Forecast Accuracy Report (FAR) Methodology

Forecast Reference Group April 29

Agenda

For presentation, questions and discussion to support formal written consultation:

Forecast accuracy report methodology

Submissions should be sent by email to energy.forecasting@aemo.com.au.

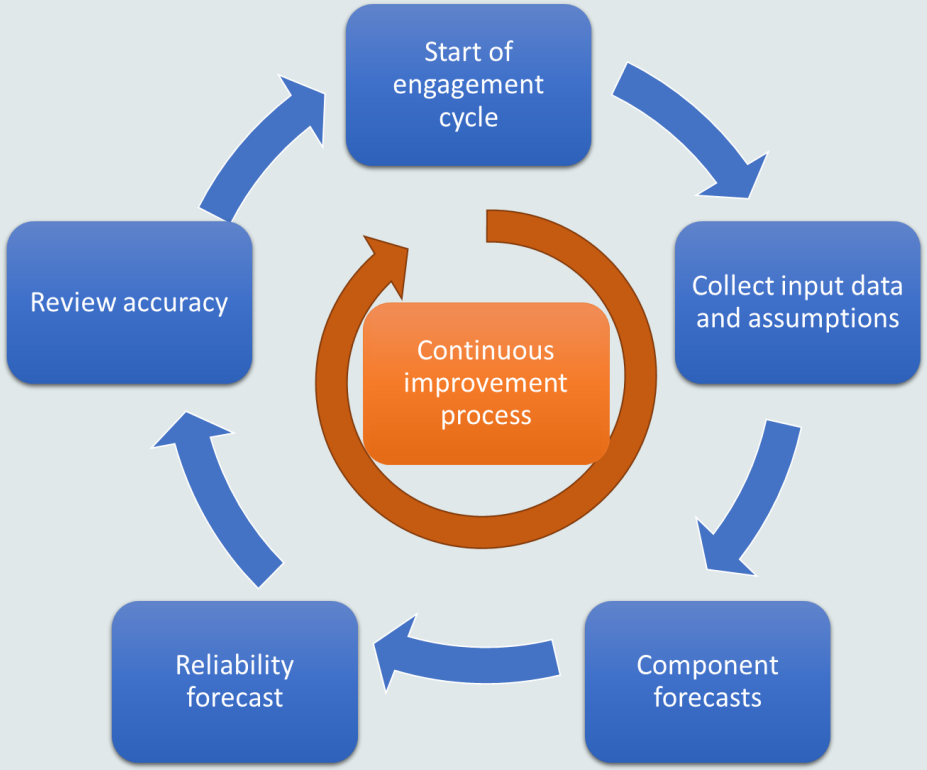
Indicative due date 3rd June 2020.

FAR – part of continuous improvement

AEMO forecasts are used in a number of reliability and planning processes.

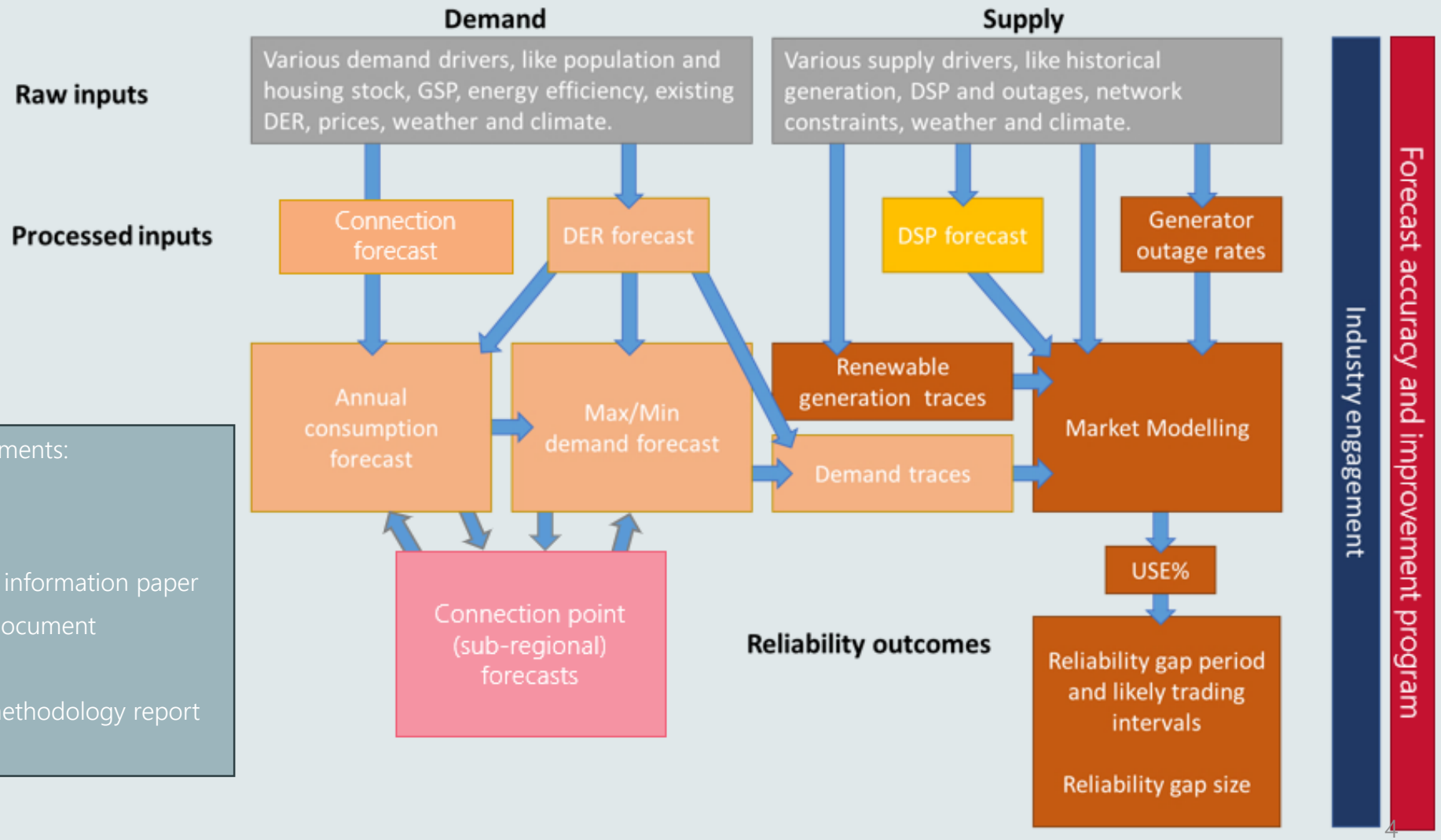
To ensure the insights and advice derived from the forecasts are as accurate as can be expected, AEMO uses a continuous improvement process which includes the assessment of forecast accuracy. Assessing accuracy is a rules requirement.

This consultation is on the methodology AEMO should use to assess accuracy. Formal consultation on methodology is a requirement of AERs Forecasting Best Practise Consultation Procedures.



As per: AEMO Final Interim Reliability Forecast Guidelines. https://www.aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Interim-reliability-forecast-guidelines/Interim-Reliability-Forecast-Guidelines.pdf

End to end high-level overview of reliability forecast process



Processes are documented in the relevant documents:

- DSP forecast and methodology paper
- Electricity demand forecasting methodology information paper
- ESOO and reliability forecast methodology document
- Interim reliability forecast guidelines
- Transmission connection point forecasting methodology report
- FAR methodology (this consultation)

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FAR inclusions

- an examination of the performance of each forecast component, per NEM region, including:
  - input drivers of demand;
  - energy consumption (annual assessment);
  - maximum and minimum demand;
  - input drivers of supply;
  - supply availability; and
  - reliability.
- an explanation of the results and any material deviation of trend in differences; and
- a list of actions undertaken, or to be undertaken, to improve the accuracy of the forecast and forecast components as part of AEMO's forecasting improvement plan.

Representing uncertainty

AEMO represents these uncertainties in two parts:

- Structural drivers, which are modelled as scenarios, including considerations such as:
  - Population.
  - Economic growth.
  - Electricity price.
  - Technology adoption.
  - Generation production and construction costs.
  - Greenhouse gas emission policies.
- Random drivers, which are modelled as a probability distribution, including considerations such as:
  - Weather-driven coincident customer behaviour.
  - Non-weather-driven coincident customer behaviour.
  - Weather-driven generation output.
  - Transmission failure rates and available capacity.
  - Generator failure rates and available capacity.

Point and Probabilistic Forecasts

Table 2 Forecast and actual residential connections growth rate comparison. 2018-19 (%)[11]

	NSW	QLD	SA	TAS	VIC
Actual (Jun18-Jun19)	1.4%	1.4%	1.0%	1.2%	1.9%
Slow Change scenario	1.6%	1.5%	1.2%	0.7%	1.7%
Neutral scenario	1.8%	1.7%	1.3%	0.8%	1.9%
Fast Change scenario	2.0%	1.9%	1.5%	0.9%	2.1%

The scenarios are constructed using deterministic forecasts of the structural drivers, meaning each scenario is assigned a set of parameters that describe a future state. These deterministic parameters are not subject to further uncertainty.

Random drivers are included in numerous forecasts, through the inclusion of a full probability distribution.

Figure 2 South Australia simulated temperature at time of maximum demand

Matrix of forecast categories

	Deterministic	Probabilistic
Input forecasts	• Economic and population growth • Energy efficiency • DER uptake • New generator connections • Generator available capacity • Transmission failure rates, losses and available capacity • Atmospheric greenhouse gas concentrations and related impacts **simple percentage error metrics are most appropriate**	• Weather and the related time-series impact on consumer behaviour, transmission capacity, generator output and asset failure rates. **qualitative description of accuracy may be most appropriate**
Component-based output forecasts	• Operational energy consumption **best to assess the contribution of each input to aggregate accuracy**	• Minimum and maximum demand • Connection point forecasts • Demand and VRE traces • Demand side participation • Supply availability • Reliability **challenging to assess accuracy using a single observation, requiring exploratory analysis and qualitative justification**

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Input forecasts

Demand and supply models incorporate numerous forecast components, including:

- Economic growth and population.
- Rooftop photovoltaic (PV) and behind-the-meter batteries.
- Energy efficiency and appliance mix.
- Electric vehicles (EVs).
- Network losses.
- Weather variability and climate change.
- New generator connections
- Generator forced outage rates

Forecast and actual residential connections growth rate. 2018-19 (%)

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As the table shows, actual connections growth over 2018-19 was mostly lower than the range of scenario forecasts, except in the case of Victoria, which grew as expected and Tasmania which grew above forecast.

The purpose of assessing accuracy is to determine whether the scenario settings are a good reflection of what happened. Given the importance of the Central/Neutral scenario in reliability analysis, most performance analysis will focus on the accuracy of this scenario.

Percentage Error

Calculation	Discussion
$percentage\ error = \frac{actual - forecast}{actual}$ x 100	A positive number indicates the actual is above forecast. Most statistically accurate with a somewhat intuitive interpretation for many users.
$percentage\ error = \frac{actual - forecast}{forecast}$ x 100	Intuitive for those who think of forecasts as budgets. A positive number indicates the actual is above forecast. Introduces statistical bias when evaluating performance across multiple models.
$percentage\ error = \frac{forecast - actual}{actual}$ x 100	A positive number indicates the forecast was an over-estimate of actual. Statistically accurate but less intuitive for some users.
$percentage\ error = \frac{forecast - actual}{forecast}$ x 100	A positive number indicates the forecast was an over-estimate of actual. Introduces statistical bias when evaluating performance and is less intuitive for many users.

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Operational energy consumption

- To better interrogate the drivers of forecast accuracy, AEMO extends the percentage error metric previously discussed.
- The operational energy consumption model is built using an econometric regression of the scenario input variables.
- For each relevant input variable, the forecast, actual and percentage difference is reported; as well as the impact on aggregate accuracy.

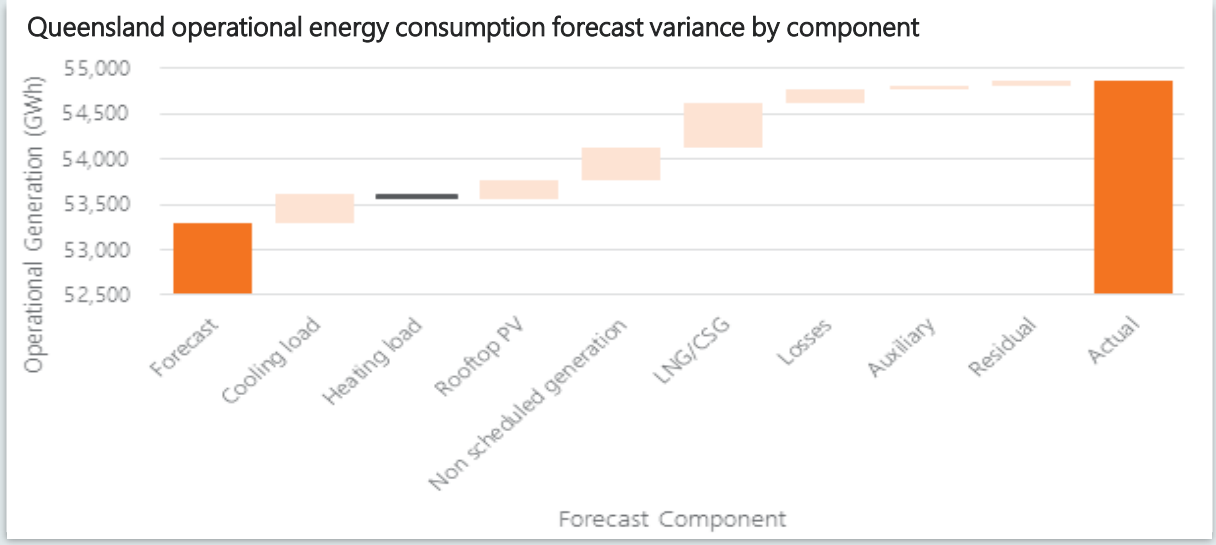

Table 4 Example: South Australia energy consumption forecast accuracy by component

Category	2018 Neutral forecast	Actual	Difference (%)	Indicative impact on total generation
Cooling degree days	436.3	685.1	+57.0%	+2.0%
Heating degree days	724.6	659.3	-9.0%	+0.2%[12]
Rooftop PV (GWh)	1,523.0	1,373.7	-9.8%	+1.2%
Small non-scheduled generation (GWh)	228.2	173.1	-24.1%	+0.4%
Network losses (GWh)	1,131.2	966.6	-14.5%	-1.3%
Operational sent out (GWh)	12,053.4	12,147.1	+0.8%	+0.8%
Auxiliary load (GWh)	325.5	294.2	-9.6%	-0.3%
Operational as generated (GWh)	12,378.9	12,441.3	+0.5%	

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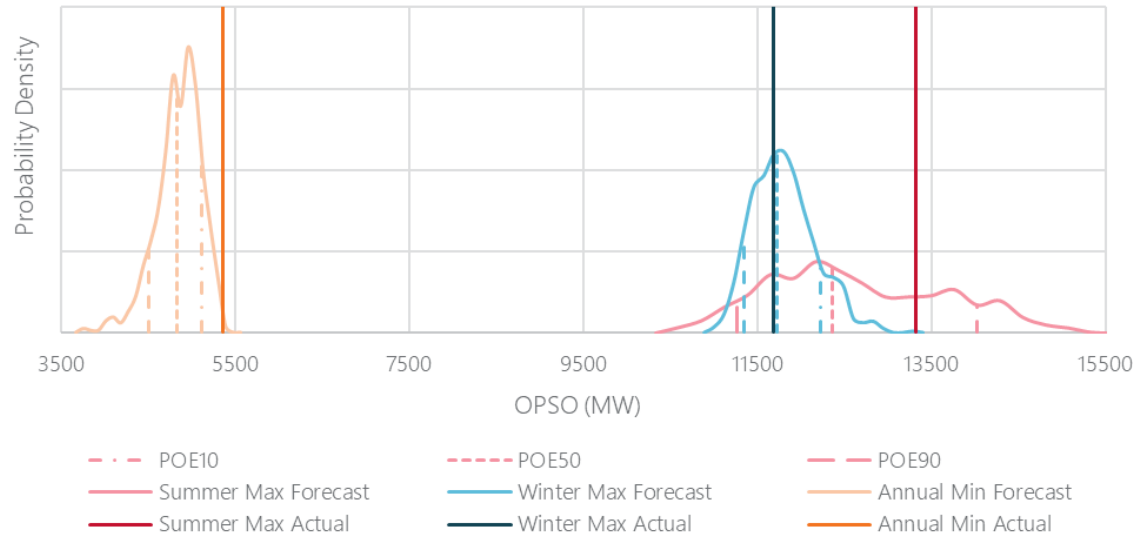
Maximum and minimum demand

- AEMO produces forecasts of the probability distributions of seasonal minimum and maximum half-hourly demand.
- These forecasts are compared against adjusted demand, as if no load shedding or demand side participation has occurred.
- The purpose of the forecast performance assessment is to understand any sources of inaccuracy, so that improvements can target the inputs or models that will generate the largest accuracy improvements.

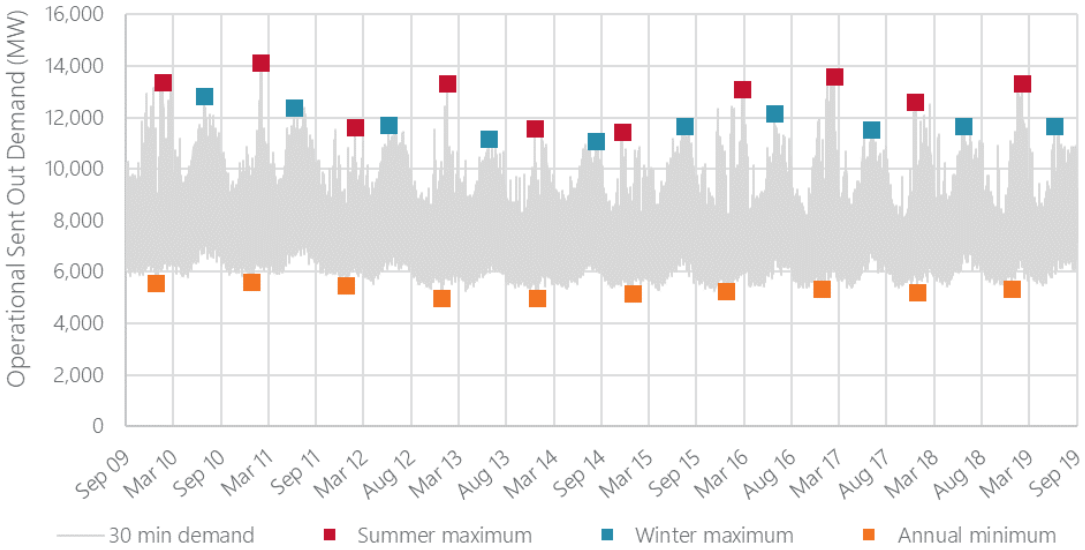
Maximum and minimum demand

Demand extremes (summer maximum, winter maximum, annual minimum) are forecast as a probability distribution. This complicates the assessment of accuracy.

New South Wales simulated extreme event probability distributions with actuals



New South Wales demand with extreme events identified

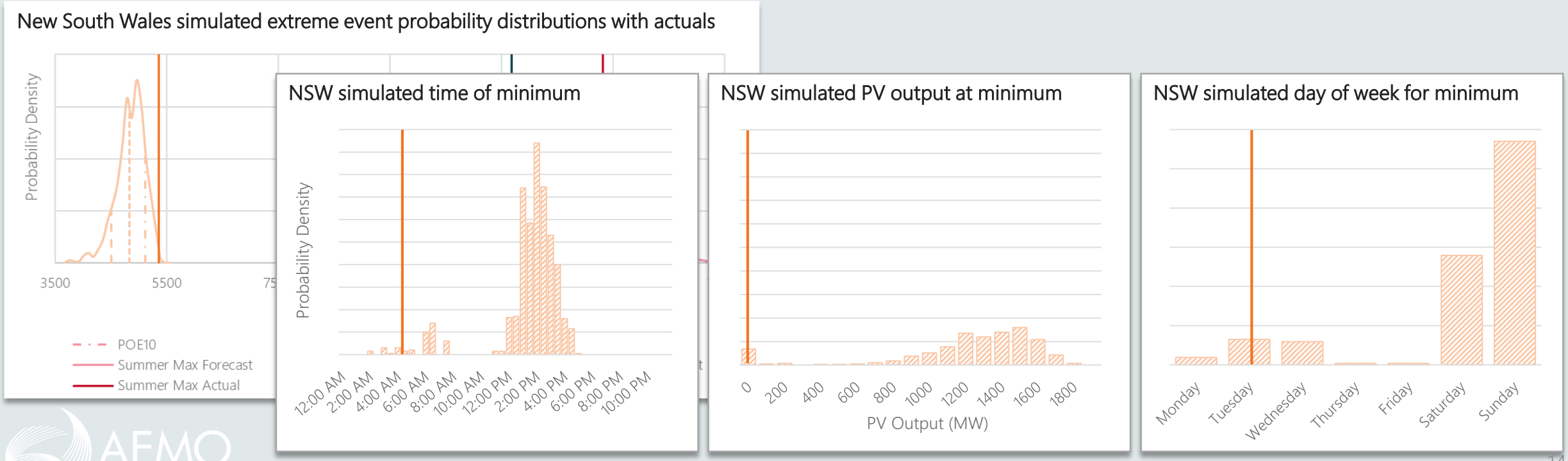


Following guidance from the University of Adelaide 'Review of Forecast Accuracy Metrics' report, AEMO has discontinued the use of 'backcasting' in favour of visualisations. The distributions allow comparison of simulated versus actual outcomes for model inputs and outputs.

https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/Accuracy-Report/ForecastMetricsAssessment_UoA-AEMO.pdf

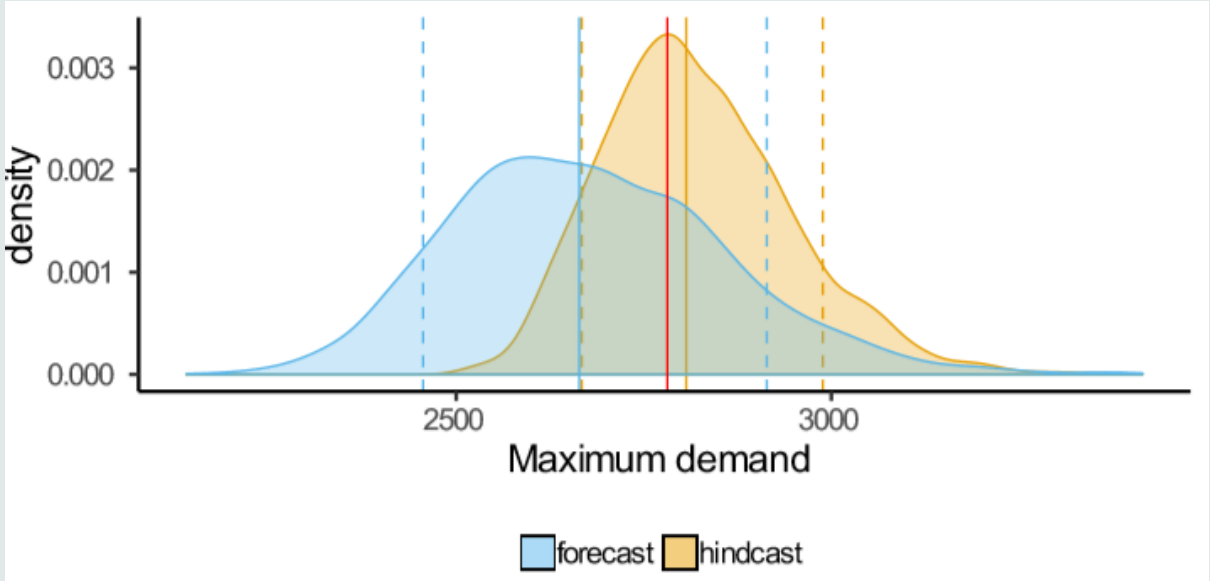
Maximum and minimum demand

- In this example, the actual minimum demand for New South Wales was 230MW above the 10% POE at the top of the forecast distribution.
- The minimum was expected to occur on a weekend afternoon, with a large contribution from PV. Instead, the minimum occurred early on a weekday morning before sunrise.
- The variation in model inputs draws us to conclude that the under-forecast of minimum demand was caused by the over-forecast of PV capacity.
    - Improvements should therefore focus on improving model inputs



Hindcasting

- Hindcasting involves comparing a forecast that was made historically with a forecast that would be made now for that year, including inputs as actually observed.
- The purpose of this method is to compare the forecast distribution without known inputs to the forecast distribution using the actual input drivers, thereby elucidating the impact of the forecast drivers on the forecast.
- The example shows the difference between the forecast and the hindcast. In this example, given known inputs, the probability distribution has narrowed, leaving only the uncertainty not explainable by measurable inputs.
- If the actual falls within the hindcast probability distribution, it provides additional confidence of forecast accuracy.

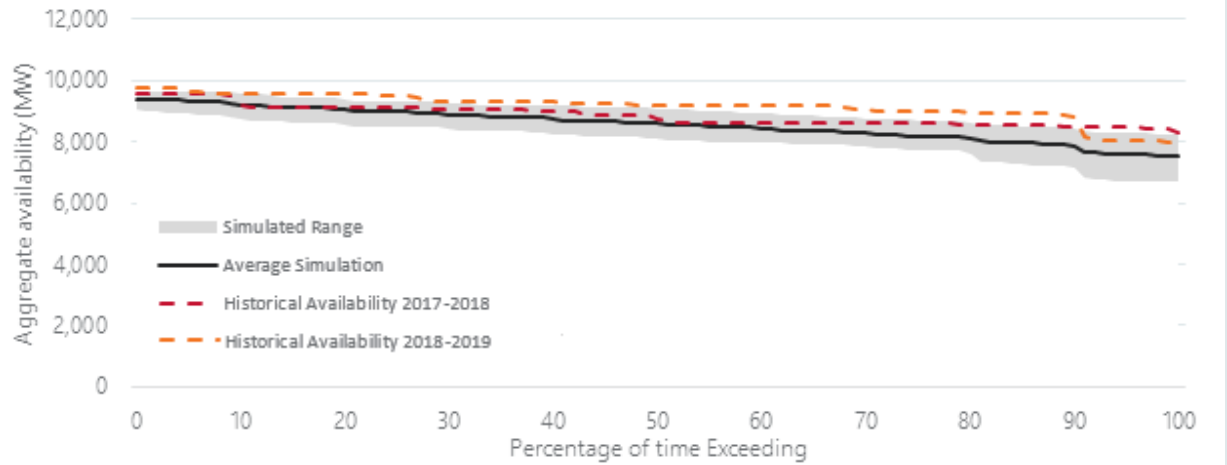


Maximum and minimum demand

Method	Discussion
A qualitative comparison of the observed demand to the forecast distribution	Easy to implement and very useful for establish context about the attributes of the event in question.
Percentage error of actual relative to 50% POE	Easy to implement and understand but fails to provide context about the performance of the probabilistic forecast, or any contribution from the input variables.
A comparison of the distribution for individual key drivers.	More complex to implement and understand but provides supplementary context about the contribution of the input variables, and any performance issues in the demand models themselves.
Probabilistic forecasting statistics	Particularly challenging to implement with few observations, and to understand. Provide little context about the contribution of input variables to the performance of the forecast.
A backcast of the top observed demand intervals	More complex to implement and understand and is inconsistent with the forecast methodology, providing no context about the performance of the forecast.
A hindcast of the forecast distribution with inputs as observed	More complex to implement and understand but provides useful insights about the performance of the forecast, once all input variables are accounted for.

Supply availability

- Supply forecasts are assessed by the degree to which capacity availability estimated in the forecast matches actual generation availability at times of highest supply scarcity risk.
- To achieve this goal, AEMO compares the forecast simulations during extreme temperature periods in the newly observed summer.
- Extreme temperature periods are likely to align closely with periods of very high demand, possible derating, and possible supply shortfalls.



Demand side participation

Demand side participation is included in the supply side modelling as per the reliability forecast process. There are two broad categories of DSP:

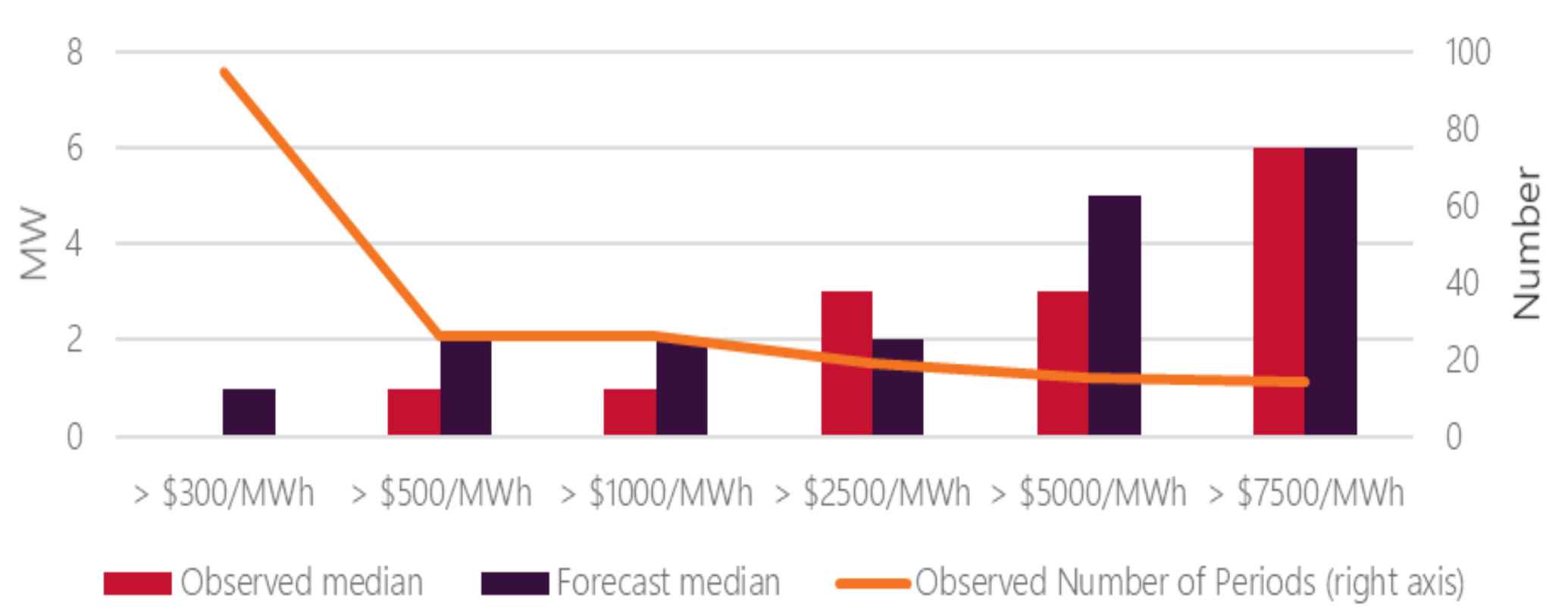
- Market-driven responses
- Network reliability responses

The accuracy of the market driven DSP responses are estimated through two processes

- Using the same process as the forecast, running through the last year of historical data (NMI load and regional wholesale prices) and comparing the observed 50th percentile response with the predicted response based on the previous 3 years of data.
- DSP on maximum demand days in the different regions are estimated and compared with the appropriate forecast (accounting for whether the network reliability programs were triggered or not and what price levels that were reached).

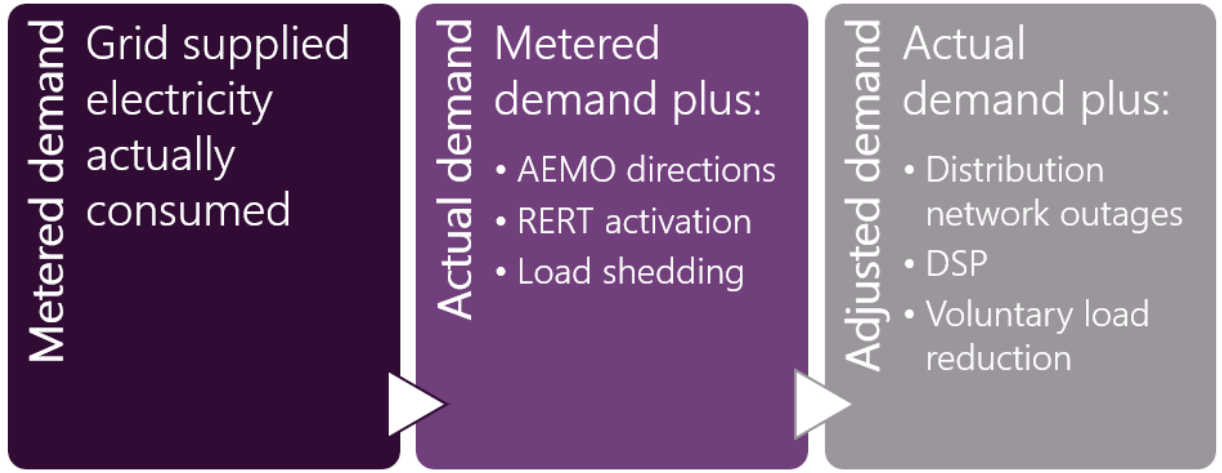
The network reliability responses are based on estimates provided by the NSPs. AEMO does occasionally ask for estimated response to particular events that will serve to validate the accuracy of these estimates.

Demand side participation



Actual and adjusted demand

Figure 6 Relationship between metered demand, actual demand, and adjusted demand



For the forecast performance assessment, it is appropriate to make further adjustments to demand, beyond those included in the *actual demand* definition above, to estimate what demand would have been under normal circumstances and allow a like-for-like comparison with the forecasts.

AEMO has split the adjustments into two broad categories:

- Firm – these are possible to estimate based on settlement metering data and cover components like DSP and impacts of distribution network outages.
- Potential – these adjustments are more approximate as based on expected behavioural responses that cannot be verified (easily) by meter data analysis. This covers cases where the public in advance is asked to conserve energy because the system is forecast to be strained in the coming day.

Questions

Submissions should be sent by email to energy.forecasting@aemo.com.au .

Indicative due date 3rd June 2020.

We welcome submissions on proposed methods, and any other methods, data requirements or visualisation suggestions that could improve understanding of forecast performance.