and 1 January 2020 (Figure 4). In discussions with AEMO, it was indicated that this is an artefact of the approach taken by AEMO to adjusting for public holidays and that the methodology is under review.

3.2 FORECASTS FOR OTHER NEM JURISDICTIONS

AEMO has forecasted that all NEM regions, with the exception of Victoria, will meet the current reliability standard for summer 2019/20 (Figure 4). AEMO have forecasted an expected USE of 0.0026% in Victoria and will require 125 MW of additional firm reserves to meet the reliability standard.

The forecasted USE exceedance is compound by the possible extension of the current unplanned outages of Loy Yang A2 and Mortlake 2 into summer, which could lead to a 'significant risk' of not meeting demand and result in material involuntary load shedding. AEMO notes that these units are planned to be back in service in mid-December 2019 (see Section 3.3.2)

Depending on the status of these two generation units, Victoria's forecasted expected USE range is 0.0047% (if both generation units remain out, an 18% likelihood of occurring) to 0.0013% (if both return to service, a 28% likelihood of occurring); tied to this is a reliability gap of 460 MW to 0 MW (i.e. no reliability gap) respectively.

AEMO's modelling takes account of the provision of support to Victoria via flows on interconnectors from other regions (NSW, South Australia and Tasmania). If the situation in Victoria was to deteriorate such that extensive load shedding was required, this could possibly impact supply to consumers in NSW and the other two regions due to Equitable Load Shedding Arrangements.

3.3 GENERATION AND TRANSMISSION INFRASTRUCTURE STATUS

AEMO, in the 2019 ESOO, has modelled the capabilities of dispatchable generation based on information provided by market participants. The expected summer available capacity is provided by each coal-fired power generator and is based on atmospheric temperatures consistent with a 10% POE maximum demand in each region, thus allowing for reduced output due to high ambient temperatures.

For the current summer, generators have informed the Panel of their preparations and status. Key actions and potential issues that were identified by generators for the coming summer, and as noted by the Panel, were inspections prior to summer, maintenance activities and stockpiling of fuel reserves.

3.3.1 Outage rates

AEMO collects historical data on the timing, duration and severity of unplanned outages. This unplanned outage data as well as information from each generator on planned outages form a component of AEMO's assessment of the expected level of USE in each region.

Planned maintenance and planned upgrades by TNSPs, DNSPs and generators is an ongoing process, with reduced maintenance activities scheduled for summer (i.e. from December through to March each year) and with a focus on flexible maintenance (i.e. easily deferrable maintenance / projects) so as to maximise the available capacity over the summer period. In talking to stakeholders, they indicated that 'shoulder periods' also pose risks due to concurrent maintenance activities being undertaken to prepare for the coming summer and where there are days of increased demand as spring days become comparatively warmer. An example of this is that AEMO declared a forecast LOR2 condition for 30 October 2019 when a number of generators were unavailable due to planned and unplanned maintenance.

For NSW, the reliability of black coal generating plant over the last four years has varied both below and above long-term and short-term averages. The historical level of full (i.e. whole plant) unplanned outage rates has remained fairly consistent, although partial unplanned outage has been rising. Since 2011/12 the aggregate unplanned outage rates (full and partial outages) has risen from ~25% average time in an outage state to over 35% (AEMO, 2019h) and is driven by the deteriorating performance of those plants that are nearing retirement, with several plants to be withdrawn over the next 10 years .

The generation performance parameters used by AEMO in the 2019 ESOO, particularly for NSW, are consistent with historical trends. However, it is of concern if current trends continue with an increasing level of partial unplanned outages. The ability of generators to arrest this trend will depend on whether they obtain sufficient market revenue to offset the cost of preventative maintenance or increased resource application in order to reduce the partial outage levels.

Recommendation 1

That the NSW Government continue dialogue with AEMO and NSW coal-fired power generators to further understand:

- the issues and scope to arrest the trend of increasing partial or full unplanned outage rates
- AEMO's assessment of an aging coal-fired power generator fleet and retirement planning

3.3.2 Present outages

Victoria currently has two generator outages: Loy Yang A2 (500 MW, offline since 18 May 2019) and Mortlake 2 (292 MW, offline since 8 July 2019). Although the generator operators have indicated a return to service by December 2019 (AEMO, 2019a; Ho, 2019; Macdonald-Smith, 2019), AEMO has indicated that the likelihood that repairs to Loy Yang A2 and Mortlake 2 will occur by the end of December 2019 at 70% and 40% respectively: this estimate is based on the repairs that need to be undertaken and previous experience on similar plant outages.

Origin Energy noted to the Panel that the repairs for Mortlake Power Station are on-track and that the project has substantially been de-risked (with the arrival on site of a replacement stator), which reduces the likelihood that Mortlake 2 generator unit will be offline for summer 2019/20. As noted by AEMO and reiterated by Origin Energy, the assumptions used for the estimates on the likelihood of repairs extending beyond December 2019 are based on historical operational experience in similar plant failures and do not take account of actual conditions.

In order to help mitigate the potential capacity reduction from Loy Yang A2 over summer, on 2 August 2019, AGL announced that it would seek permission from the South Australian Government to operate the Torrens Island A Power Station (2 units at 120 MW each) until March 2020, having previously indicated the mothballing of these units for late 2019 after the commissioning of Barker Inlet Power Station (210 MW, South Australia). As of 22 October 2019, the South Australian Government has granted approval for AGL to continue operations of Torrens Island A over summer 2019/20. This has the potential to provide extra supply, especially to Victoria, through the summer provided there is available interconnector capacity (Russell, 2019).

3.3.3 Other factors influencing summer capacity and energy availability

There are a number of other factors that can lead to partial or full unplanned outages, or derating of firm capacity, for coal-fired power stations. These include, for example, fuel supply uncertainty or potential derating of coal fired power stations due to limitations on water discharge temperatures.

3.3.3.1 Coal supply

The consistent supply of coal, both quantity and quality, is essential to ensure maximum capacity from coal-fired power stations. The Energy Australia (EA) owned Mt Piper Power Station currently has a coal supply issue that is currently limiting capacity and could pose risk to electricity supply. Over recent years, the coal for Mt Piper Power Station has been solely supplied by Springvale Mine (owned by Centennial Coal) which has approval until 2024. Geological issues at the mine have led to ongoing problems with the quantity and quality of coal supplied (Lithgow Mercury, 2019). The supply problem has impacted the operation of the power station over recent months, and has reduced the average output by around 50% (588 MW) in the second quarter of 2019 when compared to previous quarters (AEMO, 2019f). To ensure that the plant is operating at full capacity during peak demand period in the coming summer, EA announced that from September until the end of November the power station has been placed in ‘coal-conservation mode’.

Key actions and potential issues that were identified by EA for the coming summer, and as noted by the Panel, were that:

- EA remains concerned that the current low stockpile levels combined with limited alternate supply options for Mt Piper may still pose a threat to NSW’s electricity supply
- as immediate solutions to the coal supply issue, approval has been granted for Centennial Coal to truck coal in from Clarence Colliery until December 2020 and

approval has also been granted to modify the Lidsdale Coal Loading facility to receive rail deliveries of coal from the company's other mining sites. EA informed the Panel they are working toward having the unloader available in early November 2019 and in parallel would undertake maintenance work on the conveyer.

- in looking at longer term coal supply security for Mt Piper, another local mine, Angus Place, is required to ensure continuity of coal supply as the Springvale Mine reserves are due to be depleted by 2024. Centennial Coal has lodged application of the Angus Place Extension Project seeking approval to extend the life of the mine beyond March 2016.
- risks to single local mine supply could be mitigated by diversifying supply options from coal mines in other regions. For example, EA is exploring the option of re-installing rail services on the Kandos section of the rail line connecting Mt Piper to the Upper Hunter Valley mining area.

3.3.3.2 Cooling waters

Coal-fired power stations can be de-rated below their nameplate capacity, especially on hot days or during heatwave due to environmental limitations on water discharge temperatures into lakes. This issue can be compounded by increasing inlet water temperatures which results in derating of equipment as the cooling temperature band has a narrower window to operate in (i.e. a narrower margin between inlet and outlet temperatures).

NSW coal-fired generators also have Environmental Protection Licences (EPL) issued by the NSW Environment Protection Authority (EPA) that includes with cooling water discharge temperature conditions that would apply for normal electricity supply and LOR conditions. For example, Eraring Power Station cooling water may be discharged over 35.5^0C but not exceeding a maximum temperature of 37.5^0C for up to a total of 307 hours during the normal operation. An additional 18 hours are allocated to discharge over 37.5^0C but not exceeding 38.5^0C to avoid potential shortfall of electricity supply during high demand. In response to system security risks, such as LOR conditions, AEMO could direct Eraring, under the National Electricity Rules (NER), to maintain or increase generation exceeding the maximum temperature of 38.5^0C for discharge cooling water with 72 hours operation. Vales Point Power Station, which is also on Lake Macquarie, also has EPL conditions for cooling water temperature discharge.

Recommendation 1

That the NSW Government continue dialogue with AEMO and NSW coal-fired power generators to further understand:

- fuel supplies and to ensure that generators are building redundancy and resilience in these supply chains
- the consequences, in the context of a changing climate, such as derating from increasing water shortages and/or water temperature increases will have on performances.

3.4 CLIMATIC CONDITIONS

Climate and weather conditions are one of the key factors to be considered in forecasting supply and demand of energy, and they can also pose risks to the reliability and resilience of the system. To understand the potential risks the Panel received a briefing from the Bureau of Metrology (BOM) on the current outlook for the 2019/20 summer.

The outlook for this summer is for above average temperatures and below average rainfall. These conditions will be exacerbated by the antecedent conditions which include ongoing

drought conditions[6] due to multi-year rainfall deficiencies, generally higher than average maximum temperatures, generally higher than average evapotranspiration and generally lower than average soil moisture (BOM, 2019a). The springtime drivers of these conditions are a positive Indian Ocean Dipole (IOD)[7] and a negative Southern Annular Mode (SAM)[8] (BOM, 2019a).

Currently 99.4% of NSW is considered to be in drought or drought affected (DPIE, 2019b).[9] These drought conditions have impacted water supplies. Record-low rainfall over the period since the beginning of 2017 has led to a continuous decline in water storage volumes. WaterNSW reported that on 28 October 2019 rural and urban water supplies were at 31% and 47.8% of storage capacity respectively (WaterNSW, 2019).

The reduction in dam levels below 60% in Greater Sydney led to the restart of the Sydney Desalination Plant in March 2019, this plant will remain in operation until dam levels return to 70% capacity. The plant accounts for 1.5% of Sydney's total energy usage and to ensure water supply will not turn off over the summer due to electricity demand measures (DPIE, 2019a).

AEMO, in the 2019 ESOO, notes that ongoing drought has the potential to impact the water available for hydro generation and as cooling water for co-generation (AEMO, 2019a). The report notes that this issue will be closely monitored and will be reported in an updated Energy Adequacy Assessment Projection (EAAP) later in 2019 (AEMO, 2019a).

AEMO also notes that *"given current weather conditions, and a continuation of drought in some areas, bushfires may threaten the power system, limiting inter-regional transfer capabilities"* (AEMO, 2019a).

The bushfire potential for summer is high. The Forest Fire Danger Index (FFDI)[10] indicates that the potential for fire is above average. The Bushfire and Natural Hazards CRC issued a Hazard Note in August 2019 stating that "*The 2019/20 fire season has the potential to be an active season across Australia, following on from a very dry start to the year"* (Bushfire & Natural Hazards CRC, 2019).

The BOM showed trends that the start of the bushfire season has moved to be almost two to four months earlier since mid-last century (BOM, 2019a). The 2019/20 bushfire season has already started, with fires NSW and Queensland.

In August 2019, NSW Rural Fire Service (RFS) declared the start of Bush Fire Danger Period (BFDP) for more than 20 local council areas. The bush fire season traditionally starts state-wide on 1 October to 31 March each year, but because of the of dry conditions without the prospect of good rainfall, the start of the season have been brought forward for a number of areas (NSW RFS, 2019). The reduced availability of water in some locations has also impacted on the ability of authorities to fight fires, with dry firefighting techniques being used in some cases, and water being transported long distances to fight fires (Gribbin & Davis, 2019).

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[6] Metrological drought: significant multi-year rainfall deficiencies, Hydrological drought: multi-year draw-down on water resources, Agricultural drought: consecutive poor agriculture seasons (BOM, 2019a)

[7] The Indian Ocean Dipole (IOD) is defined as *"sustained changes in the difference between seas surface temperatures of the tropical western and eastern Indian Ocean"*. The IOD has 3 phases: neutral, positive and negative. A positive IOD generally *"means there is less moisture than normal in the atmosphere to the northwest of Australia. This changes the path of weather systems coming from Australia's west, often resulting in less rainfall and higher than normal temperatures over parts of Australia during winter and spring." (BOM, 2019b)*

[8] The Southern Annular Mode (SAM) *"describes the north-south movement of the movement of the westerly wind belt that circles Antarctica, dominating the middle to higher latitudes of the southern hemisphere"*. A negative SAM leads to less rainfall in the southeast and east and a greater chance of spring heatwaves in southern Australia. (BOM, 2019d)

[9] As at 15 October 2019, 46.5% Drought Affected (Conditions are deteriorating; production is beginning to get tighter. Ground cover may be modest, but growth is moderate to low for the time of year), 21.3% in Drought conditions (Conditions may be very dry, or agronomic production is tight (low soil moisture or plant growth)) and 31.5% Intense Drought conditions (Ground cover is very low, soil moisture stores are exhausted and rainfall has been minimal over the past 6-12 months). (DPIE, 2019b)

[10] Forest Fire Danger Index (FFDI) a key tool for assessing fire danger in Australia, it is calculated based on temperature, wind speed, relative humidity and fuel availability.

The Panel's briefing included an outlook on the potential for severe weather conditions. These conditions have the potential to impact energy supply for summer 2019/20 through either increasing demand for electricity or through damage to power system infrastructure (generators, power lines, etc.). The conditions include:

- ***Heatwaves -*** The positive IOD and negative SAM are leading to an increased chance of early season extreme heat and an increased risk of short-duration heatwaves in the south of Australia. The number of extreme heat days[11] in 2019 to date has already exceeded the yearly total for 2018 (BOM, 2019a). High temperatures and heatwaves can increase demand. In NSW, based on model simulations, a 50% POE maximum demand can occur between 35°C and 43°C (AEMO, 2019a). Higher temperatures have the potential to increase water temperatures in lakes and reservoirs that are used to supply cooling water for coal-fired power generators.
- ***Dust storms -*** The very dry soils when combined with high winds (often ahead of fronts) cause dust to rise. Dry soils are likely to persist given current outlooks. Issues of dust can impact the network by potentially reducing the output from solar PV or by causing network issues (such as static or arcing, when combined with increased humidity or rain events).
- ***Flooding -*** Due to low stream flow, below average soil moisture and lower rainfall there is reduced risk of widespread flooding in 2019/20. However, localised flooding due to tropical lows and thunderstorms are still possible.
- ***Severe storms -*** Severe storms can led to large hailstones (≥ 2 cm), large wind gusts (≥ 90 km/h), intense rainfall which can cause flash flooding and tornadoes. Severe storms normally increase in frequency during the warmer months. There is generally low seasonal predictability of these events, but they can be predicted several days out. Severe storms can lead to damage to network infrastructure from high wind or lightning strikes. Some locations on the NEM (such as the Queensland-NSW Interconnector [QNI]) have protocols to reduce capacity in the event of lightning strikes in the vicinity.

It is also worth noting that stakeholders consulted with indicated to the Panel that hot summers are business-as-usual for the NEM, and that there is a greater concern around extreme and/or co-incident events. If a combination of these events happen across the state and across the NEM can put multiple pressures on the electricity system, particularly on days of high demand.

[11] "The number of days each year where the Australian daily area-averaged mean temperature is extreme (above 99th percentile)" (BOM, 2019a)

4 ADDITIONAL ACTIONS FOR SUMMER 2019/20

Although NSW is well placed from an energy reliability point of view, there are a range of risks to the system from extreme weather, hot days and capacity loss due to outages and weather (e.g. lack of wind impacting turbines or events damaging infrastructure) and concurrent events across the NEM. This chapter explores actions that the NSW Government and market stakeholders have undertaken to prepare for the coming summer (and future summers) to ensure the supply of electricity to consumers and to respond to emergency situations.

4.1 ACTIONS BY THE NSW GOVERNMENT

The majority of the roles of NSW Government in relation to summer readiness for the energy system relate to response and coordination activities at times of reduced reliability (such as during LOR declarations), during energy emergency, and also during other emergency events that could affect the electricity system. The actions below reflect efforts to put in place the systems and resources, exercise their operation, and respond to events as they occur.

4.1.1 Actions since summer 2018/19

4.1.1.1 Succession planning and recruitment of key NSW Government positions

In the 2018/19 Assessment, a recommendation was made in relation to succession planning for the important JSSC and EUSFAC roles and supporting teams. The following is an overview of the developments since that recommendation.

Machinery of Government (MOG) changes that took effect from 1 July 2019 following the NSW State election included the establishment of the Department of Planning, Industry and Environment (DPIE), bringing together the functions from the former Planning & Environment and Industry clusters.

The MOG changes led to some reassignment of roles across the energy division, which is now part of the Energy Climate Change and Sustainability (ECCS) Directorate within the Department. These changes are not yet permanent and ECCS is currently considering further changes to the structure.

After summer 2018/19, the Department recruited a new Executive Director (Energy Delivery and Coordination). This position also holds the role of JSSC, which is vital in a response to a sudden event. The JSSC is supported by the Energy Emergency Management Team.

As at the 1 October 2019, the position of Director of Energy Operations is vacant, with an acting arrangement for this position. The Panel notes that the recruitment process has commenced. The Department continued succession planning and have trained two deputies for the JSSC role. These are senior staff from the Energy Delivery and Coordination area and are trained to assist and perform in the role of JSSC as required.

The EUSFAC manages the provision of information relating to the potential or actual loss of energy supply to the State, Regional and Local Emergency Operations Controllers, the NSW State Emergency Management Committee (SEMC), Emergency Services Organisations, Functional Areas and Participating Organisations. The EUSFAC monitors and coordinates management of emergencies; seeks SEOCON approval for assistance (where applicable) to manage consequences of energy supply loss; and briefs the Electricity Incident Controller as appropriate. The EUSFAC position and deputy currently has two experienced operators who are supported by another two experienced backup officers and leads the EUSFA team. All four of these officers have performed in this position for a period of time and are knowledgeable in the roles and functions associated with this position, and have established

good working relationships with other Functional Area Coordinators across government. The EUSFAC also established the EUSFA sub-committee that meets at regular intervals and continues to develop good working relationship with other functional areas and EUSFA participating organisations.

Currently the EUSFAC is reporting directly to the Acting Executive Director of Energy Delivery & Coordination. In any new structure, the Department has indicated that emergency preparedness and summer readiness will remain a high priority for the ECCS Directorate and the Department, with efforts made to maintain the JSSC (and deputies) and EUSFAC in the same team. The experience of the officers and the networks that they have established over recent years, places them in an improved position for the summer season 2019/20.

In consultations with stakeholders, they indicated that there is operational strength in the EUSFA team across the energy and other related sectors (including water, gas and liquid fuel). As discussed later in Section 5, the NEM is in transition from centralised coal-fired generation to a greater proportion of renewables and distributed energy resources, and therefore stakeholders suggested that a greater understanding of the changes and challenges facing the network would be of value in the EUSFA team and suggested some technical experience in electricity networks would be of value in any future recruitment activities.

It should also be noted that as consequence of the MOG, there was a number of staff movements and reassignments across all government agencies, which has resulted in the potential for the loss of or maintenance of corporate knowledge across key positions. This has been identified by EUSFA team and is being proactively managed.

Recommendation 2

That the JSSC and the EUSFA team develop a skills matrix for future recruitment to ensure expertise is maintained across relevant sectors. This should be developed in consultation with key energy market stakeholders and include experience and in-depth technical knowledge of changes and challenges to networks and power systems across the NEM.

Recommendation 3

That the EUSFAC continue to build relationships and the knowledge base within all NSW Government agencies to ensure that corporate knowledge is maintained (e.g. GEAR protocols and their enactment).

4.1.2 Communication between NSW Government and market stakeholders

Stakeholders have indicated that there is a good relationship and open dialogue between themselves, the Minister and the EUSFA team in regard to energy security and associated emergency situations. This was highlighted as being increasingly improved over the last two years as a result of the many joint exercises undertaken, with *Lumen Tenebris* as an exemplar.[12]

AEMO and energy providers are now regularly provided with current contact details for the JSSC, EUSFA (including deputies) and the Energy Utilities Emergency Management Unit. In 2019, these contact details/list has been updated and supplied in January and again on 10 September 2019, in preparation for the upcoming summer season. When any significant changes are made or periods of annual leave occur, the lists are updated and circulated. The Energy Utilities Emergency Management Unit also has a detailed stakeholder plan, which includes AEMO, to ensure that the requisite communications are undertaken.

[12] *Lumen Tenebris* was a joint exercise between TransGrid and the NSW Government in 2018, to exercise critical incident training of the responsibilities and functions of the SEOC, JSSC, JRO, the EUSFAC and electricity network participants

During an energy emergency, all emergency services operate from SEOC, where the EUSFAC is located and all contact information is available to them. During these events the EUSFAC is used as a conduit for emergency management agencies through to the energy provider/distributors. This process has been exercised and undertaken in real events numerous times and works well.

There is further work that could be done across all levels of stakeholders insofar as data and model sharing, which is currently under negotiation.

4.1.3 Re-energising activities

The 2018/19 Assessment recommended that:

> "*government agencies and industry stakeholders expedite the finalisation of procedures… around informing re-energising activities on days of total fire ban declarations and/or significant fire activity & forecast*"

Throughout the summer period 2018/19, draft interim measures were put in place between the Department, NSW RFS, TransGrid, Ausgrid, Essential Energy and Endeavour Energy. These procedures were 'tested' in January 2019 with the Possum Point fires that involved fires near the VNI interconnector. Several meetings have occurred subsequently between involved parties and amendments were made to the 'Operational Guidelines for NSW RFS, TransGrid, Ausgrid, Endeavour Energy, Essential Energy and the Energy and Utilities Functional Area'.

The Guidelines create a uniform procedure designed to assist operational decision making between each of the parties in regards to electrical assets and bushfires, and to understand the risk for each party.

These guidelines were last updated on the 29 August 2019 by the EUSFA after consultation with the NSW RFS. The guidelines clearly identify processes and procedures to follow relating to:

- Fire ground access – Ground
- Fire ground access – Air
- De-energisation of electrical assets
- Re-energisation of electrical assets following a request for de-energisation

The guidelines will again be reviewed in March 2020 following the bushfire period.

4.1.4 Energy exercises

Exercises and reviews undertaken by the Department support and provide guidance to the EUSFA team for operational and emergency functions for the summer period.

The Department has undertaken after-action reports and conducted appropriate exercises as an integral part of the Energy Emergency Team's Summer Readiness Program. Emergency procedures were trialled in Exercise *Lumen Tenebris* in June 2018 and then subsequently reviewed following activation of the GEAR (the 'GEAR Program After Action Review' in February 2019).

The 'Jurisdictional System Security Guidelines' were updated and exercised before summer 2017/18. A review of the Guidelines was conducted in 2018 and has continued in 2019 to ensure delivery of a collaborative approach.

The following exercises were conducted where the EUSFAC attended and were able to exercise their policies, procedures and strengthen relationships:

- *Exercise Lumen Tenebris* (2018) State Level Exercise all SEMC participation.

- *Exercise Deerubbin* (June 2019) State Level Exercise all SEMC participation. EUSFA handover document developed and exercised. A copy is now included in the EUSFA operations logbook.
- an internal exercise was conducted on the Minister's Electricity Emergency Powers on 10 July 2019. Attended by the Minister and Department of Premier and Cabinet to ensure powers, processes and template documents were understood. This built upon an information session for the Minister on 25 June 2019.
- JSSC Guidelines (Load shedding) run by AEMO planned for 29 October 2019
- internal exercise within the Department for procedures during an energy emergency is planned for November 2019, just before the beginning of the summer bushfire season.

The Panel notes that the Department is planning to undertake a number of EUSFA-led exercises prior to summer, and include DPIE Summer Readiness Exercise, the EUSFA Sub-committee communications exercise, the GEAR exercise, and the VDR exercise.

EUSFA has now established regular 'Document Review' as part of their business as usual processes to ensure that all procedures and documents are up to date. This has seen all documents reviewed and/or amended in July 2019, this includes:

- Guide to the EUSFA role
- EUSFA Liaison Officer
- Templates and weekly/monthly checklists
- Concepts of Operations for
    - Black Start
    - Bushfires
    - Heatwave
    - Storms, floods and Tsunami's
- State Emergency Operations Centre Management System Standard Operating Procedures (Exercised during *Exercise Deerubbin* June 2019).

The development of these Concepts of Operations, guidelines, templates and checklists ensure that staff performing in the role of EUSFAC are well informed and nothing is left to chance.

In speaking to stakeholders, the Panel noted that there was an opportunity to expand upon current exercise (which should be continued) to include an exercise, either single or phased, that exercises the end-to-end NSW NEM participants, from AEMO through to large energy users.

Recommendation 4

That the NSW Government:

- continues to undertake joint exercises with market participants and emergency services
- undertakes a joint end-to-end exercise (either single or phased) similar to '*Exercise Lumen Tenebris*' that involves key NSW participants in the NEM (such as AEMO, TransGrid, DNSPs, generators and large energy users)

4.2 ADDITIONAL GOVERNMENT CONSIDERATIONS FOR SUMMER 2019/20 AND BEYOND

4.2.1 Communications Plans

The Departments 2018/19 Summer Readiness Plan included a section on 'Communication, stakeholder engagement and media material'. These communications materials are aimed at stakeholder and public engagement through a variety of media outlets, radio, social media and printed ads.

The current content for the Summer Readiness Program 2019/20 is under review, and contains draft holding statements, a list of the communications materials that have been developed to support communication activities in relation to a load shedding event, relevant contact details for stakeholders and communication flows to be followed in an emergency event. The communication campaign will be run over the summer period and is currently being rebadged following the MOG changes as well as reviewing the content and confirming stakeholders and channels to be targeted. The entire summer readiness communication plan package is expected to be completed and implemented by 1 December 2019.

4.2.2 Co-location of Jurisdictional Responsible Officer / Jurisdictional System Security Coordinator

Exercise Lumen Tenebris recommended consideration of the collocation of the JRO and the JSSC during an energy emergency. This was because the response to a sudden energy event is focused on recovery (that is, restoring generation post event). This process is largely automated and involves AEMO/network operators/generators, with the NSW Government communicating with the RO (currently sits with TransGrid) and coordinating emergency response services.

Discussions were held in November 2018 for both JSSC and JRO to collocate to the TransGrid office in Haymarket in the event of an electricity emergency. This was finalised in December 2018. Effectively, the JSSC would be within walking distance from the RO's location.

There is currently consideration and exercising of a mobile SEOC, including deploying SEOC Liaison Officers early to the NSW RFS State Operations Centre at Sydney Olympic Park in the lead up to the extreme bush fire danger days in 2018/19. In the 2019/20 the SEOC has commenced providing whole-of-government support and assistance to functional areas who wish to function remotely (at RFS State Operations Centre). This has seen the majority of functional areas and the SEOCON operate remotely from this facility.

There is currently a proposal to move a number Sydney CBD-based Department personnel (including the JSSC) to new business premises at Parramatta. In the event of an energy event/emergency, the JSSC would have significant difficulties in moving from Parramatta to Haymarket. Once the move to Parramatta is completed, exercises should be conducted to assess travel procedures and timeframes to relevant emergency centres. There needs to be further discussions and contingency plans developed to deal with this situation.

Recommendation 4

That the NSW Government:

- assess procedures and protocols related to the relocation of key personnel (JSSC, EUSFAC and EUSFA) away from other key positions and/or locations (such as the JRO or SEOC)

4.2.3 Evacuation sub plans

The Sydney and North Sydney CBD Evacuation Management Sub Plan (commonly referred to as the Sydney CBD Evacuation Plan) established special arrangements to manage more serious emergency events in the Sydney CBD and/or North Sydney CBD. The plan provides advice for workers, visitors and residents of the CBD area during a serious emergency. The arrangements have been put in place to ensure that emergency services can manage the high concentration of people in these business districts.

The Sydney CBD Evacuation Sub Plan requires all participants to be prepared by:

- knowing their roles and responsibilities
- maintaining situational awareness before, during and after an event
- being aware of the messaging distribution mechanisms and their limitations
- understanding shelter-in-place as being a protective strategy
- having an awareness of movement options and restrictions.

The document is one component of an integrated preparedness and response posture for dealing with serious emergency events.

Over the past ten years, the Greater Sydney Metropolitan Region has grown significantly, expanding its existing boundaries and with a substantial amount of vertical development (including high-rise apartment and commercial buildings).

Due to the significant development and population increases, there could be a role for the State Emergency Management Committee to consider the development of evacuation sub plans for other areas of the Greater Sydney Metropolitan Region with high concentrations of people and high-rise buildings, such as Parramatta, to deal with significant and serious emergency events (such as an energy 'Black Start' event).

Recommendation 5

That the State Emergency Management Committee considers the development of evacuation sub-plans for an increasing vertical development landscape in Greater Sydney Metropolitan Region.

4.2.4 NSW Government programs

To support new generation and/or reliability in the NSW energy market, the NSW Government has announced a number of programs including the:

- Emerging Energy Program ($75 million) which provides direct grant funding for the development of innovative, large-scale dispatchable electricity and storage projects in NSW (NSW Government, 2019b). To date it has awarded 10 pre-investment studies (totalling 2,150 MW of on-demand electricity) and announced a shortlist of 21 capital projects that include more than 700 MW of capacity across technologies including pumped hydro, gas, biogas, solar thermal, Virtual Power Plants (VPP) and batteries.
- Regional Community Energy Program ($20 million) which aims to increase renewable energy generation and improve energy reliability in regional and remote communities by supporting energy hubs, regional on-demand electricity projects and emergency backup energy systems (Government, 2019).
- Smart Batteries for Key Government Buildings program will provide smart batteries for schools, hospitals and other key government buildings with rooftop solar systems (NSW Government, 2019d). Early estimates suggest that it will offer up to 13 MW of

demand response through a VPP which could help provide the grid reliability and security in peak demand events and energy emergencies.

- Empowering Homes Program will enable the installation of up to 300,000 solar-battery systems across the state over the next 10 years by providing interest-free loans to eligible NSW residents (NSW Government, 2019c).
- Solar for Low Income Households Trial program ($15 million) will provide up to 3,000 rooftop solar power systems for low income households, adding more than 8 MW of behind the meter generation capacity (NSW Government, 2019e). Eligible low-income households can apply to receive a free 3 kW rooftop solar system if they forgo their Low-Income Household Rebate for a period of ten years.
- Demand Response Program ($14 million, co-funded with the Australian Renewable Energy Agency [ARENA]) provides financial incentives for participating businesses and households that voluntarily reduce their use during extreme demand peaks (NSW Government, 2019a).

In November 2018, NSW Government also released the NSW Transmission Infrastructure Strategy that aims to unlock private sector investment in priority transmission infrastructure projects (NSW Government, 2018a). This will be delivered via:

1) upgrading or building new interconnectors to access power from other states and unlock the potential of the Snowy Hydro 2.0 Scheme
2) increasing capacity by prioritising Renewable Energy Zones in the Central West, South West and New England regions
3) working with other states and regulators to streamline regulation and improve conditions for investment.

4.3 ACTIONS BY AEMO AND NETWORK SERVICE PROVIDERS

4.3.1 2019 Electricity Statement of Opportunities Actions

AEMO has identified a list of practical and least-cost action items in the 2019 ESOO to reduce the risk of involuntary load shedding during future peak summer periods. AEMO will continue to work with ESB, AEMC, AER, Commonwealth and State Governments to implement these recommendations. This includes:

- ***Summer readiness plan*** **-** AEMO's annual plan, working with industry and governments, to prepare for the coming summer. The 2018/19 Summer Readiness Plan focused on areas of risk for summer such as climatic conditions, peak electricity, resource availability and continued focus on managing system security with the power system transition. To reduce the potential risk, a four-pillar plan was implemented, consisting of sufficient available resources (generation capacity, fuel supply and transmission networks), continuing operational improvements, contingency planning with TNSPs and generators, and collaboration and communication across government and industry. The 2019/20 summer readiness plan will be published in November 2019.
- ***Commissioning of targeted transmission augmentation*** **-** improving NSW supply-demand balance with additional transmission capability identified in the 2018 ISP, including the new QNI, VNI upgrades, HumeLink and EnergyConnect. The importance of completing QNI and VNI work ahead of the closure of the Liddell Power Station has been reconfirmed by the 2019 ESOO. A new mechanism is required for the fast-tracked delivery of 'no regrets' transmission infrastructure and

resilience projects which will be identified in the 2019 ISP. AEMO will work with all stakeholders to develop a process for the implementation of these projects.

- ***Dispatchable resources -*** AEMO's analysis suggest ~ 215 MW new dispatchable capacity is required to ensure NSW only has a 1-in-10-year risk of a significant involuntary load shed event in summer 2023/24 after the full closure of Liddell Power Station. AEMO has stated that they will identify the attributes and location of dispatchable resources to address this risk.
- ***Reliability standard -*** the current reliability standard takes average of annual USE over all possible outcomes, which AEMO states is ineffective to understand the risk of high impacts events ('tail risk') such as coincident unplanned outages. AEMO is examining what modifications could be made to the reliability standard to more accurately address the impacts of tail risks.
- ***Three-year strategic reserve -*** Victoria's inability to procure sufficient energy reserves leads to unnecessary risks and potential costs to consumers, with AEMO stating that it will continue to look to obtain the necessary flexibility to maintain reliability.
- ***Wholesale demand response -*** in reviewing AEMC's decision to support the introduction of wholesale demand response, AEMO notes that it will look for ways to accelerate participation by customers as a mechanism to support future reliability
- ***Market reform -*** AEMO will work with ESB and other market bodies to prioritise and progress market reforms that could include, but not limited to, short-term forward markets, firming and security services markets and markets supporting investments.
- ***Notice and mechanism of closure -*** AEMO will work with the ESB, governments and market bodies in reviewing the current three-year notice of closure rule.
- ***Information transparency -*** to improve decision-making with better transparency, AEMO is working with industry to increase the frequency and improve the content of information it publishes.

4.3.2 The Reliability and Emergency Reserve Trader

The RERT is a function conferred on AEMO under the NER to maintain power system reliability and system security using reserve contracts.

AEMO recently completed a consultation on AEMO's Procedure for the Exercise of Reliability and Emergency Reserve Trader as a result of the AEMC rule change reintroducing long notice RERT. AEMO may procure long notice reserve through invitations to tender where it has 10 weeks or more notice of projected shortfall.

Alternatively, AEMO may maintain a panel of RERT providers that can provide short notice (between three hours and seven days) and medium notice (between seven days and ten weeks) reserve if required and for whom technical details are pre-agreed. Panel members for short notice RERT agree on prices when appointed to the panel, whereas panel members for medium notice RERT do not, and prices are negotiated when reserve is required.

AEMO has sought tenders from entities interested in providing Long Notice RERT for summer 2019/2020 for Victoria. Responses to the invitation to tender closed on 13 September 2019. AEMO has advised that there was a very good response in terms of physical MW, some of which was beyond reasonable economic considerations. AEMO are still in the tender/negotiation phase with RERT providers. It is understood by the Panel that AEMO has met the target amount of RERT identified 2019 ESOO at a very reasonable cost.

AEMO has also sought expressions of interest for RERT Panel members in Tasmania, Queensland, NSW (including ACT), South Australia, and Victoria, who may be able to provide reserve energy on short and medium notice as part of a RERT panel.

The closing date for the Short Notice and Medium Notice Expression of Interest was Monday 2 September 2019. The total portfolio which is commercially reasonable in SA and Vic is around 1.1 GW. In NSW, AEMO are still working though some of the details in submissions. About 300 MW is likely to be on the panel. AEMO is undertaking further work on this and they expect to go tender for another RERT panel in November.

4.3.3 Network Service Providers

Key actions and potential issues that were identified by TNSP and DNSPs for the coming summer, and as noted by the Panel, were:

- ***Summer preparedness in general -*** TNSP and DNSPs undertake annual network planning, risk management and asset assessment to better understand the availability of transmission networks in preparing for the summer period and reduce potential risks. Actions for the coming summer are business-as-usual for the network operators, with regular weather monitoring and load forecasting in place.
- ***Bushfire risk management -*** TransGrid and the DNSPs prepare annual Bushfire Risk Management Reports, which provides information against statistics stipulated by Independent Pricing and Regulatory Tribunal Home (IPART). The statistics provide IPART insight on TransGrid's performance on bushfire risk mitigation programs. The statistics are provided in IPART's reporting manual, Safety Management System Performance Measurement – August 2018. The 2018 report stated that a new initiative has commenced to use on the ground results from routine easement inspections to validate TransGrid's Vegetation Risk Model, which will strengthen TransGrid's risk based approach to vegetation maintenance. The 2019 report is due to be submitted by end of October 2019. DNSPs are prepared for the bushfire season which is a month earlier than the previous year, however expressed concerns with respect to risk of coincident events (bushfire, unplanned outages of major generators, heatwaves).
- ***Capacity risk management -*** TNSP and DNSPs major concerns around capacity are for the reliability of NSW coal-fired power generators during the peak demand period and potential unavailability of major generators in Victoria as reported in 2019 ESOO.
- ***Emergency response and communication -*** the roles and responsibilities of TNSP and DNSPs are clearly established under the Electricity Supply Emergency Plan (and sub plans) with control and coordination arrangements in place. Operational communications arrangements have support of a range of telecommunication methods (e.g. landline telephone, satellite phone and government radio network). Network services providers are in close contact with EUSFAC team.
- ***End-to-end simulation -*** DNSPs acknowledged that there are currently no statewide end-to-end run of simulation from TransGrid to distributors and to large users. Such practice would be beneficial to test protocols and communications. It would also help mapping priorities of energy restoration for large end users, and in turn assist these users in developing their own plans.

Recommendation 4

That the NSW Government:

- undertakes a joint end-to-end exercise (either single or phased) similar to '*Exercise Lumen Tenebris*' that involves key NSW participants in the NEM (such as AEMO, TransGrid, DNSPs, generators and large energy users)

5 PREPARING NSW FOR FUTURE SUMMERS

The NEM is in a period of transition and there are actions required to address potential risks that NSW might face associated with the retirement of coal generators, a transition towards an increasingly renewable-dominated market, and maintaining system reliability, security and strength with an evolving modern electricity grid to be better prepared for future energy situations. This chapter considers some of these issues.

5.1 FUTURE USE FORECASTS FOR NSW

To provide further context, the 2019 ESOO provides three scenarios for forecasted levels of USE for NSW (and other jurisdictions, for that matter) that extends out to 2028/29 (Figure 5):

- ***Central scenario -*** (formerly neutral scenario under the 2018 ESOO) assumes no new projects under development beyond those currently committed. Operational consumption forecasts are slightly lower (~6%) compared to the 2018 ESOO, leading to a forecasted consumption of 179 TWh by 2028-29. It is also worth noting that the Reliability Standard is forecasted to not be met in 2028/29 in this scenario, after the retirement of Liddell
- ***Step Change scenario -*** assumes increases in economic activity, population and electrification of transport. There is also a step-change of investment in domestic PV and energy efficiency measures led by consumers, resulting in a lower forecasted consumption (174 TWh) by 2028/29 compared to the Central scenario. Expected USE is forecast to rise with the retirement of Liddell in 2022/24, but reduce after this point due to the increase projected adoption of VPPs
- ***Slow Change scenario -*** assumes lower economic activity, population growth and projected PV uptake in comparison to the Step Change scenario. There is also the assumption of lower maximum demand, due to some closures of 'at-risk energy-intensive' sectors, resulting in significantly lower consumption forecasted at 168 TWh by 2028/29

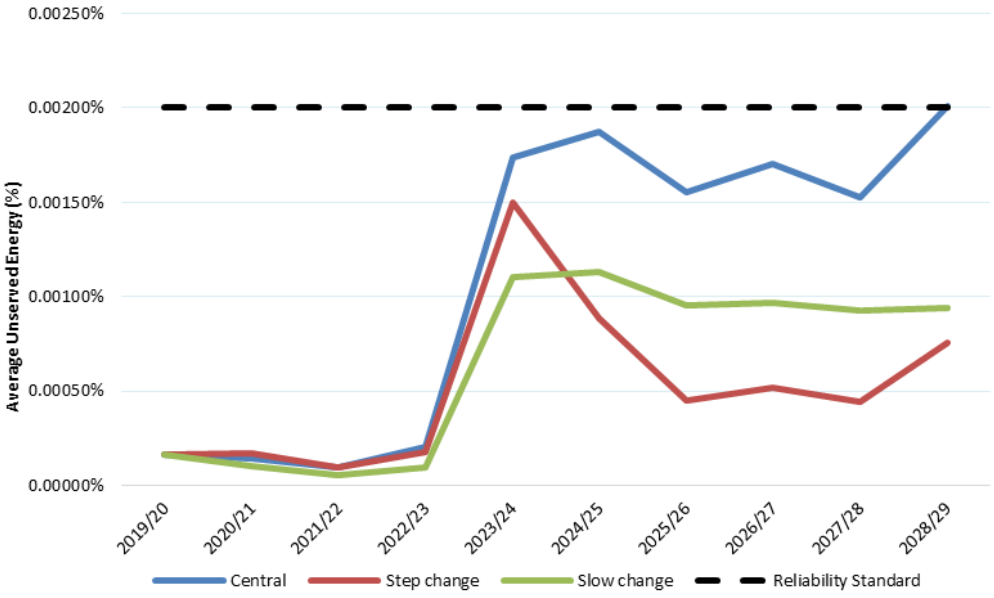

Figure 5: Forecasted NSW expected USE under three scenarios of Central, Step Change and Slow Change
Source: AEMO (2019a)

Of note, the three scenarios are all below the level of USE until 2028/29, where the central scenario is forecasted to exceed the reliability standard.

The NSW Government, Commonwealth Government and market participants have a number of programs, initiatives and plans that have the potential support reliability over the coming years. As many of these have not been finalised or only just announced, and therefore are not yet committed, they are not included in the AEMO 2019 ESOO calculations of USE.

An example of a program is the Emerging Energy Program, where 21 capital projects have been shortlisted that include more than 700 MW of on-demand capacity such as pumped hydro, gas, biogas, solar thermal, VPPs and batteries (NSW Government, 2019b). The outcomes of this are expected in the first half of 2020.

5.2 GENERATOR RETIREMENT AND UNSERVED ENERGY

AGL's Liddell Power Station (1,800 MW name plate capacity) will be the first major closure. AGL has indicated that they will continue the staged closure of all units, with the first unit (450 MW) removed from service in April 2022 and the remaining three units post-summer 2022/23. As previously discussed, this will impact the level of unexpected USE for NSW, forecasted to rise from the first unit closure (0.0002%) to the final units' closure (0.00174%) just below the reliability standard (Figure 5). It is also important to note that the nameplate capacity of Liddell was revised from 2,000 MW to 1,800 MW in 2018 (AEMO, 2018c).

Post the closure of Liddell, AEMO has indicated that NSW could be susceptible to significant supply gaps and possible involuntary load shedding in the absence of any mitigation action: for example, AEMO has forecasted that between 135,000 - 770,000 NSW households could be without power for three hours in an extreme heat event by 2023/24 (AEMO, 2019a). In order to limit the potential risk for exceeding the reliability standard, mitigation actions would include additional investment in 375 MW that would be required for 2023/24.

It is important to note that the forecasts of USE presume no additional generation, transmission or demand management investments beyond that which has already been committed. For example, the forecast does not include interconnector projects, both the QNI and VNI, which are still under regulatory approval processes, nor the commissioning of Snowy 2.0 (assumed operational by March 2025) as the modelling undertaken by AEMO does not include the associated HumeLink transmission infrastructure that is awaiting regulatory approval and that would unlock firm capacity from Snowy 2.0 to load centres. It also does not include a number of projects (such as those just announced by NSW Government (e.g. Section 4.2.4) and others that have not been approved.

The retirement of coal-fired generation will continue across NSW, Queensland and Victoria in NEM into the future, with approximately 14 GW reaching the end of technical life by 2040 and retire. The majority of the NSW coal-powered fleet will retire by 2040 based on announced retirement times or a technical operating life of 50 years for black coal-fired generators as estimated by AEMO 2018 ISP (AEMO, 2018b). This starts with the closure of Liddell Power Station followed by Vales Point (2028/29), Eraring (2034/35) and Bayswater (2035/36). AEMO acknowledged that the projected retirement timing is highly uncertain considering a wide range of commercial and financial factors that could impact the final decisions.

Recommendation 1

That the NSW Government continue dialogue with AEMO and NSW coal-fired power generators to further understand:

- AEMO's assessment of an aging coal-fired power generator fleet and retirement planning

Recommendation 6

That the NSW Government continues conversations with and provide support to the AEMC's Reliability Panel, AEMC, AEMO, AER, ESB and other market participants to understand and/or contribute to:

- the development of AEMO's 2019 Integrated System Plan (draft December 2019, final June 2020)

5.3 MAINTAIN POWER SYSTEM RELIABILITY, SECURITY AND STRENGTH WITH A TRANSITIONING MARKET

5.3.1 The Australian electricity market is in transition

In some jurisdictions the demand for electricity is declining. Over the next five years, NSW operational demand is expected to remain relatively flat (Figure 6). Growth in residential load is projected by AEMO to be offset by slight growth in rooftop PV and a decline in business load due to decline in energy-intensive sectors and increasing energy efficiency by both large and small consumers.

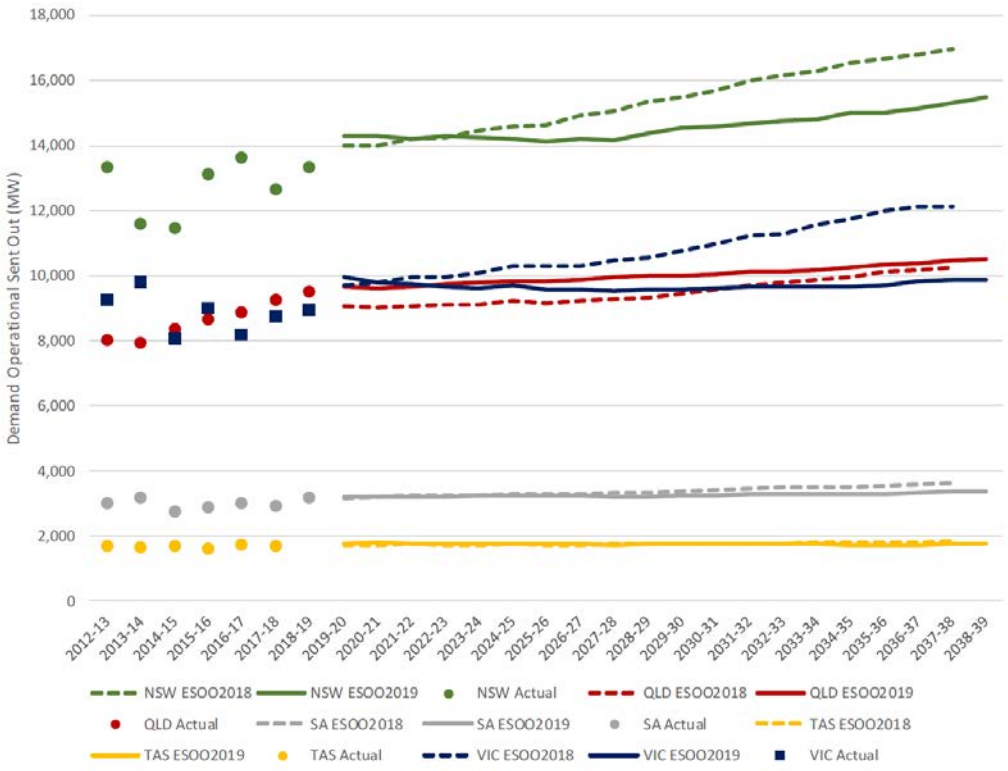

Figure 6: Regional summer (winter for Tasmania) 10% POE maximum operational demand (sent out) comparing 2018 ESOO vs 2019 ESOO
Source: AEMO (2019a)

The current NSW generation mix is dominated by fossil fuel generation, however this will be increasingly transitioned into a renewable-dominated scenario with the retirement of aging coal-fired power generation fleet. NSW has 1.8 GW committed large scale solar and a significant pipeline of proposed renewable projects with 5.7 GW wind and 7.3 GW solar. However, the new wind and solar coming online will only make contribution to a small improvement to the reliability outlook unless there is additional firming capacity brought into the system through batteries, gas and hydro-electric generation. As previously mentioned, there are initiatives underway by the NSW Government that could help to address these issues (Section 4.2.4)

Similarly, the development of new wind and solar generation across the NEM has continued to be strong with 41 GW of proposed wind and solar projects known to AEMO. The 2019 ESOO analysis includes nearly 5 GW of committed new generation capacity that are expected to become available by 2023 (excluding 2 GW from Snowy 2.0 in 2025). There are 11.5 GW of new dispatchable generation of hydro, gas and battery energy storage capacity proposed but not yet committed.

Most of these new generation projects are variable renewable energy generators that often do not generate at their full capacity during periods of peak demand, due to their intermittent nature (intrinsically linked to the climatic conditions and time of day) or congested network. Despite providing significant energy over the year, these renewable projects are forecast to only provide a limited contribution to meeting peak demand which is now anticipated to occur later in the day between 1700 to 1900 (AEDT).

Australia also has the highest penetration of residential rooftop PV in the developed world with 21.6% of all houses (excluding apartments) having a PV system installed (Roberts et al., 2018). As of 30 June 2019, NEM has a total estimated capacity of 8.1 GW behind the meter PV system based on Clean Energy Regulator (CER) and Australian Photovoltaic Institute (APVI) data. AEMO has projected a strong growth of rooftop PV uptake with an estimated NSW installation of 6 GW by 2038 (NSW Government, 2018b).

Small and medium scale solar PV generation, as non-scheduled Distributed Energy Resources (DER), pose potential complications for emergency control should an energy contingency occur. These scenarios could introduce sudden changes in supply and demand, which may contribute to decreased network security should it occur when the system capacity is already stressed (e.g. such as periods of peak demand).

Therefore, the change in generation technology and mix has, and will continue to have, significant implications for the resilience, reliability and security of the power system that should be examined in future years.

5.3.2 Power system reliability

Power system reliability means that the power system has an adequate amount of capacity (including generation, interconnector capacity and demand response) to meet consumer needs. It therefore requires there to be an adequate pattern of investment and disinvestment, and appropriate operational decisions, so that supply and demand are in balance at a particular point in time (AEMC, 2018). In order to deliver a reliable supply, a buffer (reserves) capacity is required so that supply is greater than expected demand.

In the NEM, reliability is an outworking of investment, retirement and operational decisions that are underpinned by various market structures. The system operator, AEMO, can intervene in the market in specific circumstances to maintain power system reliability.

The level of the reliability sought from the NEM's generation and interconnection assets is expressed in the reliability standard:

> "*The reliability standard for generation and inter-regional transmission elements in the national electricity market is a maximum expected unserved energy (USE) in a*

region of 0.002% of the total energy demanded in that region for a given financial year"[13]

The reliability standard embodies the trade-off between the expected impact of not supplying energy (value of energy not supplied) against the expected cost of the provision of supply side and/or demand side capacity. This is not zero per cent since this would be too costly for consumers. It also guides various decisions made by AEMO in its role as the system operator, including when it can intervene in the market if there is an expectation that the standard will not be met.

In the 2019 ESOO, AEMO presents arguments for modifying the reliability standard. It presents the forecast for NSW in 2023/24 as an instructive example, and focuses on the tail risk – those events from its simulations that result in unserved energy (Figure 7).

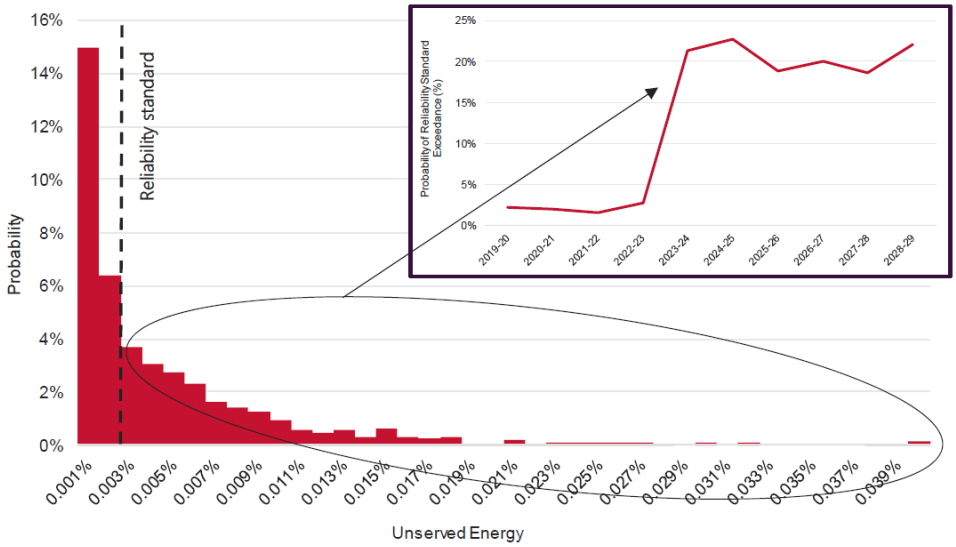

Figure 7: Distribution of annual USE in NSW, 2023/24
Source: AEMO (2019a)

AEMO's modelling indicates that while the 'expected' USE is 0.00174%, which is within the current standard, there is a significant risk that 'actual' USE may be significantly higher than 0.002%. AEMO's analysis indicates that in the modelled events, if USE was to occur, there is a 21% probability that USE will exceed 0.002% in 2023/24.

AEMO claims that because of the way the standard itself is framed, it does not capture the potential full impact of these uncertainties and associated risks. Uncontrollable, but increasingly likely, high impact ('tail risk') events such as coincident unplanned outages are masked in the current reliability standard, which requires USE to be averaged across the full range of possible outcomes for a given financial year.

AEMO is working with the Commonwealth and State Governments, the ESB, and the AEMC to explore the implementation of a refined standard operationally. It is important that the NSW Government is actively engaged in this process.

Key issues that need to be considered in any review of the standard include:

- What impact does the "tail risk" have on determining the expected level of energy not supplied (which is to be balanced against the cost of providing supply)?
- Does the value of energy used in the determination of the reliability standard adequately represent the economic and social costs when consumers are not supplied with electricity?

[13] National Electricity Rules, clause 3.9.3C(a)

- Is the use of a single value of energy not supplied appropriate? Are different values required as a function of the magnitude of the energy not supplied and the length of time such energy is not supplied?

Any increase in the reliability standard or reframing the standard that gives rise to increased levels of supply capacity will result in increased costs to consumers.

Recommendation 6

That the NSW Government continues conversations with and provide support to the AEMC's Reliability Panel, AEMC, AEMO, AER, ESB and other market participants to understand and/or contribute to:

- subsequent rule changes on power system security, reliability and strength. This includes, but is not limited to, discussions on and the development of the most appropriate reliability standard for a changing NEM

5.3.3 Retailer Reliability Obligation

The increase in intermittent renewable generation, along with recent and upcoming closures of coal-fired power generators, requires additional measures in the NEM to achieve a reliable electricity system.

The NER have been amended to implement the Retailer Reliability Obligation (RRO)[14] which requires electricity retailers and some large energy users to hold contracts or invest directly in generation or demand response to support reliability in the NEM.

Retailers and large users can choose to contract with any form of generation, however the "firmer" the contracted generation is, the greater their contribution will be to meet their obligation. The RRO commenced on 1 July 2019.

AEMO is required to identify any potential reliability gaps in each NEM region in the coming five years in its ESOO. If a reliability gap exists 3¼ years (39 months) from the identified gap, AEMO must request the AER to make a 'T-3' Reliability Instrument to trigger the RRO. An AER determination on the trigger must be made 3 years and 1 month prior to the start of the identified gap.

If the AER triggers the RRO, liable entities will be required to enter into sufficient qualifying contracts to over their share of a one-in-two year peak demand at the time of the gap. Liable entities are required to submit their contract positions to the AER who will adjust each contract for relative "firmness".

If the market response is insufficient and the AER confirms a reliability gap one year out, liable entities must disclose their contract positions to the AER. If actual system peak demand exceeds an expected one-in-two year peak demand, the AER will assess the compliance of liable entities. AEMO may commence procurement of emergency reserves at this point through the RERT framework to address the remaining gap with costs to be recovered through the Procurer of Last Resort cost recovery mechanism.

As noted by AEMO in the 2019 ESOO, as this is the first year that the RRO is in effect, there are no T-3 reliability instruments in existence. There are no forecast reliability gaps in the T-1 timeframe (2020/21) and as such AEMO did not request any T-1 reliability instrument in the 2019 ESOO. The closure of one unit (450 MW) at Liddell in April 2022 only results in a slight deterioration in forecast reliability in NSW in the T-3 timeframe (2022/23). AEMO did not request a T-3 reliability instrument in the 2019 ESOO.

[14] National Electricity Amendment (Retailer Reliability Obligation) Rule 2019, National Electricity Law Section 90EA

Recommendation 6

That the NSW Government continues conversations with and provide support to the AEMC's Reliability Panel, AEMC, AEMO, AER, ESB and other market participants to understand and/or contribute to:

- AER's checklist of compliance and enforcement regime (due simultaneously to AEMO summer readiness briefing, November 2019)

5.3.4 Power System Security

System security is when frequency and voltage are maintained within limits - even when something goes wrong. A secure system resists changes, can be restored to normal levels when something does go wrong, and has emergency schemes in place as a last line of defense. Security is about the technical performance of the system.

System Security – Inertia

Synchronous generators like coal, biomass, gas and hydro operate with large spinning turbines that help maintain consistent frequency and voltage, thus keeping the system stable. They inherently produce inertia – the energy momentum that lets the system ride through sudden disturbances and rapid frequency deviations, and maintain its operating frequency of around 50 Hz (±0.15Hz).

Non-synchronous generators like wind and solar have no or low inertia. Systems with increased penetration of non-synchronous generation are weaker and harder to control, in that they have less time to recover from sudden equipment failures before frequency collapses and blackouts occur.

With the increase in non-synchronous generation being connected to the grid, the projected increase in this generation and the potential retirements of coal-fired power generation, it is expected that the amount of inertia will decrease and thus the power system is less able to resist large changes in power system frequency[15]. Consequently, AEMC has amended the NER to place obligations on AEMO and TNSPs in respect of inertia in order to manage the rate of change of power system frequency.

AEMO must determine sub-networks in the NEM that are required to be able to operate independently as an island and, for each sub-network, to determine the minimum required levels of inertia; and to assess whether a shortfall in inertia exists or is likely to exist in the future. If a shortfall exists, TNSPs have an obligation to provide minimum levels of inertia at the least cost possible.

As provided for in clause 11.100.2 of the NER, the NSW region is the initial inertia sub-network.

AEMO has determined the inertia requirements for 2018. For NSW, AEMO estimate that the typical level of inertia is 32,600 MW (AEMO, 2018a). The required secure operating level of inertia is 12,500 MW with the minimum threshold level of inertia being 10,000 MW. AEMO's next inertia update is due early next year and this is envisaged to include a five year forecast for each of the regions.

One area where there may be an emerging inertia issue is South West NSW beyond Darlington Point. AEMO is managing a number of constraints in this area, including in North West Victoria. These sub-networks present a relatively weak inertia area where an inertia shortfall may develop. Otherwise, an inertia shortfall is not anticipated to be declared in NSW within the timeframes of the next 3 – 4 years. However, the market is moving very fast and

[15] Noting that Primary and Secondary Frequency Control is available, once the system frequency leaves the normal frequency band, including through frequency control ancillary services

the dynamics of the new non-synchronous generators, which are displacing synchronous generators, may result in an economic displacement of some inertia.

5.3.5 Power System Strength

System strength is a characteristic of an electrical power system that relates to the size of the change in voltage following a fault or disturbance on the power system. System strength can be measured by the availability of fault current at a given location. High fault levels are generally found in a strong power system while low fault levels are representative of a weak power system.

When the system strength is high at a connection point, the voltage changes very little for a change in the loading (i.e. a change in load or generation). However, when the system strength is lower, the voltage would vary more with the same change in loading.

System strength has reduced following the retirement of fossil fuel-fired synchronous generators and the increasing levels of non-synchronous renewable generation and input at lower voltage levels (such as DER).

Strong power systems respond well to small and large system disturbances. Weak power systems are more likely to be influenced by voltage instability or collapse following a disturbance.

The AEMC, recognising that the power system is evolving and changing, has amended the NER sections that are directed at managing system fault levels. AEMO is now required to develop a system strength requirements procedure from which it can determine the required fault level at key locations in each transmission network necessary for the power system to be maintained in a secure operating state. In June 2018, AEMO published its 'System Strength Impact Assessment Guidelines'.

Where a system strength shortfall exists, there is now an obligation on TNSPs to procure system strength services needed to provide the fault levels determined by AEMO. AEMO has determined the required fault levels, which are used as a proxy for system strength. Currently, TransGrid is not required to procure system strength services.

5.3.6 Future Power System Design

The ISP is a whole-of-system plan that provides an integrated roadmap for efficient development of the NEM over the next 20 years. It is a cost-based engineering optimisation plan by AEMO that forecasts the overall transmission system requirements for the NEM. The result of this work is the identification of those investments in the power grid that can best unlock the value of existing and new resources in the system, at the lowest cost, while also delivering energy reliably to consumers.

The 2019/20 ISP is under development and due to be published in June 2020. AEMO has now completed its consultation on the scenarios, inputs, assumptions, methodology, timeline and consultation process for a collection of forecasting and planning publications, including the 2019/20 ISP. Consultation workshops are being held in January and February 2020.

5.3.7 Post 2025 Market Design

The COAG Energy Council has requested the ESB to advise on a long-term, fit-for-purpose market framework to support reliability, modifying the NEM as necessary to meet the needs of future diverse sources of non-dispatchable generation and flexible resources including demand-side response, storage and DER participation.

The ESB issued a 'Post-2025 Market Design Issues Paper' in September 2019, with submissions due 30 September.

By early 2020, the ESB will identify fit-for-purpose market frameworks for evaluation. These will be evaluated throughout 2020. At the end of 2020, the ESB will either recommend a package of measures to adapt the existing market design or recommend alternative market designs.

Recommendation 6

That the NSW Government continues conversations with and provide support to the AEMC's Reliability Panel, AEMC, AEMO, AER, ESB and other market participants to understand and/or contribute to:

- ESB Future Power System Design and Post 2025 Market Design (end of 2020

5.4 DIGITALISATION AND CYBERSECURITY

As widely accepted, there is a strong trend of increasing digitalisation of power systems that will make them vastly different from the past. This digitalisation is dominated by new technologies and business models, with increasing complexity, such as next-generation ICT infrastructure including 4G/5G networks, smart meters, various sensors and data-gathering devices already deployed in the system. DER, demand side participation (DSP), roof-top PV systems and VPP increasingly rely on ICT systems for monitoring and control.

Cybersecurity is emerging as an important risk to be managed for digitalised power systems. Cyber system generally means the communication networks and computer systems which support the physical power system operations, and cybersecurity is the security of this cyber system. The current NEM system can be regarded as an integrated cyber and physical energy system with an expanding cyber network to provide monitoring, control, market data, distributed generation data and demand side management data, etc.

Cybersecurity may sound remote, however the risks do exist – for example, the 2015 Ukraine blackout was caused by synchronised and coordinated cyber-attacks through its regional electric power distribution companies, leaving 225,000 customers without power for several hours[16]. Under certain conditions, cyber-attacks may not cause physical power system security problems but may introduce market irregularities so as to introduce extra costs to customers.

Cyber-attacks may take advantage of accessibility through various components of the power system (e.g. smart meters, home area networks) or system access credentials so as to cause both security problems with the physical power system and/or the market. This opens more probabilities of potential cybersecurity on top of the ICT infrastructure for smart grid and energy market operations for the NEM.

To address the evolving cyber threat landscape, AEMO, in partnership with Australian Cyber Security Centre (ACSC) and Critical Infrastructure Centre (CIC), has developed the Australian Energy Sector Cyber Security Framework (AESCSF) in 2018. The framework enables participants to undertake assessments of their own cybersecurity capability and maturity. AEMO will deliver annual reports into cybersecurity preparedness of the NEM to the ESB. The 2018 annual report provided responses to recommendation from the 2017 Finkel Review Report and identified next steps to strengthen NEM's cyber integrity. The 2019 AESCSF Assessment Report will be published on December 2019.

ACSC has also launched a nationwide program of cyber resilience and response activities for the electricity industry and for government agencies that have an energy and cybersecurity role. The program includes information exchange and training activities and it will enable professionals to share experiences, information and techniques to better prevent,

[16] On December 23, 2015, the Ukrainian Kyivoblenergo, a regional electricity distribution company, reported service outages to customers. The outages were due to a third party's illegal entry into the company's computer systems.

detect, respond to and recover from cybersecurity incidents. These workshops and events have been planned over October to December 2019.

Recommendation 6

That the NSW Government continues conversations with and provide support to the AEMC's Reliability Panel, AEMC, AEMO, AER, ESB and other market participants to understand and/or contribute to:

- AEMO's Australian Energy Sector Cyber Security Framework (December 2019)

ACRONYMS

Acronym	Complete Term
AEMO	Australian Energy Market Operator
AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
AESCSF	Australian Energy Sector Cyber Security Framework
ARENA	Australian Renewable Energy Agency
ACSC	Australian Cyber Security Centre
BAU	Business as Usual
BFDP	Bush Fire Danger Period
BOM	Bureau of Metrology
CBD	Central Business District
CER	Clean Energy Regulator
CIC	Critical Infrastructure Centre
COAG	Council of Australian Governments
ConOps	the Concept of Operations
CSE	NSW Chief Scientist & Engineer
DER	Distributed Energy Resources
DNSP	Distribution Network Service Provider
DPI	Department of Primary Industries
DPIE	Department of Planning, Industry and Environment
DSP	Demand Side Participation
EA	EnergyAustralia
EAAP	Energy Adequacy Assessment Projection
ECCS	Energy Climate Change and Sustainability Directorate, DPIE
EOCON	Emergency Operations Controller
EPL	Environmental Protection Licence
ESB	Energy Security Board
ESOO	Electricity Statement of Opportunities
EUSFA	Energy and Utilities Services Functional Area
EUSFAC	Energy and Utilities Services Functional Area Coordinator
FFDI	Forest Fire Danger Index
GEAR	Government Energy Action Response
GW	Giga Watts
JDR	Jurisdictional Designated Officer
JRO	Jurisdictional Responsible Officer
JSSC	Jurisdictional System Security Coordinator
Hz	Hertz
IOD	Indian Ocean Dipole
IPART	Independent Pricing and Regulatory Tribunal
ISP	Integrated System Plan
LOR	Lack of Reserve
MOG	Machinery of Government
MT-PASA	Medium Term Projected Assessment of System Adequacy
MW	Mega Watts
NEM	National Electricity Market
NER	National Electricity Rules
NSW	New South Wales
NSW EPA	NSW Environment Protection Authority
NSW RFS	NSW Rural Fire Service
POE	Probability of Exceedance
PV	Photovoltaics

QNI	Queensland to NSW Interconnector
RERT	Reliability and Emergency Reserve Trader
RIT-T	Regulatory investment test for transmission
RO	Relevant Official
RRO	Retailer Reliability Obligation
RFS	NSW Rural Fire Service
SAM	Southern Annular Mode
SEOC	State Emergency Operations Centre
SEOCON	State Emergency Operations Controller
SEMC	State Emergency Management Committee
SOPs	Standard Operating Procedures
TNSP	Transmission Network Service Provider
TWh	Terra Watt hours
USE	Unserved Energy
VDR	Voluntary Demand Response
VNI	Victoria to NSW Interconnector
VPP	Virtual Power Plant

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APPENDIX 1 - TERMS OF REFERENCE

ASSESSMENT OF SUMMER PREPAREDNESS FOR THE NSW ENERGY MARKET

In 2017 the Minister for Energy and Utilities established a NSW Energy Security Taskforce to look at how NSW manages energy security and resilience, including readiness, planning, preparation and response capability to extreme events such as weather. The Taskforce released its initial report on 22 May 2017 and its final report on 19 December 2017.

The initial report focused on the actions that could be implemented to deal reliability and security risks for the 2017/18 summer and the final report looked at the longer-term resilience of the NSW electricity systems.

In October 2018, the Minister for Energy and Utilities, requested that the NSW Chief Scientist & Engineer chair a panel to assess the adequacy of the state's 2018/19 summer preparedness in relation to the energy market and associated emergency management, and identify any actions for emerging risks in 2018/19 summer and beyond.

The Panel reviewed the Department of Planning and Environment's Summer Readiness Action Plan and the NSW Government's responsibilities and levers in the energy market and emergency management.

The Panel concluded that the NSW Government was well prepared for the 2018/19 summer, noting that protocols and exercises by the Department of Planning and Environment, other NSW Government agencies and industry stakeholders have improved summer readiness and energy emergency response over the previous 12 months. The Panel also made eight recommendations to the NSW Government for summer 2018/19, summer 2019/20 and medium to longer term considerations.

NSW is generally well placed to deal with electricity reliability and security risks. However, adequacy of electricity supply is at heightened risk during extreme weather events, such as heatwave conditions, lost/reduced output of forecast generation output and the reliability of ageing coal-fired power generators.

The NSW Government is seeking expert advice from the NSW Chief Scientist & Engineer on risks within the national electricity market, especially in relation to summer. This will build on the work of national bodies and focus on opportunities for the NSW Government to take further action to maintain the reliability of supply in the State.

Scope of review

The review will:

1. provide an assessment by 30 October 2019, that:
    a. synthesises work undertaken by the Australian Energy Market Operator (AEMO) and other national bodies in relation to the supply and demand outlook in NSW, including the adequacy of firm generation, transmission and demand response;
    b. considers national measures, ongoing work by AEMO and other market bodies, and current NSW Government actions, to address energy reliability and security risks;

c. builds on previous NSW Chief Scientist & Engineer assessments of summer preparedness of the NSW energy market and reviews the work completed by the NSW Government in response to the recommendations from those reports;

d. identifies any emerging risks for the 2019/20 summer and makes recommendations on actions to address any vulnerability identified; and

e. examines opportunities for enhanced working relationships between AEMO, TransGrid and the NSW Government regarding energy emergencies.

2. Upon request, provide an update to the assessment and yearly thereafter to 2023, that:

    a. accounts for market developments, ongoing monitoring and work from national bodies, including updates to AEMO's Integrated System Plan (ISP) and Electricity Statement of Opportunities (ESOO);

    b. includes ongoing assessments of summer preparedness for the NSW energy market; and

    c. identifies any emerging risks for NSW and makes recommendations on actions to address any vulnerability identified.

In undertaking this work, an expert Panel as well as staff selected by the NSW Chief Scientist & Engineer will consult with, and consider work being undertaken by, the NSW Government and other relevant organisations including TransGrid, AEMO, the Australian Energy Regulator, the Australian Energy Market Commission and the Energy Security Board.

Process

The Panel is to provide a report by 30 October 2019 and upon request, provide updates to the review yearly thereafter to 2023. There is significant work being undertaken by AEMO. The Panel should draw on this work where possible and focus on areas particularly related to NSW.

APPENDIX 2 – BRIEFINGS AND PRESENTATIONS

The Panel and secretariat received briefings and presentations from national energy market bodies, state government agencies, network operators, major generators and consumers on their on their preparedness for summers (Table A2.1).

Table A2.1: Briefings and presentations

Sector	Organisation
National bodies and government agencies	Australian Energy Market Operator (AEMO)
	Australian Energy Market Commission (AEMC)
	Australian Energy Regulator (AER)
	Bureau of Meteorology (BOM)
	NSW Department of Planning, Industry and Environment (DPIE)
	Energy Security Board (ESB)
Network operators	TransGrid
	Ausgrid
	Essential Energy
	Endeavour Energy
Generators	Energy Australia
	Origin Energy
	Sunset Power International (trading as Delta Electricity)
Others	Tomago Aluminium