AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Summer 2019-20 Readiness Plan

December 2019

A report for the National Electricity Market

Important notice

PURPOSE

AEMO has prepared this document to provide information about its preparations for summer 2019-20. 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 4 November 2019.

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VERSION CONTROL

Version	Release date	Changes
1	4/12/2019	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 (SWIS). AEMO's key responsibility is to oversee the operation of the power system to ensure electricity is supplied safely, securely, and reliably to Australian homes and businesses, and that the power system operates in the long-term interests of consumers.

In summer, the power system must manage additional risk as it responds to high consumer energy demand, increasing periods 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 the heightened risks to power system operations.

AEMO's plan to address risks and deliver reliable and secure power to consumers throughout summer 2019-20 builds on the strategies and actions which helped deliver reliable, secure supply during summer 2018-19, and is structured around four pillars:

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

Heightened risks in summer

The key focus areas of risk for summer 2019-20 are:

- **Climatic conditions**, with potential impacts on both demand and supply.
  - The Bureau of Meteorology (BoM) is forecasting an increased risk of bushfires, with drier conditions, extreme temperatures, and an earlier start to the bushfire season resulting in an extended fire season. Bushfires can directly impact generators and transmission networks, and also limit the transmission network power transfer capability.
  - This summer, the BoM predicts warmer than average temperatures, with an increased risk of early season extreme heat resulting in short but sharp heatwaves in southern Australia. 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.
  - There are ongoing drought conditions in some parts of the country, particularly in New South Wales and Queensland. This increases the likelihood and severity of dust storms when very dry soil combines with high winds ahead of weather fronts. Dust particles in the air may pose issues for solar photovoltaic (PV) output and also transmission lines.

- **Peak electricity demand management**.
  - The electricity peak in each region is forecast to be similar to historical record levels, across most NEM regions. Management of concurrent peak demand across multiple NEM regions 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 in all regions than it did last year. This continues an existing observable trend, as growth in rooftop PV uptake sees consumers generating more of their own energy supply during daylight hours, before drawing on grid supply into the evening.
- **Resource availability.**
  - Extreme conditions can impact the adequacy and availability of generation and network resources when they are needed for the power system to meet demand.
  - In the 2019 Electricity Statement of Opportunities (ESOO) for the NEM, AEMO's modelling identified the risk of unserved energy for Victoria during some peak conditions this summer. AEMO has put arrangements in place for additional reserves to meet the NEM reliability standard.
  - The risk of unserved energy in Victoria is more acute if there is any delay in the planned return to service of the units of Loy Yang A (Unit 2) and Mortlake Power Station (Unit 2), which are currently on long-term outages.
  - As part of its reserve management strategy and to manage supply shortfalls, AEMO has identified additional reserves which can be made available on short or medium notice through AEMO's Reliability and Emergency Reserve Trader (RERT) panel function. The short and medium notice RERT reserve is used only if the market does not respond with enough supply or demand resources to ensure the reliability standard is met, or to manage power system security incidents.

Managing system security is AEMO's focus 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. As the power system continues its transformation, security challenges will increasingly arise at times of low, as well as high, 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 work stream include:

- Increased capacity in the market – some 3,700 megawatts (MW) of new capacity has entered the NEM since summer 2018-19. The bulk of this new capacity (some 90%) is rooftop PV and grid-scale solar generation.
- Maximising the availability of existing generation in the NEM – working with generators to minimise planned outages during summer and identify and mitigate risks that could cause unplanned outages.
- Non-market generation and demand resources – procuring long notice RERT in Victoria, not normally available to the market, to reduce the forecast reliability and security risks. Additional short and medium notice RERT reserves for Victoria and South Australia can be called on if needed to help manage risk when reserves are low or where power system incidents occur. Expressions of interest for further short and medium term RERT reserves have been sought for all regions.

- Availability of fuel for generation – AEMO coordinates with generators to identify and mitigate risks to the availability of fuel for generation (coal, gas, hydro, and diesel).
- Maximising the 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 improve its operational systems and processes, and become more adaptive so as to better manage increased uncertainty related to supply, demand, and reserve levels under varying power system conditions. Recent enhancements have included:

- Deployment of the AEMO and Australian Renewable Energy Agency (ARENA) self-forecasting joint initiative for renewable energy generation.
- Improvements to the number and sampling of real-time rooftop PV feeds to enhance near-time solar forecasting systems and reduce uncertainty.
- Enhancements to forecasting regression algorithms and model retraining to improve energy forecasting accuracy.

Close collaboration with AEMO's weather service providers, including the BoM and Weatherzone, proved valuable last summer. This year, that collaboration has delivered further improvements to the speed and quality of information about weather conditions and extreme weather hazards 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 engaged 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 November 2019 to April 2020, AEMO will host weekly briefings with governments and TNSPs regarding forecast weather, 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. This includes utilisation of digital platforms such as Energy Live, AEMO's website, and key social media sites, as well as message alignment and amplification through distribution networks service providers (DNSPs) and retailers.

Contents

1. Summer 2019-20

This section outlines the risks and challenges expected for the National Electricity Market (NEM) in summer 2019-20. 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 forecasts are now the most important input into forecasting of demand and supply of generation for the NEM.

As well as the impact of the increase in renewable resources, extreme temperatures and events including bushfires, lightning, storms, and high winds can reduce the output of all types of generation, impact transfer capacity of 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 Bureau of Meteorology (BoM) and Weatherzone so its operational planning and support is underpinned by the most accurate and up-to-date climatological forecasts.

On 24 September 2019, the BoM advised that:

- A strong positive Indian Ocean Dipole (IOD) event is underway, which is expected to remain the key climate driver through spring, before decaying in early summer as the Asian monsoon trough moves into the southern hemisphere[1].
- A negative Southern Annular Mode (SAM), potentially exacerbating the effects of the positive IOD, is forecast to push winds further north than normal[2].
- These climate drivers are increasing bushfire risk in the south-east of Australia, and increasing the risk of a warmer and drier end of the year. Much warmer than average conditions are forecast in the south-west, while drier than average conditions are forecast to persist through the south-east.
- 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:

- Below-average rainfall conditions to continue, particularly for eastern Queensland.
- Early onset of increased bushfire potential, particularly in the south-east, resulting in an extended fire season.
- Increased risk of early season extreme heat and risk of short but sharp heatwaves in the south.
- Increased chance of dust storms due to very dry soils, which, when combined with high winds ahead of fronts, can result in areas of raised dust.

[1] For the latest BoM climate outlook, see http://www.bom.gov.au/climate/outlooks/#/overview/summary.

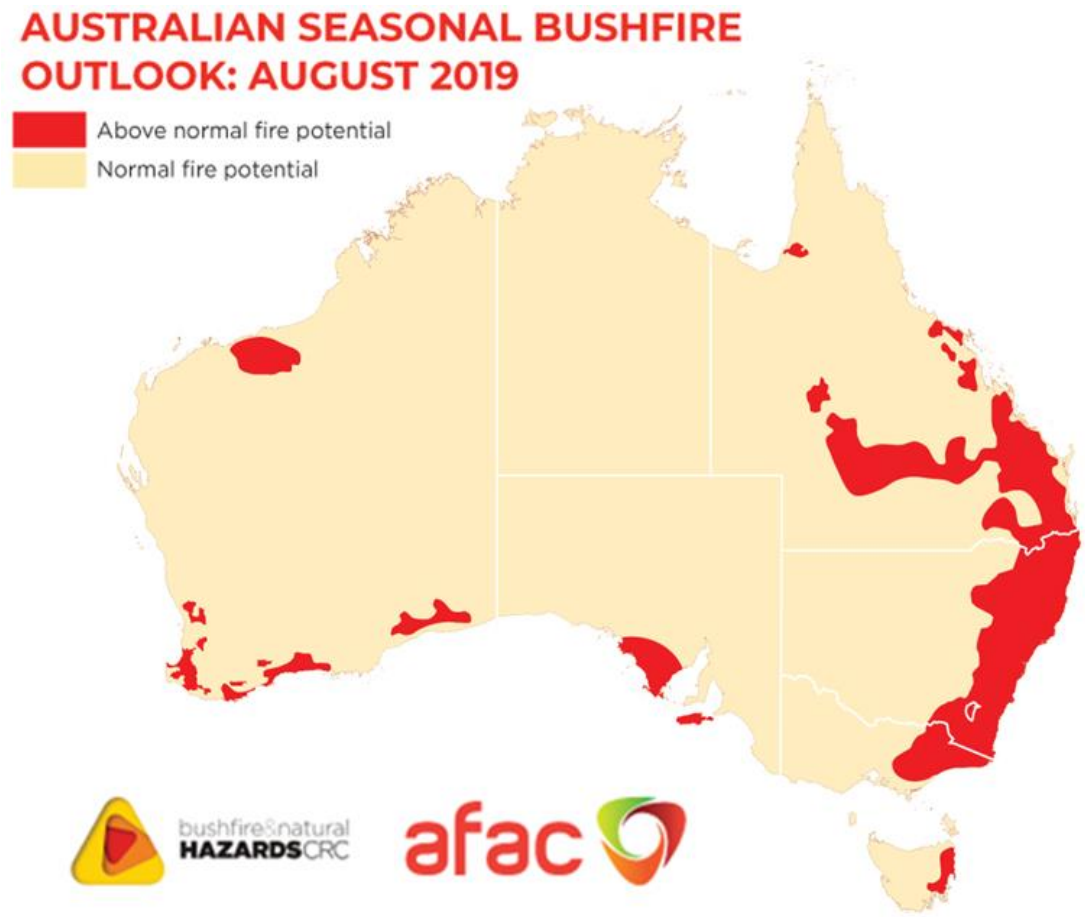
[2] BoM information videos of Australia's climate drivers, at https://www.youtube.com/playlist?list=PLbKuJrA7Vp7kx56b-zPdmdf1GLnMW8dtu.

- Reduced likelihood of widespread flooding in 2019-20; however, floods can still occur regardless.
- 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.

Figure 1 shows the Bushfire and Natural Hazard Cooperative Research Centre (CRC) seasonal bushfire outlook, illustrating above normal fire potential for most of the east coast of Australia in the lead-up to the summer months.

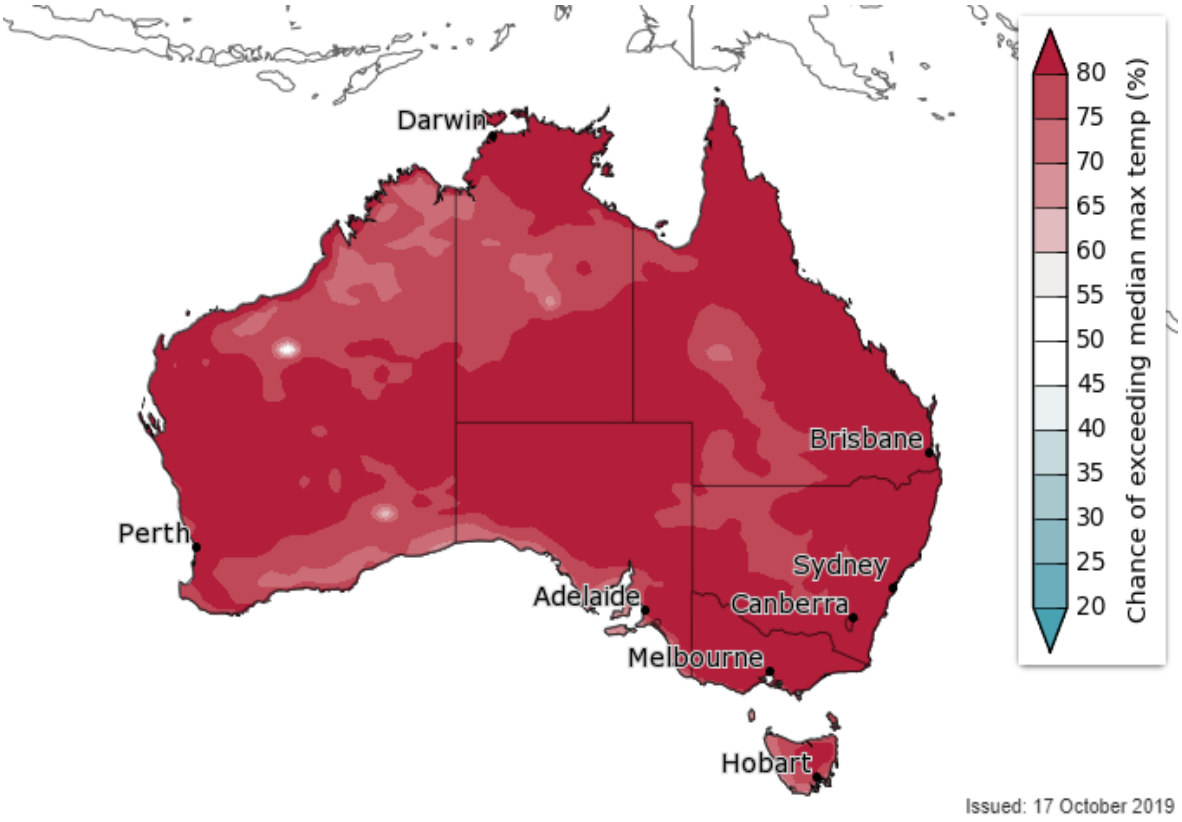
Figure 1 Australian Seasonal Bushfire Outlook: August 2019



Source: Bushfire and natural hazards CRC, https://www.bnhcrc.com.au/hazardnotes/63.

Figure 2 shows that, over December 2019 through February 2020, most of Australia, and in particular all capital cities, are forecast to have a high chance of experiencing warmer than average maximum temperatures.

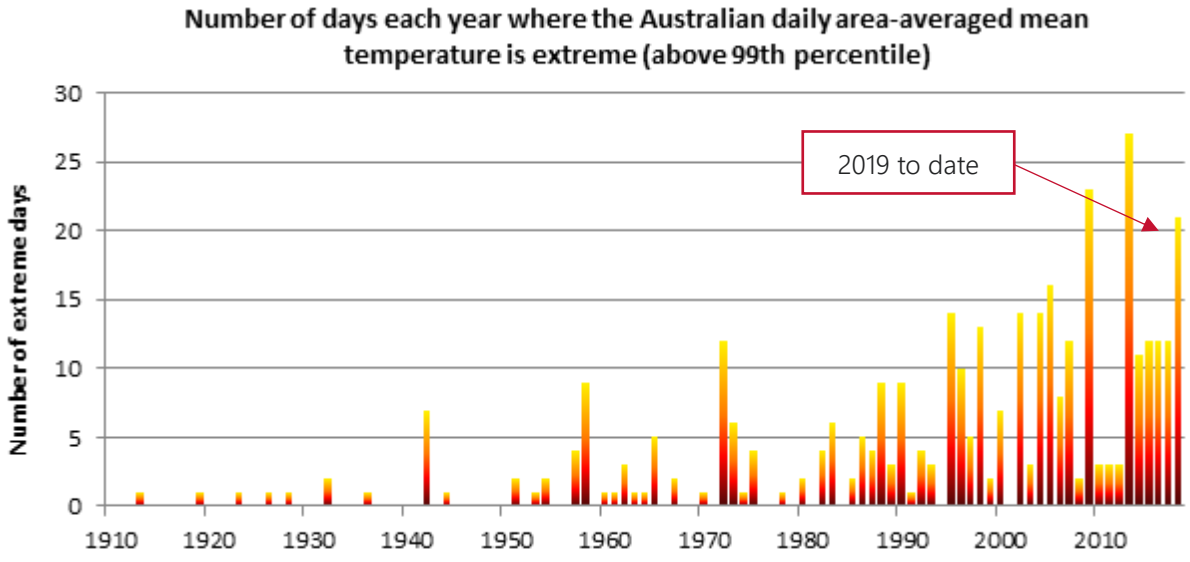
Figure 2 Chance of exceeding median maximum temperature, December 2019 to February 2020



Source: BoM climate outlooks, http://www.bom.gov.au/climate/outlooks/#/temperature/maximum/median/seasonal/1.

As Figure 3 below shows, the BoM's data indicates that 2019 to date is continuing the trend towards increasing extreme mean temperature (above 99th percentile). The BoM expects this trend to continue in the summer of 2019-20.

Figure 3 Trends in extreme temperatures in Australia



Source: BoM.

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 photovoltaic (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.

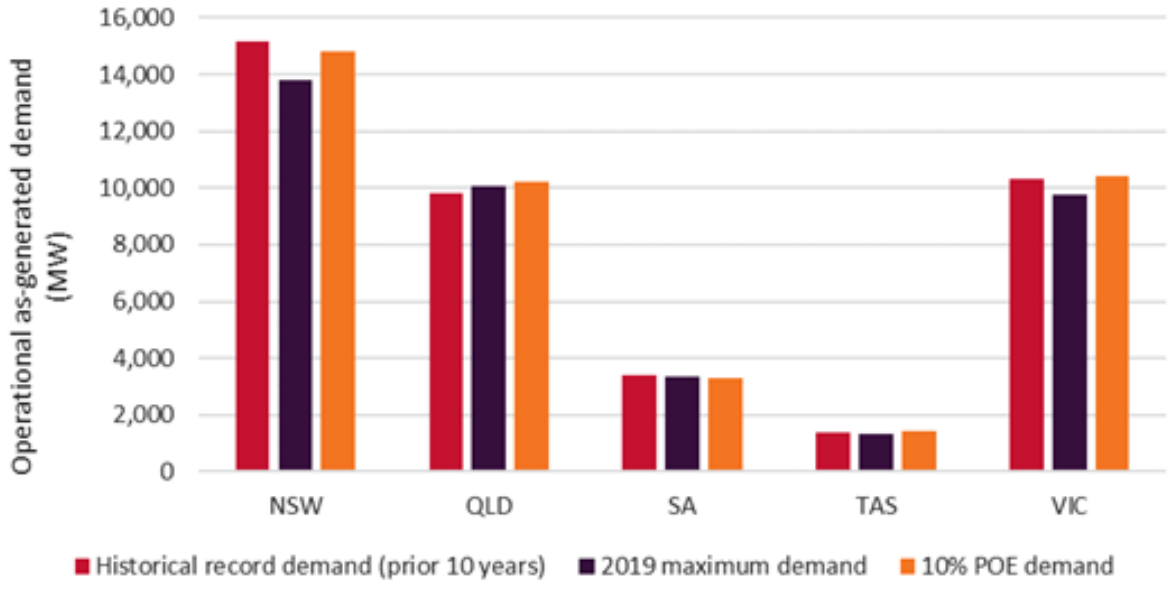
The trend of maximum demand shifting later in the day is also expected to continue, as consumers generate more of their own energy supply from rooftop PV during daylight hours, before drawing on grid supply into the evening.

Figure 4 shows the 10% probability of exceedance (POE) maximum demand forecast for this summer, compared to both the 2018-19 peak and the previous historical record, for each NEM region[3]. 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 driver for the 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). Other drivers of maximum demand include weekend/weekday as well as the coincidence of individual idiosyncratic behaviour in response to weather and other factors.
- A 10% POE demand forecast is based on the conditions AEMO would expect under very high temperatures, at major load centres (normally capital city locations) in each region, on a weekday in January or 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



[3] Figure 4 accounts for adjustments made to historical demand to reflect demand levels that would have occurred if not for the exercise of RERT resources and load shedding. Operational demand refers to the electricity supplied by scheduled, semi-scheduled, and significant non-scheduled generating units, excluding demand from scheduled loads.

1.3 Supply for summer

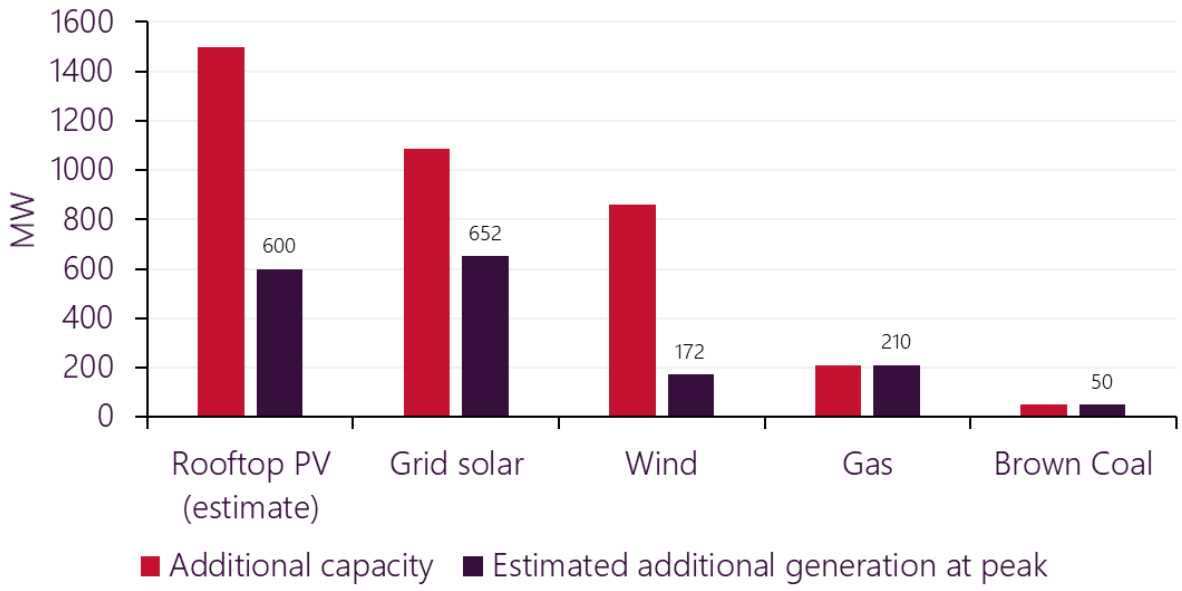
AEMO continues to improve its capability to assess key uncertainties that can impact supply reliability, including climate change and extreme weather events, the variability and diversity of intermittent generation, the reliability of thermal (coal- and gas-fired) generation, and the capability of the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

The 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, AEMO's supply forecasts take into account:

- Changes in unplanned outages rates of thermal generation over recent history.
- The possibility of a delay in the return to service of the units of Loy Yang A and Mortlake Power Station that are currently on long-term outages.
- 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 lines – including major interconnectors between regions – are subject to risks from unplanned outages and bushfires.

Figure 5 shows approximately 3,700 megawatts (MW) of new additional capacity has entered the NEM since summer 2019. The bulk of this new capacity comes from rooftop PV and grid-scale solar.

Figure 5 NEM additional new capacity since summer 2019, and estimated output during summer peak



For context, the NEM's total registered generation capacity in August 2019 was around 53,000 MW, of which wind and solar represented around 9,000 MW[4].

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 market participants to be ready to address these security challenges effectively throughout summer.

[4] As reported in the 8 August 2019 update on AEMO's Generation Information web page, at http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information.

1.4 Power supply reliability in summer 2019-20

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 directing available but unutilised generation into service if electricity supply is scarce, known as a reserve shortfall[5].

AEMO's 2019 NEM Electricity Statement of Opportunities (ESOO) projected a level of 0.0026% unserved energy in Victoria for 2019-20, in excess of the 0.002% reliability standard[6]. This projection accounted for the potential for a delay in the return to service of either one or both generating units currently on long-term outages in Victoria.

The ESOO projected unserved energy levels within the reliability standard in New South Wales and South Australia, but there remains a potential for the loss of consumer load in both regions[7]. In any region, the actual occurrence of load shedding could be higher than forecast, and potentially significantly exceed the reliability standard, given particular combinations of weather events, plant outages, or bushfires.

The 2019 ESOO modelling concluded that an additional 125 MW of reserves would be needed to meet the reliability standard in Victoria under expected conditions.

[5] AEMO is also able to utilise out of market reserves and issue directions to market participants to maintain or restore power system security.

[6] Unserved energy means energy that cannot be supplied to consumers, resulting in involuntary load shedding (loss of customer supply), as a result of insufficient levels of generation capacity, demand response, or network capability, to meet demand. 'Expected' in this case is a mathematical definition, describing the weighted-average outcome. The current reliability standard requires that expected USE within a given financial year does not exceed 0.002% in any NEM region.

[7] For details of modelling and forecasts, see AEMO, 2019 NEM 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 transmission network service providers (TNSPs) through Medium Term Projected Assessment of System Adequacy (MT PASA), Short-Term (ST) PASA, and Pre-Dispatch (PD) PASA[8]. If required during periods of potential low electricity reserves, AEMO may also ask 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 at maximum power output or with increasing temperatures. AEMO has developed an understanding of this potential capacity reduction for all generation across the NEM and is addressing heightened risks with specific generators.
- AEMO has mapped the environmental limitations of generators in the NEM to easily identify those generators which can operate at higher outputs during low reserve periods.
- AEMO has continued 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 this year 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

The Reliability and Emergency Reserve Trader (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 (currently) 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:

- Identifying the need.

[8] The MT PASA looks ahead two years and is published weekly. Every day, AEMO publishes the ST PASA, looking two to seven days ahead, and the PD PASA for the following day.

- Seeking tenders or expressions of interest in the provision of additional reserve capacity.
- Negotiating contracts with resources tendered or submitted through the procurement process.
- Developing, testing, and implementing RERT management systems, to be operationally ready to manage RERT reserves.
- Consulting with:
  - Jurisdictions (state governments in NEM regions) on the adequacy of RERT resources, and costs prior to executing any agreements; and
  - Market participants, and other stakeholders.

In consultation with governments, AEMO has identified additional reserves under the RERT mechanism for the coming summer. Short or medium notice RERT reserves have been identified across most NEM regions as a precautionary measure under AEMO's panel arrangements. Reserve contracts for those resources are only formed when it is considered likely they will be needed. Long notice RERT has only been sought in Victoria, as a result of the forecast potential for the reliability standard not to be met.

RERT resources for this summer

The 2019 ESOO projected reserve shortfalls in excess of the reliability standard in Victoria this summer.

To manage this projected shortfall in Victoria, AEMO released tenders for long notice RERT in August 2019, to provide adequate time to identify, technically assess, and negotiate appropriate commercial terms with successful RERT providers and deliver the reserves in time for the summer period.

AEMO is also entering into short and medium notice panel agreements for RERT both in Victoria and in other jurisdictions. These panel agreements allow AEMO to manage the risk of not meeting the reliability standard 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.

RERT reserves for Victoria

To secure the 125 MW of resources assessed as the level needed to meet the reliability standard in Victoria in a cost-effective manner, AEMO will:

- Use reserves available from the third year of the three-year joint AEMO/Australian Renewable Energy Agency (ARENA) demand side participation (DSP) trial. Under this trial, 149 MW of reserves are currently available, of which 64 MW can support reliability in Victoria.
- Secure 61 MW of off-market reserves using long notice RERT contracts, bringing the total to 125 MW. Based on previous experience, the nature of the resources, and RERT offer block sizes, an additional 11 MW has been secured to cover the risk of some contracted resources not being available when required (a total of 72 MW).

Reserves ready for contracting on short or medium notice

AEMO will seek to enter into additional short and medium notice RERT panel agreements which allow AEMO to more rapidly enter into reserve contracts if required.

These agreements do not commit AEMO to a reserve contract or require upfront availability payment commitments. To date, AEMO has received expressions of interest for more than total of 1,500 MW of emergency reserves across the NEM (over 1,000 MW combined for Victoria and South Australia) available to cover the risks associated with extreme system scenarios.

Negotiations are continuing, and the final amounts accessible under panel agreements will be published by AEMO in accordance with the RERT Guidelines.

AEMO will continue to assess expected unserved energy against the reliability standard 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 Generator Energy Limitation Framework survey (GELF).
- AEMO will monitor the return to service of the units of Loy Yang A (Unit 2) and Mortlake Power Station (Unit 2) that are currently on long-term outages.
- If at any time this review process indicates additional reserve is required to meet the reliability standard under forecast conditions, beyond the RERT already secured, AEMO will consider seeking more reserves, as appropriate, relative to the timing and quantity of the projected reserve shortfall.

Comparison to RERT last summer

For summer 2018-19, when AEMO had forecast a reliability standard shortfall of 120 MW in Victoria, 930 MW of RERT resources were available across Victoria and South Australia. Of that total, approximately 40 MW was available as long notice RERT, 90 MW under the AEMO/ARENA DSP trial, and the rest under short or medium notice panel agreements. Across the NEM as a whole, up to 1,150 MW of RERT reserves were available.

In 2019-20, AEMO has identified a similar level of resources needed to meet the reliability standard in Victoria. AEMO currently anticipates that the procurement approach outlined above will deliver more emergency reserves under panel arrangements than last year, with slightly more long notice RERT and similar amounts under the ARENA DSP trial arrangements.

2019-20 RERT cost estimate based on 2018-19 conditions

Last summer, on 24 and 25 January 2019, AEMO used all available RERT at a total cost of approximately $34.5 million:

- **24 January** – 366 MW of short notice reserves (contracted on the day) and 30 MW of long notice reserve (previously contracted reserve): 396 MW in total.
- **25 January** – 596 MW of short notice reserves (contracted on the day) and 29 MW of long notice reserve (previously contracted reserve): 625 MW in total.

In addition to voluntary load reductions in total on both days, 538 MW of load was left unserved and had to be disconnected in Victoria, impacting up to 200,000 consumers.

To produce an indicative cost comparison for RERT in 2019-20, AEMO has calculated the cost of using the assumed 2019-20 RERT portfolio for the same conditions that occurred on 24 and 25 January 2019. This found that the quantity of RERT required to meet all demand in the same conditions (that is, avoiding the 538 MW of load shedding that actually occurred) would cost approximately $40.4 million. After adding the forecast availability payments of $3.9 million under long notice RERT contracts for 2019-20, this would result in a total RERT cost of around $44 million for the period 1 November 2019 to 31 March 2020.

2.3 Availability of fuel for generation

Gas supplies for electricity generation

AEMO continues to engage with gas participants via direct discussions and AEMO's annual gas maintenance coordination forum. These mechanisms have not identified any gas availability shortfalls for Australia's eastern and south-eastern gas markets in summer 2019-20 based on the latest producer forecasts.

AEMO will continue to collaborate with gas production and pipeline businesses to coordinate maintenance of facilities. Through the minimisation of gas transmission pipeline and production facility outages during critical NEM periods, AEMO aims to maximise the capacity of the gas transmission system to supply gas for gas-powered generation of electricity (GPG) when it is required.

AEMO will also collaborate 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.

Supplies for hydro, diesel, and coal generation

AEMO has been working with generation participants to identify whether there are any existing or anticipated key fuel supply risks to their operations. In addition to direct dialogue with and assurances from with generators, AEMO uses the GELF survey, in which generators provide specific information around potential energy constraints (fuel limitations). This could include, for example, water available for hydro generation, or cooling water for thermal generation during drought conditions. To date:

- Drought conditions are projected to have minimal impact on supply adequacy this summer. The risk of supply interruption is primarily driven by increased vulnerability to climatic events such as extended periods of high temperature, corresponding with low wind or solar availability and unplanned generation outages.
- Limitations supplied by thermal generators related to fuel supply have no projected impact on the level of unserved energy in any region. Fuel limits are generally submitted for longer periods, such as annual or quarterly limits, and provide enough flexibility to allow generators to have fuel available at times of tight supply-demand balance.

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 continues to work with TNSPs to co-ordinate preparation plans for summer, and better understand and manage potential risks. This has included:
  - Confirming 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.
  - Maximising transmission availability during periods when it is required. This means minimising planned outages during periods of extreme conditions, to reduced risk to the power system.
- 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, to get the best capacity from the networks.
- AEMO has continued to work with TNSPs and interconnector providers to optimise and increase interconnector capacity.

3. Operational improvements

AEMO continuously works to improve its operational forecasting models, enhance situational awareness, and increase its investment in the skills of AEMO's team.

3.1 Improving forecasting

AEMO has improved short-term forecasting with initiatives including:

- Successful deployment of the AEMO and ARENA self-forecasting joint initiative for renewable energy generation. Grid-scale renewable energy generators can now submit forecasts to AEMO for use in dispatch. The first self-forecasts were used in dispatch in September 2019, and registrations for self-forecasting are increasing rapidly.
- Improvements to the number and sampling of real-time rooftop PV feeds to enhance near-time solar forecasting systems and reduce uncertainty. Full implementation of these improvements was completed in 2019, by adding nearly 3,000 additional data points collected from rooftop PV systems across the NEM to the existing system, improving accuracy and reliability.
- Release of an operational data specification for AEMO's Virtual Power Plant (VPP) Demonstrations project[9]. The specification sets out standards for provision of forecast and actual performance data for embedded and distributed resources. The first VPPs are currently working with AEMO to implement the system required to provide real-time and forecast information to AEMO.
- Release of a temperature forecast accuracy investigation, focusing on aspects of operational weather forecasting critical to demand forecasting during peak summer events. The results are being explored in collaboration with the meteorological industry to investigate potential methods for the improvement of temperature and weather forecasts that are critical to energy forecasting.
- Improvements to existing demand forecasting systems:
  - Enhancements to the electricity forecasting regression algorithms and model retraining. Enhancements include incorporating multiple neural network models designed to capture daily demand troughs and peaks, as well as reconfiguration of the modelling of smaller electricity demand areas such as major industrial loads to optimize operability of the models.
  - Continuous development and improvement of electricity demand forecasting models.
  - Further development of machine learning techniques to build an ensemble-based approach to operational load forecasting. AEMO now uses a suite of demand forecast models to deliver a spread of forecasts which provide performance benchmarking and an understanding of forecast variance. This assists greatly in quantifying operational risk, particularly on extreme days.

[9] For more on the VPP Demonstrations, see https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/DER-program/Pilots-and-Trials.

- Commissioning of a live electricity forecast model performance assessment dashboard. The dashboard facilitates rapid, real-time assessment of model performance and forecast error attribution, to increase process transparency and support real-time operational decisions and risk assessment.
- Enhanced modelling and automation techniques for the rapid update of the forecasts for demand under load-reduction scenarios, such as during RERT and load-shedding events.

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

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

- Automation and enhancement of real-time monitoring through development of a 1-minute weather data dashboard, allowing for rapid update of situational awareness to facilitate informed and rapid decision-making.
- Continued BoM presence in AEMO's real-time operations centre, facilitating ongoing and timely support to operations staff.

3.2 Operator skills and training

AEMO continues to invest in a team with diversified skills, including 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.

As a result of the BoM's forecast severe weather conditions for this summer and a higher risk of bushfires, NEM real-time operations summer readiness training will have a significant focus on bushfire risk management. This has included a review of key bushfire risk management processes, conducted in collaboration with TNSPs through the quarterly Power Systems Security Working Group (PSSWG).

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, October 2019

The annual joint emergency exercise of the National Gas Emergency Response Advisory Committee (NGERAC) and National Electricity Market Emergency Management Forum (NEMEMF) was conducted on 17-18 October 2019 in Hobart.

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 Summer Readiness Jurisdictional Sessions

AEMO workshopped a desktop scenario session with each jurisdiction to ensure alignment across both operational and communication activities. These sessions cover government, industry, and AEMO summer readiness activities.

The desktop scenario was on the Victorian load shedding events on 24 and 25 January 2019.

4.3 7-day readiness briefings

AEMO is again hosting weekly summer readiness outlook briefings from November 2019 to April 2020. 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 outages and the potential for unplanned outages, and broader risks such as bushfires, for the week ahead.

5. Collaboration and communication

With increasing 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 2018-19 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 jurisdictional representatives, 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. Key briefings will be initiated in the lead up to and during significant Lack of Reserve (LOR)[10] conditions across the NEM to ensure key information is exchanged. Collaboration with governments on messaging protocols which include the potential use of voluntary reductions will be paramount for the coming summer.

5.2 Communicating with households and businesses

AEMO will continue to use its digital platforms – Energy Live (https://energylive.aemo.com.au/), AEMO's website (https://aemo.com.au/), and key social media – to provide the community with information on summer preparedness activities and on how AEMO, industry, and governments 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.

[10] LOR conditions indicate the system may not have enough spare energy if something major and unexpected happened, like the loss of a generator or interconnector, and AEMO issues LOR notices to inform the market of times extra reserves may be required to avoid the need for load shedding to maintain or restore power system security. This is addressed in clause 4.8.4 of the National Electricity Rules.