AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Summer 2018-19 Readiness Plan

November 2018

A report for the National Electricity Market

Important notice

PURPOSE

AEMO has prepared this document to provide information about its preparations for summer 2018-19. These preparations are designed to minimise the risk of customer supply disruption in the National Electricity Market during the periods of highest demand for electricity from the grid. This report is based on information available at 1 November 2018.

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VERSION CONTROL

Version	Release date	Changes
1	16/11/2018	Initial release

Executive summary

AEMO operates the power system for the National Electricity Market (NEM) that serves the eastern and south-eastern regions of Australia, and the Western Australian South West Integrated System. Our key responsibility is to oversee the operations of the power system so electricity is supplied safely, securely, and reliably to Australian homes and businesses, and the power system operates in the long-term interests of consumers.

In summer, the power system must manage extra risk as it responds to high consumer energy demand, in the face of high temperatures and climatic events including bushfires and storms.

Annually, AEMO prepares a summer readiness plan, collaborating with generation and transmission network providers, federal and state governments, and key agencies to actively manage heightened risks to power system operations.

The readiness plan to address risks and deliver reliable and secure power to consumers throughout summer 2018-19 builds on the strategies and actions which delivered reliable, secure supply during summer 2017-18 (the second-warmest on record)[1], and is structured around these four pillars:

- Sufficient available resources.
- Continuing operational improvements.
- Contingency planning.
- Collaboration and communication.

Heightened risks in summer

The key focus areas of risk for summer are:

- Climatic conditions, with potential impacts on both demand and supply.
  - The Bureau of Meteorology (BoM) is forecasting an elevated risk of bushfires, with drier conditions, increased temperatures, and an earlier start to the bushfire season. Bushfires can either directly impact generators and transmission networks, or limit the transmission network's power transfer capability.
  - The BoM predicts warmer than average temperatures, with heatwaves of shorter duration in the south but longer duration in the northern regions. Extreme temperatures and extended heatwaves elevate the risk of extreme peak demands on the network, and can limit generator capacity or lead to equipment failures.
  - Drought conditions in some parts of the country have been declared, particularly in New South Wales. Droughts can reduce the output of both hydro and thermal (mainly coal- and gas-fired) generation. Hydro generators use water as a fuel, and thermal generators need it for cooling.

[1] AEMO's reports on readiness for the 2017-18 summer and post-summer review of operations are available at http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Summer-operations-report.

- Peak electricity demand management.
  - The electricity peak in each region is forecast to be similar to historical record levels, across most NEM regions and the WEM. Management of concurrent peak demand across multiple NEM jurisdictions remains a key operational risk, and a focus of AEMO's reserve management strategies.
  - Maximum demand is expected to occur slightly later in the day than last year in all regions. This continues an existing trend, as growth in rooftop photovoltaic (PV) uptake sees consumers generating more of their own energy supply during daylight hours, before drawing on grid supply into the evening. South Australia, for example, with the NEM's highest rooftop PV penetration as a percentage of peak demand, experienced its peak at 8.00 pm (AEST) last summer.
- Resource availability.
  - Extreme conditions can impact the adequacy and the availability of resources when they are needed for the power system to meet demand.
  - In the 2018 Electricity Statement of Opportunities (ESOO), AEMO's modelling forecast risks this summer for Victoria (and South Australia, due to its level of connection with Victoria) of unserved energy during some peak conditions unless additional reserve resources were procured.
  - There is a particular risk of the reliability standard (which requires a maximum of 0.002% of unserved energy in a year in any NEM region) not being met in Victoria under some peak demand conditions. This risk is more acute given approximately 250 megawatts (MW) of thermal generation has been identified in the Medium Term Projected Assessment of System Adequacy (MT PASA) as unavailable in Victoria/South Australia during summer. AEMO is working with the owners of this generation to understand its availability during peak demand conditions.
  - As part of its reserve management strategy and to manage supply shortfalls, AEMO has identified additional reserves which can be made available through the Reliability and Emergency Reserve Trader (RERT) function. This reserve is used only if the market does not respond with enough supply or demand resources to ensure the reliability standard is met, for example at times of very high periods of electricity demand, or to manage power system incidents. These reserves are expected to close the risk of not meeting the reliability standard, identified in the 2018 ESOO.

Managing system security as the power system transitions is a focus all year round, not just during periods of peak summer electricity demand. The summer plan includes continued focus on management of frequency, voltage, system strength, and inertia to maintain a secure power system throughout summer, including security challenges posed at times of low grid demand.

Four-pillar plan for summer

Sufficient available resources

The plan focuses on having appropriate resources available for AEMO, as system operator, to call on so:

- Supply is adequate to meet consumers' energy requirements, including at peak demand times, and to manage risks at times of extreme weather.
- Power system security can be maintained at all times, including when times of low grid demand make it more challenging to manage frequency, voltage, system strength, and inertia.

Areas addressed in this key work stream include:

- Increased capacity in the market – some 2,100 MW of new generation and storage capacity has entered or is expected to enter the NEM during 2018 and will be available for the coming summer. This is in addition to the generation added to the NEM in time for last summer, which continues to operate.
- Availability of existing generation in the NEM – working with generators to minimise planned outages and identify and mitigate the risk of unplanned outages at times of high summer demand.

- Non-market generation and demand resources – seeking prudent levels of generation and demand resources not normally available to the market (RERT) to reduce the reliability and security risks. These additional resources can be called on if needed to help manage risk when reserves are low or where power system incidents occur.
- Availability of fuel for generation – AEMO coordinates with generator owners to identify and mitigate risks to the availability of fuel for generation (coal, gas, hydro, and diesel).
- Availability of transmission networks – AEMO coordinates with transmission network service providers (TNSPs) so transmission networks are available to carry the required levels of electricity supply.

Continuing operational improvements

AEMO continues to identify and to improve our operational systems and processes to be more adaptable and better manage increased uncertainty related to supply, demand, and reserve levels under varying power system conditions. Changes have included:

- Consultation and enhancements to our reserve management through improvements to the Forecasting Uncertainty Measure (FUM) before this summer. These improvements allow for better risk management across a range of timescales.
- Increased sampling of real-time data from rooftop PV systems to improve the accuracy of short-term forecasts.
- Improved forecasting data and methods to account for the changing weather conditions which can materially impact the generation mix with more renewables coming online and increasing uncertainty.
- Close collaboration with weather service providers, including the BoM and Weatherzone, proved valuable last summer and has been expanded to further improve the speed and quality of information about weather conditions and extreme weather hazards that is available to power system operators in real time.
- AEMO has also invested further in extensive control room and support staff skills and training.

Contingency planning

AEMO has collaborated with governments, generators, TNSPs, and other stakeholders to identify relevant summer risk scenarios and conduct extensive briefings and emergency exercises to test contingency plans, communication processes, and decision-making at all levels.

From October 2018 through to April 2019, AEMO hosts weekly briefings among AEMO, governments, and TNSPs regarding forecast weather and power and gas system conditions for the week ahead, with a view to identifying and mitigating risks before they materialise, where possible.

Collaboration and communication

AEMO has engaged with stakeholders across government and industry to establish working groups and share contingency plans, procure RERT, co-ordinate gas and electricity outage management plans, facilitate new generator connections, confirm fuel availability, undertake emergency exercises, identify and implement forecasting improvements, and improve network resilience.

AEMO has also identified opportunities to improve communication with businesses and households around supply risks, before and during summer.

Contents

1. Summer 2018-19

This section outlines the risks and challenges expected in summer 2018-19. It summarises weather forecasts, expected demand for electricity, uncertainties related to supply, and how these combine to deliver current power reliability assessments for summer. It also notes system security challenges in the changing power system.

1.1 Weather and climate

Weather impacts the level of demand for electricity and can also impact all generation to varying degrees.

Weather has always been one of the most important considerations in power system operations, and its importance has increased exponentially as Australia has become more reliant on renewable resources. Extreme temperatures and events including bushfires, lightning, and storms can reduce the output of thermal, solar, and wind generation, impact transmission lines, and result in loss of supply. Drought is also a factor in the output of hydro generation, which uses water as fuel, and thermal generation, which uses water in cooling.

AEMO is working closely with both the BoM and Weatherzone so our operational planning and support is underpinned by the most accurate and up to date climatological forecasts.

On 9 October 2018, the BoM advised that:

- There is about a 70% chance (triple the normal risk) of El Niño occurring in 2018. An El Niño would mean an increased likelihood of lower rainfall this summer and, consequently, drought relief is less likely.
- A positive Indian Ocean Dipole (IOD) is also likely underway, which can exacerbate rainfall deficiencies in spring and, combined with El Niño, can increase the possibility of a warm, dry end to the year[2].

Although severe weather can occur at any time of the year, October to April is the peak period for Australia's bushfires, heatwaves, flooding, tropical cyclones, and severe storms.

In the months ahead, the BoM has informed AEMO that Australia can expect:

- A low chance of drought-relieving rainfall before autumn 2019.
- Elevated bushfire potential, particularly in the south-east.
- An increased risk of heatwaves, with shorter duration but more extreme heatwaves expected in the southern regions of the NEM, and longer in the north.
- Reduced likelihood of widespread flooding.
- A below average number of tropical cyclones.
- A normal risk of severe thunderstorms.

The figures below illustrate critical aspects of the weather forecast which can have a significant effect on the power system and are important considerations in AEMO's summer readiness planning.

[2] For more about the BoM's El Niño-Southern Oscillation (ENSO) outlook, see http://www.bom.gov.au/climate/enso/index.shtml.

Figure 1 shows the BoM's expectation that November 2018 to January 2019 is likely to be drier than average for parts of eastern and southern Australia.

Figure 1 Chance of exceeding median rainfall, November 2018 to January 2019

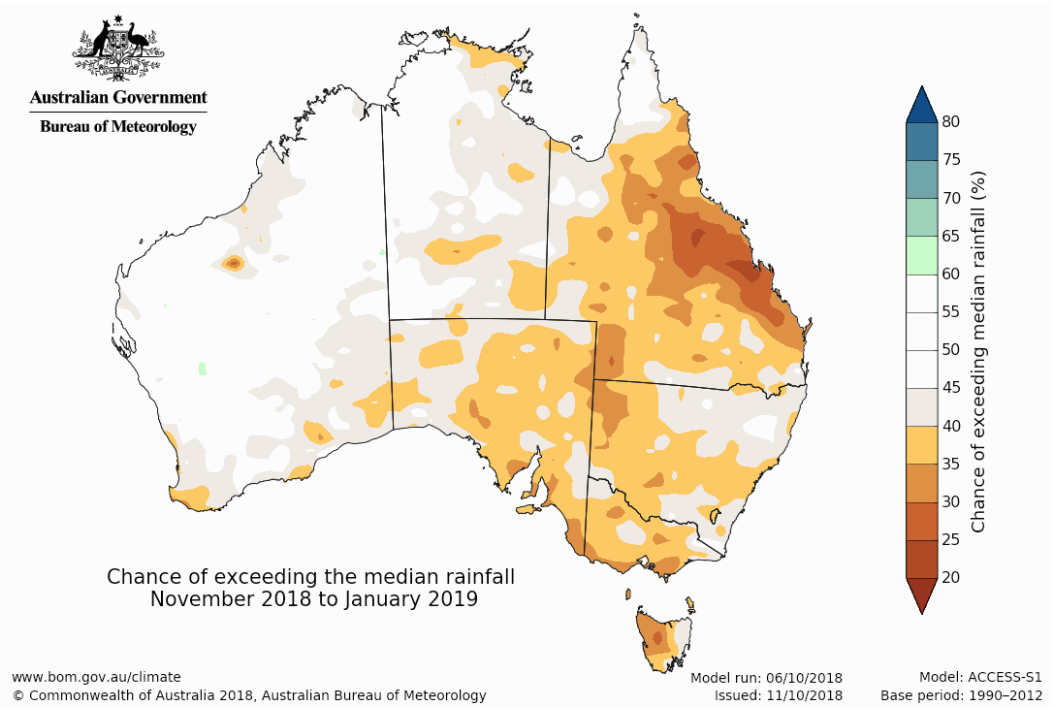
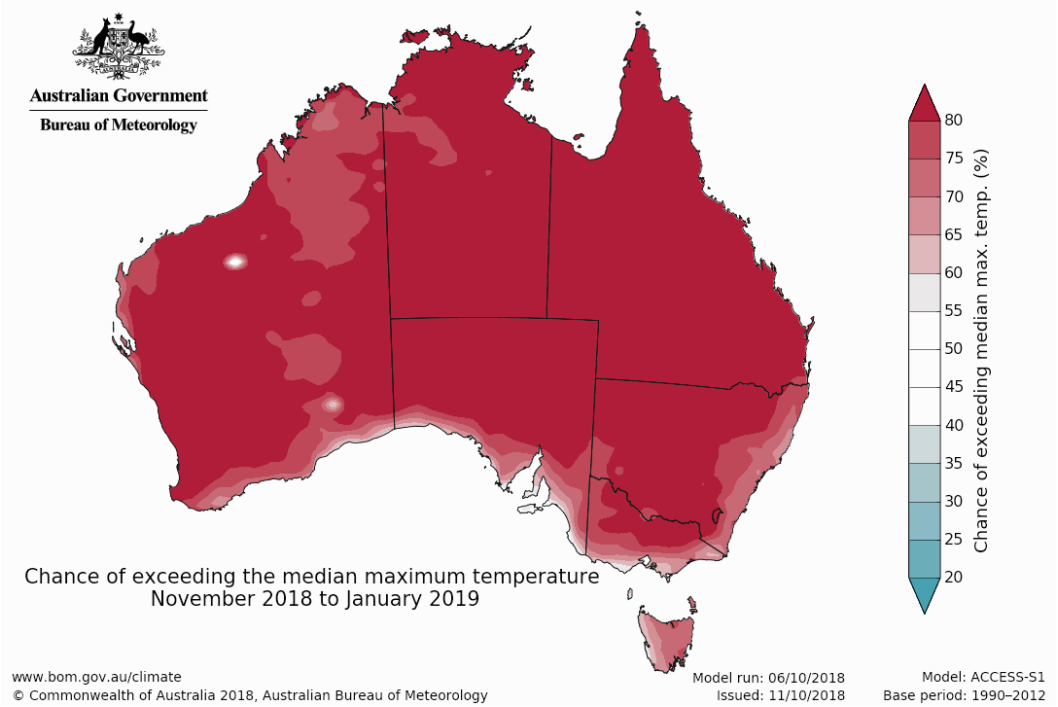


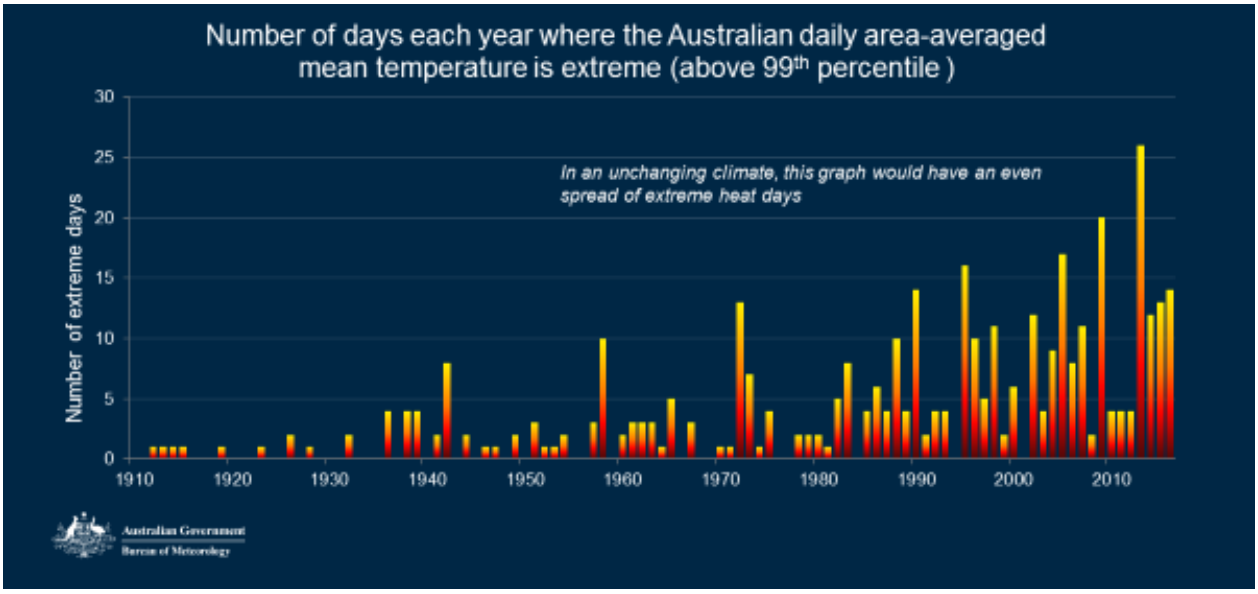
Figure 2 shows that, over the same period, most of Australia is forecast to have a greater chance of experiencing warmer than average maximum temperatures.

Figure 2 Chance of exceeding median maximum temperature, November 2018 to January 2019



As Figure 3 below shows, the BoM's data indicates that 2017 continued the trend towards increasing extreme mean temperature (above 99th percentile). The BoM expects this trend to continue in the summer of 2018.

Figure 3 Trends in extreme temperatures in Australia



1.2 Peak demand expectations

Forecasts for operational consumption (resources drawn from the grid over a period of time) and maximum demand (resources required from the grid at a single point in time) continue to be impacted by the ongoing growth in rooftop PV systems installed in households and businesses. While underlying demand (the total energy used by consumers) is expected to be higher, the growing contribution of rooftop PV means this is not expected to translate to higher grid demand.

The trend of maximum demand shifting later in the day is also expected to continue, as consumers generate more of their own energy supply from rooftop PV during daylight hours, before drawing on grid supply into the evening. South Australia, for example, has the NEM's highest rooftop PV penetration and experienced its peak last summer at 8.00 pm.

Figure 4 shows the 10% probability of exceedance (POE) maximum demand forecast for this summer, compared to both the 2017-18 peak and the previous historical record scheduled demand[3], for each NEM region. To understand POE forecasts:

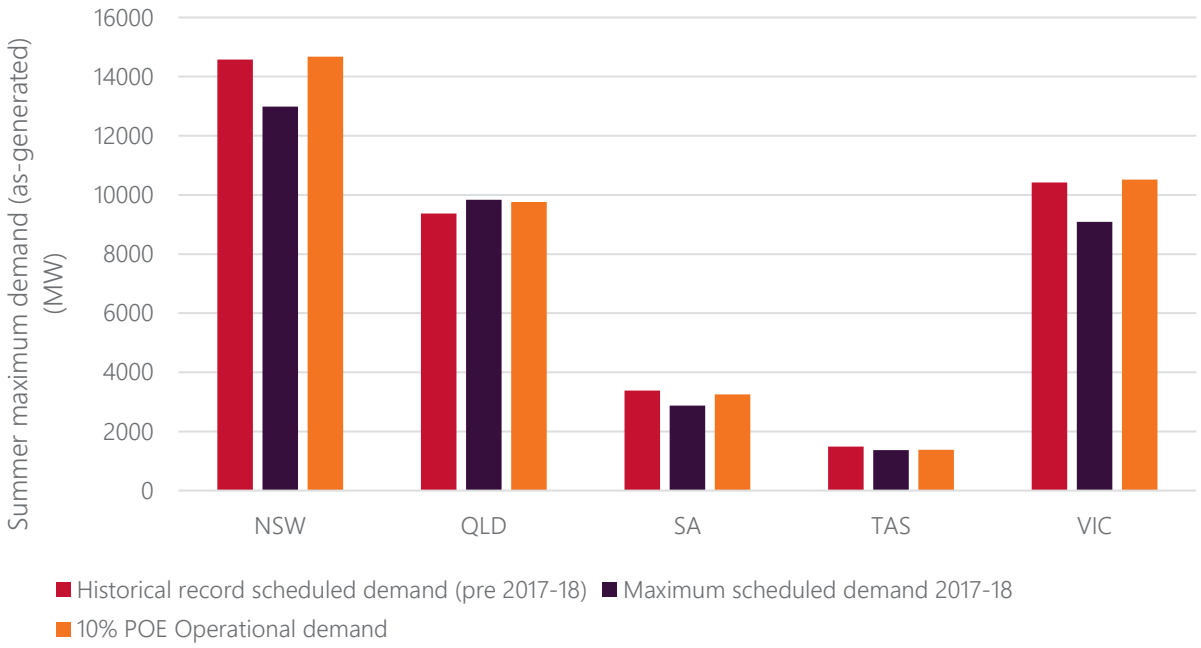
- POE is the statistical probability of a forecast being met or exceeded.
- A 10% POE forecast is expected on average to be exceeded only one year in 10, while 50% forecasts are expected to be exceeded one year in two.
- The difference between average and extreme weather conditions is a key difference between 10% and 50% POE forecasts, because weather is a major driver of maximum demand, especially in regions where residential demand makes up a larger proportion of the total (New South Wales, South Australia, and Victoria).
- A 10% POE demand forecast is based on the conditions AEMO would expect under very high temperatures, at major load centres (normally CBD locations) in each region, on a weekday in January or

[3] Scheduled demand in a region is demand met by local scheduled and semi-scheduled generation and by generation imports to the region. Scheduled demand excludes demand met by non-scheduled (wind/solar and non-wind/non-solar) generation and exempt generation, and includes the demand of local scheduled loads. For more information and definitions, see http://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Dispatch/Policy_and_Process/Demand-terms-in-EMMS-Data-Model.pdf.

February when industrial and commercial businesses have returned from the Christmas holiday period, and where prior days have also had high temperatures.

All states in the NEM peak in summer, except Tasmania, which is winter-peaking due to demand for heating.

Figure 4 Summer maximum demand comparison



1.3 Supply for summer

AEMO continues to improve our assessment of key uncertainties that can impact supply reliability, including climate change and extreme weather events, the variability and diversity of intermittent generation, the reliability of thermal (coal- and gas-fired) generation, and the capability of the transmission network.

AEMO's most recent assessments are based on close consideration of real-time operational experience, discussions with external stakeholders, data integrity checks, and expert consultancy reports. As a result, our supply forecasts take into account:

- Changes in unplanned outages rates of thermal generation over recent history.
- How generation output can reduce during extreme hot weather (generator derating).
- More site-specific assessment of the contribution of wind and solar generation at times of peak demand.
- Improved modelling of battery operations, and of how the transmission network performs in transporting energy to where it is needed. Transmission line ratings are also affected by hot weather, and transmission lines – including major interconnectors between regions – are subject to risks from unplanned outages and bushfires.

Across the NEM, current commissioning schedules indicate that approximately 2,100 MW of additional new capacity will have been added in the year to December 2018, made up primarily of wind and solar generation, as well as some battery storage.

Specifically, AEMO's planning for Victoria includes some supply changes with increased wind and solar generation capacity and two new utility-scale battery installations to be operational by summer at Ballarat (30 MW/30 MWh[4]) and Gannawarra (25 MW/50 MWh).

For context, the NEM's total registered generation capacity in July 2018 was around 56,000 MW, of which wind and solar represented around 6,000 MW[5].

While this additional capacity makes new sources of supply available, the continued change in generation mix and location of new generation also brings operational challenges related to transmission capacity and the management of frequency, voltage, and inertia in the power system. AEMO is working with participants to be ready to address these security challenges effectively throughout summer.

1.4 Power supply reliability in summer 2018-19

AEMO assesses reliability – the ability of supply to meet demand – over periods from a decade down to the next 5-minute dispatch interval, and provides information to the market to support generation capacity being available to supply consumers. Under the National Electricity Rules, AEMO also has the option of seeking additional reserves from outside the market or issuing directions if electricity supply is scarce. During times of scarcity, this is known as a reserve shortfall[6].

AEMO's 2018 ESOO forecast a risk in summer 2018-19 of the reliability standard not being met under certain operating conditions, and a potential for the loss of consumer load in Victoria. South Australia can also be impacted under these scenarios, due to the regions' level of interconnectedness[7].

The level of consumer loads forecast to be lost in Victoria in the 2018 ESOO was projected to be just within the reliability standard, at 0.0019%. The actual occurrence of load shedding could be different, and outcomes can be considerably higher than the standard with particular combinations of weather events, plant outages, or bushfires.

The 2018 ESOO reported a relatively high forecast likelihood (1-in-3 chance) of some unserved energy in Victoria this summer without further action, with most projected to occur under plausible, extreme weather conditions.

The 2018 ESOO also modelled a scenario where a level of dispatchable generation capacity was not available this summer within 24 hours recall (that is, PASA available), effectively equivalent to removing some 250 MW of generation in either South Australia or Victoria. AEMO's objective was to simulate the impact on levels of unserved energy of generation not being available due to a prolonged forced outage or for commercial reasons. The analysis found that this would increase the risk of supply interruptions in Victoria this summer, with expected unserved energy exceeding the reliability standard.

2018 ESOO modelling concluded that an additional 120 MW of reserves would be needed across Victoria and South Australia to meet the reliability standard in Victoria under these assumptions, or 525 MW if the generation was unavailable under 10% POE conditions (that is, extreme weather).

As of 19 October 2018, 240 MW of generation remains unavailable for recall within 24 hours. AEMO is therefore using the analysis from this ESOO scenario as the basis for assessing the volume of reserves required this summer. AEMO also continues to work with the owners of this generation to determine any impediments to it being able to operate during the summer period.

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[4] Battery capacity is expressed both in terms of power and energy. Power capacity is expressed in megawatts (MW), to indicate the rate at which the battery can charge and discharge. Energy capacity is expressed in megawatt hours (MWh), to indicate how much energy can be stored in the battery

[5] As reported in 31 July 2018 update on AEMO's Generation Information web page, available at http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information.

[6] AEMO is also able to utilise out of market reserves and issue directions to market participants to protect power system security.

[7] For details of modelling and forecasts, see AEMO, 2018 ESOO, at http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/NEM-Electricity-Statement-of-Opportunities.

2. Sufficient available resources

2.1 Capacity and availability of resources in the market

A key focus of planning for this summer is confirming resources are available at times they are needed, especially times of peak demand during very high summer temperatures.

Initiatives to maximise availability and reduce supply uncertainty through the summer months include:

- AEMO will continue to monitor outages advised by generators and TNSPs through MT PASA, Short Term (ST) PASA, and Pre Dispatch (PD) PASA. This includes asking operators of mothballed generation to formalise their intended availability during the summer period. If required during periods of potential low electricity reserves, AEMO may also ask request generators or TNSPs to reschedule or cancel planned outages where this does not increase any risk to future reliability of equipment or present a safety issue.
- AEMO will continue working with all generators to better understand and manage risks to availability, particularly generators more susceptible to reduction in maximum power output with increasing temperatures. AEMO has mapped this potential capacity reduction for all generation across the NEM and is addressing heightened risks with specific generators.
- Last year, AEMO implemented a new recall facility for generators which identified their recall times in hours. If necessary the 'Generator Recall Portal' will be used during summer, requiring generators to submit information via the portal to inform AEMO about recall times of outages, providing an easier identification of available resources for optimising supply during low electricity reserve periods.
- AEMO has repeated its generator risk profiling this year, using a specialised engineering consultancy to perform the task. In addition to the assessment undertaken last year, a particular focus was on new intermittent wind and solar generation added to the NEM since last summer.
- AEMO continues to work closely with TNSPs to ensure preventative maintenance, bushfire mitigation, and network upgrade plans are performed ahead of summer, plus ongoing management of planned outages to ensure a more resilient secure system.

2.2 Non-market generation and demand resources

RERT is a function conferred on AEMO under the National Electricity Rules. Under RERT, AEMO can enter into reserve contracts with resources (generation or load) not available to the market if needed to ensure reliability of supply meets the reliability standard, and to maintain power system security. RERT contracts can be entered into in advance of reserve shortfalls with short (less than a week), medium (between one week and ten weeks), and long (between ten weeks and nine months) notice periods.

The RERT process includes AEMO:

- Negotiating contracts.
- Developing, testing and implementing RERT management systems so we are operationally ready to manage RERT reserves.

- Consulting with jurisdictions (state governments in NEM regions), market participants, and other stakeholders.

In consultation with governments, AEMO has identified, and where appropriate will contract, additional reserves under the RERT mechanism for the coming summer. While resources under RERT have been identified across most NEM regions as a precautionary measure (see below), long notice RERT will only be sought in Victoria, as a result of the forecast potential for the reliability standard not to be met.

All other resources across the NEM, including additional resources to manage risk below the reliability standard in Victoria, will be short or medium notice RERT, for which reserve contracts are formed only when those resources are needed.

RERT resources for this summer

The 2018 ESOO published in August 2018, when taken together with the current MT PASA, projects reserve shortfalls in excess of the reliability standard in Victoria this summer. This analysis is based on information provided by market participants, including generation capacity currently reported by participants to be unavailable for recall within 24 hours as noted in Section 1.4 of this report.

AEMO has sought additional reserves via RERT to manage reliability and security risks identified in its modelling. Tenders were released in July 2018 and September 2018, to provide adequate time to identify, technically assess, and negotiate appropriate commercial terms with RERT providers and deliver the reserves in time for the summer period.

In addition to securing reserves to meet projected reserve shortfalls in excess of the reliability standard in Victoria for the upcoming summer, AEMO is also entering into short and medium notice panel agreements for RERT in other jurisdictions. Short and medium notice panel agreements allow AEMO to manage the risk of unserved energy due to unforeseen operational conditions (such as bushfires or the trip of multiple generation or transmission assets), without committing to reserve contracts until they are needed. Short and medium notice RERT will also be sourced in Victoria to help manage risks.

Setting RERT levels for Victoria

As noted above, AEMO's approach to securing reserves for Victoria for summer 2018-19 has two components, as we seek to address risks cost-effectively:

- Long notice reserve contracts assessed as the level needed to meet the reliability standard on current estimates.
- Short and medium notice reserves available for rapid contracting to manage unexpected risks, for which reserve contracts are not entered into ahead of summer.

Contracted reserves

To secure the 120 MW of resources assessed as the level needed to meet the reliability standard, AEMO will:

- Use reserves available from the second year of the three-year joint AEMO/Australian Renewable Energy Agency (ARENA) Demand Side Participation (DSP) trial[8]. Under this trial, 132 MW of reserves are currently available, of which 90 MW (70 MW in Victoria and 20 MW in South Australia) can support reliability in Victoria. An additional 57 MW will potentially become available this summer, including 25 MW in Victoria and South Australia.

[8] For more information, see https://www.aemo.com.au/Media-Centre/ARENA-and-AEMO-join-forces-to-pilot-demand-response-to-manage-extreme-peaks-this-summer.

- Secure 40 MW of off-market reserves using long notice RERT contracts, bringing the total to 130 MW. Based on previous experience and the nature of the resources, an additional 10 MW has been secured to cover the risk of some contracted resources not being available when required.

Reserves ready for rapid contracting

AEMO will seek to enter into a minimum of 405 MW of short and medium notice RERT panel agreements (in Victoria and South Australia) which allow AEMO to rapidly enter into reserve contracts if required to manage further unexpected risks, such as demand exceeding forecast expectations and unplanned events resulting in a reduction in generation capacity.

Because these panel agreements do not commit AEMO to a reserve contract or require upfront availability payment commitments, AEMO will be seeking up to a total of 800 MW of reserves to cover the risks associated with these more extreme scenarios. Negotiations are continuing and final amounts accessible under panel agreements will be published by AEMO in accordance with the RERT Guidelines.

AEMO's approach to procuring reserves to manage reliability shortfalls in Victoria will provide up to 930 MW (90+40+800) of reserves in total, while only committing to reserve contracts for 40 MW of reserves secured under long notice RERT.

Additional short and medium notice resources will be arranged in other jurisdictions where they are available.

AEMO will continue to review expected unserved energy up to and during summer:

- Assumed available generation capacity will be based on the latest available advice from participants, including information sourced from PASA across all time horizons and the Energy Adequacy Assessment Projection (EAAP) – see Section 2.3 below.
- If at any time this review process indicates additional reserve is required to meet the reliability standard under forecast conditions, beyond the 130 MW long notice RERT already secured, AEMO will consider seeking more reserves.
  - If there is more than 10 weeks' notice of the additional requirement, AEMO will consider running a second round of tendering for long notice RERT.
  - If there is less than 10 weeks' notice, AEMO will consider an additional round of tendering for medium notice RERT, including from RERT panel members.
  - Entering into reserve contracts with existing RERT panel members.

Comparison to RERT last summer

For summer 2017-18, 1,141 MW of RERT resources were available, and the final RERT costs were $51.99 million, covering payments for availability ($27.03 million), pre-activation ($21.56 million), and activation ($3.23 million). These costs were recovered from market customers in South Australia and Victoria. AEMO's review of last summer's operations estimated that this equated to an annual average of less than $6.00 (about 0.3% of an average household bill) per household bill[9].

The approach outlined above for summer 2018-19 has identified a similar level of resources needed to manage the identified risks, although the types of resources and cost structure differs due to the resources identified through the procurement process. This year, only 40 MW of resources are contracted under long notice RERT, with additional reserves accessible through the existing AEMO/ARENA trial, or on short and

[9] AEMO's review of operations in summer 2017-18, with annexures about two events in which RERT reserves were activated, and a summary of RERT costs in the 2017-18 financial year, are available at https://aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Summer-operations-report.

medium notice RERT panel agreements. The total cost is expected to be lower than last summer (this expectation is based on current understanding of resources made available to the market).

2.3 Availability of fuel for generation

Gas supplies for electricity generation

AEMO has engaged with gas participants and identified that there are no gas availability shortfalls for Australia's eastern and south-eastern gas markets in summer 2018-19 based on the latest producer forecasts.

More broadly, AEMO has undertaken several actions to support the availability of gas supply for gas-powered generation of electricity (GPG) this summer, including:

- Pre-summer, collaborating with gas production and pipeline businesses to coordinate maintenance of facilities. By minimising outages of gas transmission pipeline and production facilities during critical NEM periods, we aim to maximise the capacity of the gas transmission system to deliver supplies to GPG at these times.
- During summer, monitoring and engaging with pipeline operators and gas producers during periods of high NEM demand to ensure sufficient pipeline capacity and gas supply exist to meet GPG demand.
- Similarly, collaborating closely with TNSPs to improve overall visibility of their planned maintenance programs to establish a consolidated and integrated perspective and avoid issues on the electricity network where they may put at risk electricity supply critical to gas production facilities.
- Coordinating a Gas Supply Guarantee (GSG) exercise to ensure all participants understand and practice the business processes required in the event a gas supply shortfall is forecast for GPG during critical NEM demand periods.

The Australian Domestic Gas Security Mechanism (ADGSM), introduced in 2017, allows the Federal Government to limit gas exports. The ADGSM requires a predicted gas shortfall in the following calendar year and that the process is triggered before 1 October.

On 1 October 2018, LNG export producers reconfirmed their commitment to supply the domestic market with sufficient gas to meet GPG fuel requirements.

Supplies for hydro, diesel, and coal generation

AEMO is required to publish an EAAP once a year, and update it as required if there are expected issues identified. The EAAP quantifies the impact of potential energy constraints on expected levels of unserved energy in the NEM over a two-year outlook period. Essentially the EAAP assesses the fuel available for generators – such as water, coal, gas, and liquid fuels.

The underlying data for the modelling is gathered via the Generator Energy Limitation Framework (GELF) survey, whereby the generators provide specific information around potential energy constraints (fuel limitations). An example could include water available for hydro generation, or cooling water for thermal generation during drought conditions.

EAAP utilises probabilistic (Monte Carlo) risk assessment modelling techniques based on several rainfall scenarios and provides an overall viewpoint on the impact of energy constraints on unserved energy in each region. The EAAP considers a low, short-term average (10 years), and long-term average (50 years) rainfall scenario.

The latest EAAP update was published in May 2018. It concluded the following points from a summer perspective:

- Drought conditions have minimal impact on supply adequacy this summer. The risk of supply interruption is primarily driven by increased vulnerability to weather events such as extended periods of high temperature, corresponding with low wind or solar availability and unplanned generation outages.

- However, under prolonged low rainfall conditions, if sufficient cooling water for Latrobe Valley generators cannot be accessed from the drought reserve, the forecast expected unserved energy level in Victoria increases in the second year of the outlook period.
- Limitations supplied by thermal generators related to fuel supply have no impact on the level of unserved energy observed in any region. Fuel limits are generally submitted for longer periods, such as annual or quarterly limits, and provide sufficient flexibility to allow generators to have fuel available at times of tight supply-demand balance.

These will be updated with the next report release scheduled for the end of November 2018. Based on modelling to date, AEMO expects the November EAAP to report similar findings in relation to summer 2018-19.

2.4 Availability of transmission networks

Transmission capacity must be optimised so power can flow where and when it needs to, and to avoid unnecessary network limitations that could reduce power transfer capability.

The summer readiness plan focuses on the following areas.

- AEMO has worked with TNSPs to co-ordinate preparation plans for summer, and better understand and manage potential risks. This has included:
  - Confirming that preventive maintenance on critical elements of the transmission network is performed ahead of the summer period to deliver a more resilient transmission system, including bushfire mitigation works and network upgrade plans.
  - Minimising planned outages that need to be scheduled during summer, to reduced risk to the power system. AEMO and TNSPs have developed a guideline for transmission network outage planning over the 2018-19 summer period, and AEMO is working closely with TNSPs so system security and reliability are maintained.
- AEMO liaises with TNSPs on an ongoing basis so the latest changes to the network, including connection of new generation, are reflected in the limit advices and constraint equations (mathematical representation of the transmission system capacity) used to determine electricity dispatch through AEMO's market systems, so we can get the best capacity from the networks.
- AEMO continues to work with interconnector providers to optimise interconnector capacity, and will inform participants when there are material changes.
- AEMO continues to work with all network providers, including distribution networks, to optimise the system for voltage management under a range of operating conditions. This challenge, as highlighted in AEMO's summer review report from 2017-18[10], has been identified as an emerging issue, particularly under the very load demand conditions which can occur over the Christmas and New Year periods.

[10] AEMO, *Summer 2017-18 Operations Review Report*, May 2018, available at http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Summer-operations-report.

3. Operational improvements

AEMO continuously works to improve our operational forecasting models, enhance situational awareness, and increase our investment in resourcing.

3.1 Improving forecasting models

AEMO has improved our short-term forecasting with initiatives including:

- Updates to the reserve management systems, including enhancements to the Forecast Uncertainty Measure (FUM) and dynamic Lack or Reserve (LOR) system introduced in February 2018. AEMO has concluded a consultation process aiming to better assess reserve forecast uncertainty under varying system conditions. Enhanced FUM is scheduled to be operational by 30 November 2018, and already improvements in a range of areas, including AEMO's operational forecasting and generators capacity bidding, have generally seen reserve requirements reduce over a range of time horizons from dispatch out to 72 hours.
- Improvements to the number and sampling of real-time rooftop PV feeds to enhance near-time solar forecasting systems and reduce uncertainty. AEMO will incorporate these improvements by early 2019, but in time for the peak of summer, adding nearly 3,000 additional data points collected from rooftop PV systems across the NEM to the existing system.
- Improvements to existing demand forecasting systems:
  - 5-minute forecast retraining, ensuring the model estimates reflect recent changes to demand patterns and improve forecast accuracy.
  - Adjustment of the weighting of variables within demand forecasting models that manage how the models react to fluctuations in the daily demand profile. This will improve the performance of intraday forecasts, providing market participants with more stable forecasts and a higher degree of certainty.
  - Increase data feeds by the addition of 17 weather stations mapped to major population centres. This will mean data is sourced from 40 weather stations, distributed across the NEM regions. This initiative will improve the correlation of weather observations and forecasts with customer load, resulting in enhanced forecast performance.
  - Enhancements to the forecasting regression algorithms and model retraining. Enhancements include incorporating multiple neural network models designed to capture daily troughs and peaks, as well as reconfiguration of temperature modelling to improve forecast performance during temperature extremes.
- During the 2017-18 summer, AEMO identified improvements we could make to the method of using energy limited plant in determining LOR conditions in ST PASA and PD PASA, involving a more appropriate spreading of spare capacity over peak periods to more closely reflect the reality of bidding of this energy limited plant by market participants. In July 2018, we implemented the change, so the energy

limited plant will be first used to minimise LOR conditions, and the remaining energy limited plant will then be allocated proportional to regional demand in reserve reporting.

Collectively, these initiatives improve the performance of AEMO's short-term forecasting models, improving information flows and giving a higher confidence in managing reserves under a range of operating conditions.

AEMO has worked in close collaboration with weather service providers BoM and Weatherzone on initiatives to improve the quality and timeliness of weather and hazard information provided to real-time operations. These increase the situational awareness of AEMO's control room staff, ultimately contributing to an enhanced management of the broader power system. The initiatives include:

- Automation and enhancement of daily weather reporting to real-time operations and emergency management reporting, achieved by using streamlined information flows from weather forecasting service providers.
- Continued BoM presence in the Brisbane real-time operations centre, facilitating ongoing and timely support to operations staff.
- Market notices notifying market participants of any weather uncertainties which may materially impact demand forecasts.

3.2 Operator skills and training

AEMO continues to invest in a team with diversified skills, covering engineers, forecasting analysts, and data science specialists, to meet the technical challenges of a rapidly transforming industry

AEMO has continued to deliver extensive training for control room operators and operational support staff across a range of areas such as reserve management, system restart, enhancements to forecasting systems, and other situational awareness tools. AEMO has also further augmented operational rosters, facilitating the provision of additional operational support seven days a week during critical periods.

4. Contingency planning

As well as preparing for a range of operating scenarios over summer, AEMO collaborates with all governments and electricity and gas market participants to identify relevant, tailored, risk-based summer readiness scenarios for each region, develop contingency plans, and run emergency exercises.

4.1 Joint emergency exercise, August 2018

The second annual joint emergency exercise of the National Gas Emergency Response Advisory Committee (NGERAC) and National Electricity Market Emergency Management Forum (NEMEMF) was conducted in Sydney on Tuesday, 28 August 2018.

This exercise brought together more than 70 representatives, including NGERAC and NEMEMF members, Public Affairs teams from government and industry, ministerial advisors from several jurisdictions, observers, and AEMO operations staff.

The desktop scenarios were developed in stages and designed for participants to work through the responses to a multi-jurisdictional, dual-fuel (gas and electricity) emergency. The exercise was designed to explore:

- Communications processes for multi-jurisdictional events.
- Decision-making at ministerial level in the context of sharing scarce energy resources across jurisdictions.
- Interdependency with other infrastructure sectors, particularly telecommunications and liquid fuels.
- Development of processes incorporated into revised response documents, based on findings from previous exercises.

The objectives were tested effectively throughout the session and all desired outcomes were achieved.

4.2 Other emergency planning

AEMO workshops a number of state-specific desktop scenarios sessions with each state government and the jurisdictional responsible officer (the state's TNSP) to ensure alignment across both operational and communication activities.

AEMO also attended and participated in several exercises run by TNSPs to support coordinated end-to-end emergency preparedness across industry.

4.3 Seven-day readiness briefings

AEMO is again hosting weekly summer readiness outlook briefings from October 2018 to April 2019. The briefings bring together jurisdictional government representatives, TNSPs, and AEMO to help foster open communication so all relevant stakeholders are briefed and aware of forecast conditions regarding weather, supply (including fuel for generation), demand, planned and potential for unplanned outages, and broader risks (such as bushfires) for the week ahead.

5. Collaboration and communication

Given enhanced public awareness and interest in the changing energy sector, AEMO continues to collaborate closely with external stakeholders and to communicate and engage openly and transparently with NEM consumers.

Summer 2017-18 illustrated that considered planning and collaboration across governments and industry was crucial to the power system having the required resources to meet extreme peaks in demand.

Before and during last summer, AEMO communicated and engaged openly and transparently with stakeholders and the wider community. Building on the success of last summer, AEMO will continue to:

- Engage in intensive communication with the wider industry and government jurisdictions.
- Take a proactive approach to communicating with the broader community about the upcoming summer, particularly where there are apparent risks to the power system such as heatwave events or during serious bushfires which could potentially impact major energy system infrastructure.

5.1 Collaborating with industry and government

AEMO is working closely with state governments, TNSPs, and generators, through one-on-one discussions, working group meetings, and desktop exercises, to share information and progress and expand on summer preparedness activities.

5.2 Communicating with households and businesses

AEMO will continue to use our Energy Live online news portal to provide the community with information on our summer preparedness activities and how we have collaborated to prepare for extreme conditions and unforeseeable events. AEMO will also be sharing regular updates from the BoM, together with relevant information pieces, such as why there is a need for strategic reserves and tips on how consumers can stay cool while using less energy.