18 May 2018

FROM THE OFFICE OF THE
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Mr John Pierce
Commissioner
Australian Energy Market Commission
Sydney NSW 2000

Dear Mr Pierce

Submission to the Reliability Frameworks Review Directions Paper

Thank you for the opportunity to comment on the Directions Paper to the Australian Energy Market Commission's Reliability Frameworks Review.

As the AEMC recognises in its Directions Paper, the energy sector is experiencing multiple disruptions resulting in rapid transformation, characterised principally by a changing generation mix, more active demand side and the introduction of storage technologies.

The Reliability Frameworks Review provides the opportunity to adapt market frameworks to address the issues that this transformation presents.

AEMO's submission focuses on the four areas addressed in the Directions Paper: forecasting and information provision, day-ahead markets, strategic reserve and demand response.

AEMO looks forward to engaging with you further during the course of this review. If you would like to discuss the contents of this submission further, please do not hesitate to contact Antara Mascarenhas at antara.mascarenhas@aemo.com.au or 03 9609 8485 or Brett Hausler at brett.hausler@aemo.com.au or 03 9609 8707.

Yours sincerely

Audrey Zibelman
Managing Director and Chief Executive Officer

Attachments:

- AEMO Submission to the Reliability Frameworks Review Directions Paper.
- ARENA/AEMO joint Submission to the Reliability Frameworks Review Directions Paper to the Reliability Frameworks Review Directions Paper.

Submission to the Reliability Frameworks Review Directions Paper

May 2018

Introduction

AEMO welcomes the opportunity to comment on the Australian Energy Market Commission (AEMC) Reliability Frameworks Review Directions Paper. The Directions Paper sets out the AEMC's initial views on forecasting and information provision and three Finkel Panel recommendations:

- Facilitation of demand response in the wholesale market,
- The suitability of day-ahead markets, and
- The need for a strategic reserve.

As the AEMC recognises in its Directions Paper, the energy sector is experiencing multiple disruptions that are resulting in rapid transformation, characterised principally by a changing generation mix, more active demand side and the introduction of storage technologies. The previously centralised system, supported by synchronous generation, is shifting to one characterised by greater volumes of variable energy sources, decentralised demand based resources, storage technologies, new business models for delivering value to consumers, and increased requirements for resiliency throughout the system to address climate changes.

The changes in the power system provide associated benefit potential to consumers, provided that we also introduce market and regulatory changes that support requisite changes in the operations of the power system. As the AEMC notes, due to the increased variability and lack of predictability of both supply and demand, AEMO has found it increasingly necessary to both impose constraints on generation and use our directions power to maintain system security and a reliable operating state.

AEMO described the operating challenges in our earlier filings and separate reports, including in *AEMO Observations: Operational and market challenges to reliability and security in the NEM* (March 2018)[1].

We have also noted international initiatives by power system operators and regulators to reform the markets to support investment and operation of resources that result in more flexible, faster and multi-directional integrated power system. The International Energy Agency refers to such trends and initiatives in its *Insights Series 2018: System Integration of Renewables*[2].

For the NEM, this means the development of markets that support:

- Investment in and availability of dispatchable and flexible resources on the system.
- Integration of demand-based resources in the markets.
- The development of strategic reserves to ensure supply reliability during rare but potential system events.
- The investment in transmission necessary to support a more economic and resilient system.

While AEMO welcomes the AEMC's consideration of market changes to improve the availability of such resources in the Directions Paper, AEMO takes this opportunity to reinforce the view, expressed in our observations report, that reliability and system security are interconnected. Improvements to market and regulatory frameworks to support enhanced reliability and security should be considered through one comprehensive and coordinated work program to help ensure the optimal required investments in the market are made at the lowest overall cost to consumers.

The remainder of this submission focuses on the four areas addressed in the Directions Paper:

1. Forecasting and information provision.
2. Day-ahead markets.
3. Strategic reserve.
4. Demand response.

[1] Available at http://www.aemo.com.au/Media-Centre/AEMO-observations---operational-and-market-challenges.

[2] Available at https://www.iea.org/publications/insights/insightpublications/system-integration-of-renewables.html.

1. Forecasting and information provision

AEMO performs short-term, medium-term, and long-term forecasting to inform market participants and support AEMO's decision-making. In its Directions Paper, the AEMC has analysed the accuracy of demand forecasts produced for the medium-term projected assessment of system adequacy (MT PASA), short-term PASA (ST PASA), and 30-minute pre-dispatch forecast. This section responds to the AEMC's initial views on forecasting and information provision in its Directions Paper.

1.1 AEMO's short-term forecasts

Operational forecasting is used to make certain that resources are available to meet demand in the operational time frame, that is, the forecasting time period ranging from five minutes to seven days ahead of real time.

AEMO's short-term forecasting role also includes critical situational awareness for the control room – for example, about severe weather or ramping events, which are a key input into managing security and reliability in the NEM.

The AEMC's analysis of short-term forecasts indicates that the variance between forecast and actual, over a range of forecasts and time horizons, has not deteriorated over time.

1.1.1 Short-term forecasting in an uncertain environment

AEMO agrees with the AEMC's view that increased variability and uncertainty on both the supply side and demand side, a tighter supply-demand balance, and increased climatic variability, place greater emphasis on forecasting and the understanding and quantification of uncertainty. Short-term forecasting is also likely to become increasingly challenging as a result of these market and weather dynamics.

To meet these challenges, in addition to continuous improvement of our existing models, AEMO is undertaking initiatives to refine our short term-forecasting approach as follows:

- A move toward risk-based and probabilistic forecasting. An example is the recent introduction of the forecasting uncertainty measure (FUM) to augment existing lack of reserve (LOR) notifications. This employs a Bayesian belief network to enable AEMO to quantify future forecasting uncertainty while improving operational decision-making in the control room.
- Use of data science techniques and machine learning to enhance forecasts. Existing regression-based modelling techniques struggle with extreme weather events and high levels of variability. AEMO is developing machine learning models that provide enhanced performance, particularly in extreme events, and engaging the CSIRO to enhance the development of these models.
- Significant improvements in weather forecasting and now-casting (accessing real time observations) to improve inputs into forecasting models. AEMO is partnering with the Bureau of Meteorology (BoM), CSIRO, and other weather providers to increase the number of weather stations and the frequency of observations of forecasts and establish a now-casting network. These initiatives will improve the performance of weather forecasts and provide greatly enhanced situational awareness.
- Using multiple service providers for forecasts of weather, demand, and generation. This approach aligns with recent developments in meteorology, which is moving towards the use of consensus forecasting to improve the central forecast and quantify risk boundaries.
- The introduction of new interfaces enabling wind and solar generators to submit self-forecasts and the operators of Virtual Power Plants to submit their forecasts of orchestrated demand response.

- A multi-year program to implement the re-architecture of the AEMO IT platform to facilitate new forecasting approaches. The new approaches require the use of multiple vendors/service providers and the requirements of data science techniques for readily-accessible data.
- Investigation of transmission connection point forecasting (bottom-up forecasting). Currently we forecast at transmission level for each jurisdictional region. We will investigate the creation of forecasts for each transmission point. This will enable us to more clearly understand the impact of distributed energy resources (DER) on energy flows in the transmission and sub-transmission network.

1.1.2 The benefit of these initiatives

The impact of these initiatives in aggregate will improve the inputs to our near-term forecasts, particularly intra-day. By adopting a philosophy of 'more observations more often' – particularly with respect to weather – we will improve our situational awareness and access more information on which to base our forecasts. This is particularly important for machine learning approaches that assimilate big data to enhance forecast performance.

In addition to increasing our visibility of weather related inputs we are also seeking to improve our awareness of other key variables such as intermittent renewables, DER (VPPs) and large loads – again with a focus on near real time and intra-day time horizons. As variability and uncertainty in the NEM escalates due to the ever-increasing impact of weather on supply and demand, together with rapid changes in customer behaviour we will continue to augment our visibility of the drivers of unpredictability in supply and demand.

The most important theme, however, in our strategy for enhanced operational forecasting is to embrace uncertainty; to understand it and to manage it. The fundamental nature of weather and human behaviour is unpredictable and chaotic and is having an increasing impact on our markets and forecasts. On this context, we have a continuing driver to improve our forecasts and understand, qualify, quantify its impact and consequent risks.

1.2 AEMO's medium-term forecasts

The MT PASA is a planning tool that is the principal means of forecasting electricity system security and reliability over a two-year period. Through regular assessment of any projected failure to meet the reliability standard, the MT PASA assesses the adequacy of expected electricity supply to meet demand across the upcoming two-year horizon.

As a key indicator of supply adequacy, the MT PASA is designed to inform generators and TNSPs when planned outages should be scheduled or rescheduled, so that the market can deliver the resources required to meet the potential peak demand on every day of the year. It also looks to inform participants making investment and operational decisions.

The supply adequacy assessment in the MT PASA process tests the ability of the available generation (submitted by market participants) with the available transmission capacity (advised by TNSPs) to meet the potential peak demand on each day. To meet this objective, the demand trace used in the MT PASA should be seen as an upper bound, or the extreme peak that could occur on that day rather than a forecast of likely demand.

AEMO agrees that there needs to be greater transparency in forecasting and, in the case of the MT PASA, a clearer understanding of the nature and intent of the process and the demand 'forecast' used in it.

As the AEMC notes in its Directions Paper, some stakeholders have raised concerns about the accuracy of centralised forecasting in the NEM and its potential impact on reliability. In response, the AEMC has analysed the differences between forecast and actual demand produced for the MT PASA and ST PASA (as well as 30-minute dispatch).

The AEMC analysis of MT PASA indicates that forecast demand has consistently been higher than actual demand across all NEM regions over the past six years. The AEMC's conclusion is incorrect as it is based on a misunderstanding about the forecast definition used in the MT PASA assessment. The analysis also does not take into account the changes to MT PASA that came into effect in May 2018.

This section addresses the following points:

- The AEMC's analysis of MT PASA forecasts.
- The new MT PASA approach.

- Improvements to our forecasting approach.
- Enhancing transparency of forecasts.
- The need for enhanced DER data.
- Retailers submitting load forecasts.

1.1.1. Daily vs Annual 10% Probability of Exceedance forecasts

The AEMC's analysis is based on the assumption that POE10 daily forecasts published under clause 3.7.2(f)(1) to (3) of the Rules forecast is a *daily* POE10 forecast, which means that each day there is a 10% probability that the forecast value would be exceeded by the observed actuals for the day[3]. The analysis shows this is not the case and accordingly concludes that forecast values are too high.

The MT PASA approach is in fact based around an *annual* POE10 forecast, which has been profiled to daily values[4] seeking to maintain its characteristics as an annual extreme forecast. This is done to guide industry about the risk of unserved energy at time of extreme demand:

- Under this approach, taking generating plant out in a particular month would still ensure that peak demand could be met in nine out of ten years if measured against the POE10 forecast (and every second year if measured against the POE50 forecast).
- By contrast, using a daily POE10 measure as assumed by the AEMC, if a participant intended to take a unit offline for a month there would be three days in this period in which supply interruptions may occur, which would significantly exceed public expectations about reliability.

The box below shows the difference between the different forecast definitions.

[3] Similarly, a daily POE50 forecast will be exceeded with a 50% probability by the actual observed maximum daily demand.

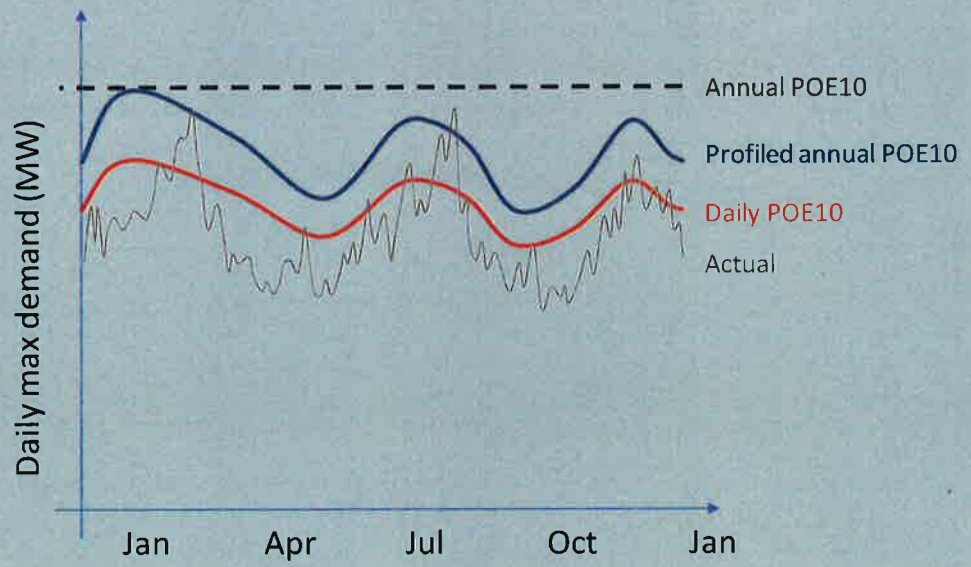
[4] This profiling is based on historical relationships between annual peak demand, and daily peaks based on seasonal weather variations and day of week patterns.

Demand definitions

The relationship between *daily* POE10, *annual* POE10, and profiled *annual* POE10 is illustrated conceptually in Figure 1 below. This figure shows that:

- The *daily* POE10 is always lower than the *annual* POE10.
- The hypothetical actual values (grey line) will regularly exceed a daily POE10 forecast (red line), and only occasionally exceed a profiled *annual* POE10 (blue line).
- There is only 10% chance that any of the 365 daily values would exceed the *annual* POE10 forecast (dotted line).

1. Figure 1: Conceptual relationship between different demand definitions



The AEMC has in their analysis been comparing actual historical values (grey line) against assumed daily POE (red), rather than the correct profiled annual POE (blue) and therefore draws an invalid conclusion.

AEMO points out that the accuracy of the annual POE, which are sourced from the ESOO process, is assessed annually by AEMO in its reporting to the Reliability Panel.

1.1.2. A new approach to assessing MT PASA

In 2016 AEMO identified the need to move from the deterministic approach used in MT PASA, which was introduced at market-start and was heavily based on assumptions around daily demand shape and not designed for an electricity system containing large amounts of intermittent generation sources. Following input from stakeholders, the new approach to MT PASA commenced on 10 May 2018. This new approach aims to provide more accurate forecasts of supply adequacy through the use of new technology and a probabilistic forecasting methodology.

New technology provides the computational power to run a full and more precise probabilistic analysis each week, better capturing the contribution of intermittent generation (on a half-hourly basis) to meet demand.

In technical terms, the new MT PASA process calculates reliability indices using a representative range of POE10 and POE50 half-hourly demand traces. These demand traces are based on historical observations (currently for eight different reference years) that are scaled to ensure the maximum demand matches either the annual POE10 or the POE50 forecasts. Matching half-hourly profiles for solar and wind generation are used to ensure historical correlation of weather driven demand and generation is retained.

This is consistent with what is used in ESOO modelling, and allows a true probabilistic assessment on unserved energy to be calculated rather than approximated deterministically in the old system.

The AEMC's analysis of MT PASA forecast accuracy is not relevant to the new MT PASA system.

1.1.3. Further improvements

The AEMC's analysis also showed no obvious minimising of the differences between forecasts and actuals as the time period approaches real time. AEMO agrees with this and it is an issue that AEMO is keen to address.

Currently, the same methodology and input assumptions are applied to forecasting MT PASA demand for the entire two-year period. However, if some of the input uncertainties that drive the probabilistic annual peak demand forecasts can be projected with greater certainty as the time period approaches real time, AEMO is keen to adjust demand probabilities accordingly.

Given increased challenges, AEMO is committed to improving the quality of forecasts. One of the main input uncertainties relates to weather forecasts. Forecasting weather weeks ahead is challenging, and AEMO is working closely with the BoM to better understand weekly and seasonal weather forecasts in the year ahead.

AEMO will continue to engage openly with industry subject matter experts each month through the Forecasting Reference Group to explore this and other forecasting initiatives aimed at continually improving the forecasting process. Four areas of immediate focus are:

- Incorporating improvements in modelling consumer demand under heatwaves and accounting for extreme temperature events in the demand forecast, based on recent collaboration with climate science experts.
- Using improved methodologies to estimate the impact of new battery charging and discharging profiles on peak demand.
- Improving understanding of what is happening behind the grid by studying historical detailed meter data to observe consumption patterns, down to individual consumer segments.
- Developing the scope for a new Forecast Monitoring System, which will monitor forecast performance regularly across a year and will cover metrics for both annual consumption and maximum demand, noting that maximum demand is a probabilistic forecast. To the extent possible, this will include some level of back casting to allow any implicit assumption biases to be detected and corrected.

1.1.4. Enhancing transparency of forecasts

AEMO agrees with the AEMC on the need for increased transparency and is committed to working collaboratively with the AEMC and market participants to improve the transparency of our forecasts.

AEMO already compares actual maximum demand (MD) to POE forecasts to qualitatively assess if such forecasts are reasonable, as part of our continuous internal checks and quality control, as well as to meet requirements to provide annual forecast accuracy information for consideration to the AEMC Reliability Panel.

AEMO is also examining the potential to identify some leading indicators that will inform the market of changes of trends in key dependent variables. Rather than an independent agency reviewing our forecasts, AEMO sees greater value in continuing efforts to improve our forecasts dynamically through ongoing stakeholder engagement.

As the confusion regarding MT PASA analysis reveals, forecasting is a complex issue that is becoming increasingly more complex. As an independent body that relies on forecasts as a key input to our operational functions, AEMO is naturally incentivised to produce accurate forecasts, as well as being required to report on forecast accuracy.

We would welcome further discussion with the AEMC and market participants to further enhance our processes through new technologies such as machine learning. AEMO is already taking steps to improve our forecasts and stakeholder engagement as follows:

- A new Short-Term Forecasting Reference Group, through which we will seek input and feedback on an operational forecasting strategy and specific initiatives to improve our short-term forecasting techniques.
- The existing Forecasting Reference Group, which comprises industry subject matter experts, government officials, and representatives from the AEMC and Australian Energy Regulator (AER). We will continue working with this group to provide transparency on medium-term forecasting, continuous analysis and improvement, and updated approaches based on information and reviews. AEMO is also

examining a range of alternative indicators that will inform the market of changes or trends on key dependent variables.

- AEMO will increase reporting in the next cycle (commencing with the publication of the 2018 ESOO) and will consult with stakeholders on preferred metrics.
- We are also working with external experts to address the issue of reporting forecast accuracy where we are dealing with probabilistic (POE) forecasts. We will still be reporting the POE10 forecasts because it is a Rules obligation while engaging more extensively to share understanding of forecasting processes.

1.1.5. The need for improved DER information

Data on DER is a key input into accurate forecasts. DER are already an important component of the power system, with forecast continued growth in this area.

AEMO acknowledges existing work in this area, including consideration of a DER Register, and is engaging in further work to increase the dynamic visibility, availability and use of DER for AEMO, aggregators, and Distribution System Operators (DSO) as an input to forecasting, reliability, and security of the system.

AEMO and the AEMC are working jointly on a broader DER program.

1.1.6. Retailers submitting forecasts to AEMO

The AEMC seeks views on retailers submitting load forecasts to AEMO.

AEMO sees this approach as unlikely to lead to more accurate forecasts, for the following reasons:

- Forecasting capability varies significantly among retailers, and aggregating results across submissions has proven to be a suboptimal approach in the past.
- Dedicated AEMO forecasting began in 2012. Before 2012, forecasts were based on an aggregate of forecasts from transmission network service providers (TNSPs), and were shown to derive unrealistic future demand profiles (see Figure 3.3 of the Directions Paper).
- Retailers are subject to commercial incentives, which may bias the provision of accurate forecasts of maximum demand at each half-hour.
- Regardless of whether retailers submit load forecasts to AEMO, AEMO requires the ability to adjust the outputs when required as an input to operate the system so it remains in a secure state on a real time basis.

2. Demand response

AEMO is supportive of comprehensive initiatives to facilitate more demand side in the wholesale markets. Demand response can play a much greater role than at present, especially in the context of technological advancements and the need for flexible and dispatchable resources.

While the AEMC refers (in 5.1.2 of the Directions Paper) to a range of different types of demand response, including wholesale, emergency network, and ancillary services, the Directions Paper focuses solely on wholesale demand response. From a reliability perspective, and to maximise the benefits of demand response, AEMO would support broader consideration of demand response.

The two options (Option 1 and 2) put forward by the AEMC in the Directions Paper can both play a role in encouraging more flexible price response loads to participate in the NEM:

- Option 1 (Baseline Demand Response Mechanism) will give customers and their agents a greater ability to access pool prices in the same way generation does today.
- Option 2 (Multiple trading relationships or metered method) will allow flexible DER such as storage to access the market as generation or load. It also provides customer choice to engage with multiple parties for various service offerings.

To inform and shape the nature of emerging changes, AEMO supports testing or trialling of these and other approaches.

In 2017, AEMO and the Australian Renewable Energy Agency (ARENA) carried out a demand response RERT trial and are currently scoping a joint work program to build on the 2017 trial. The program will aim to undertake a series of further trials to evaluate and test a range of demand response models. These models will include Options 1 and 2 outlined in the Directions Paper, as well as the role of third-party aggregators in helping to procure and operate demand response assets and customers.

AEMO and ARENA have prepared a joint submission to the Directions Paper at Attachment 1, which provides more detail on this program. AEMO also looks forward to working further with the AEMC on demand response, and on related matters through a joint DER program. AEMO also notes that the Energy Security Board (ESB) is also considering these issues and looks forward to furthering relevant initiatives through this channel.

3. Day-ahead markets

AEMO welcomes the AEMC's discussion and investigation of ahead features in the NEM as part of this review. In its Directions Paper, the AEMC seeks stakeholder views on the ahead features of the NEM that may require change through targeted improvements of existing arrangements or a centrally facilitated ahead market design.

3.1 Directions

As AEMO described in our observations report[5], the changing resource mix and increasing unpredictability of resources in the system mean AEMO must increasingly impose constraints on generation and use our directions powers to maintain system security and a reliable operating state.

With increased intermittency in generation resources (such as wind) and lack of economic incentives for thermal generators, AEMO has consistently been directing units (such as synchronous units) to offer services other than energy and frequency control during the last 12 months. Since April 2017, AEMO has exercised its powers of direction on 20 occasions in South Australia – 10 of these directions have been in this calendar year alone. The single longest continuous direction took place over 216 hours during April 2018.

Through these directions AEMO is, in effect, running an ahead commitment process to make these services available but without the efficiency and price certainty of a market. With the energy spot price alone not enough to incentivise the right type of unit commitment, AEMO expects the need for services other than frequency control to continue into the foreseeable future.

3.2 Market design implications

Timely reform to market frameworks is needed to avoid continued directions. AEMO's observations report noted that ahead features can support optimisation of resource commitment ahead of real time to ensure availability of the resources required to meet demand and provide adequate operating reserves.

[5] Available at http://www.aemo.com.au/Media-Centre/AEMO-observations---operational-and-market-challenges.

AEMO agrees with the AEMC's view that ahead markets can provide better quality information as an input into unit commitment and demand response decisions and bids/offers, increasing the efficiency of outcomes in the NEM wholesale market, including reliability and security outcomes.

The continuous directions in South Australia are not optimal for the market or consumers, and AEMO sees this review as an opportunity to introduce market changes to address these issues. As the AEMC notes in its Directions Paper, AEMO has an evolving work program on current issues and potential market improvements. We look forward to sharing our insights on current and emerging challenges in the near future and working jointly with the AEMC and ESB to identify a path forward.

3.3 A short-term forward market

Objective 1 of the Directions Paper day-ahead section includes introduction of a market improvement in the form of a Short-term Forward Market (STFM). While an STFM would not solve the issues associated with a lack of available system services in real time, it could provide complementary value by providing greater certainty around contracting for dispatchable generation while providing participants price certainty ahead of dispatch.

A liquid STFM would also provide AEMO with additional insight into forward positions to inform market operation and dispatch. Currently, our visibility of generator contracted positions is limited to ST PASA and pre-dispatch. Additionally, gas-fired generators would have additional avenues to lock in their contract positions in the NEM ahead of real time – in turn supporting their flexibility to procure gas more efficiently, leading to better security and reliability outcomes in real time.

AEMO is supportive of further initiatives to incentivise demand response in the market. As we noted in our observations report, demand-based resources can benefit from a market design that supports earlier commitment. An STFM would enable demand response to pre-commit ahead of time with added price certainty, providing a further avenue for increasing the utilisation of demand response in the NEM.

4. Strategic reserve

4.1 RERT rule changes

AEMO has publicly advocated for an enhanced reserve mechanism to enable AEMO to manage the system through shortfalls, including through two rule change proposals aimed at providing a stronger backstop – Reinstatement of Long Notice RERT and Enhanced RERT.

AEMO supports the AEMC's recommendation to consider implementation of a strategic reserve through these two rule changes, the first of which has been recently initiated.

4.2 An operational reliability standard

Related to a strategic reserve, AEMO's preference is to adopt an operational reliability standard to support better management of risk in real time. As mentioned in our observations report[6], AEMO actively advocates for the introduction of an operational reliability standard to determine the quantity of operating reserves that should be procured. The volume procured needs to reflect the expected risks and variability in each region and time period.

AEMO's recent analysis, based on historical observations, points to the chance that significant involuntary load shedding could occur during severe but plausible supply and demand conditions, potentially with economically efficient reserve options (such as voluntary load shedding/demand response) if AEMO were not to use its existing intervention powers. AEMO has previously stated that it does not consider load shedding, even within the USE allowed for under the standard, as a publicly acceptable outcome.

[6] Available at http://www.aemo.com.au/Media-Centre/AEMO-observations---operational-and-market-challenges.

AEMO is undertaking further work to assess international precedents for how reliability standards are applied operationally, and how approaches to setting reliability standards are evolving as the generation mix and energy market evolves. AEMO looks forward to working with the AEMC and Reliability Panel to explore these issues further.