Draft Forecast Accuracy Report and Improvement Program

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Forecast Reference Group – October 2020

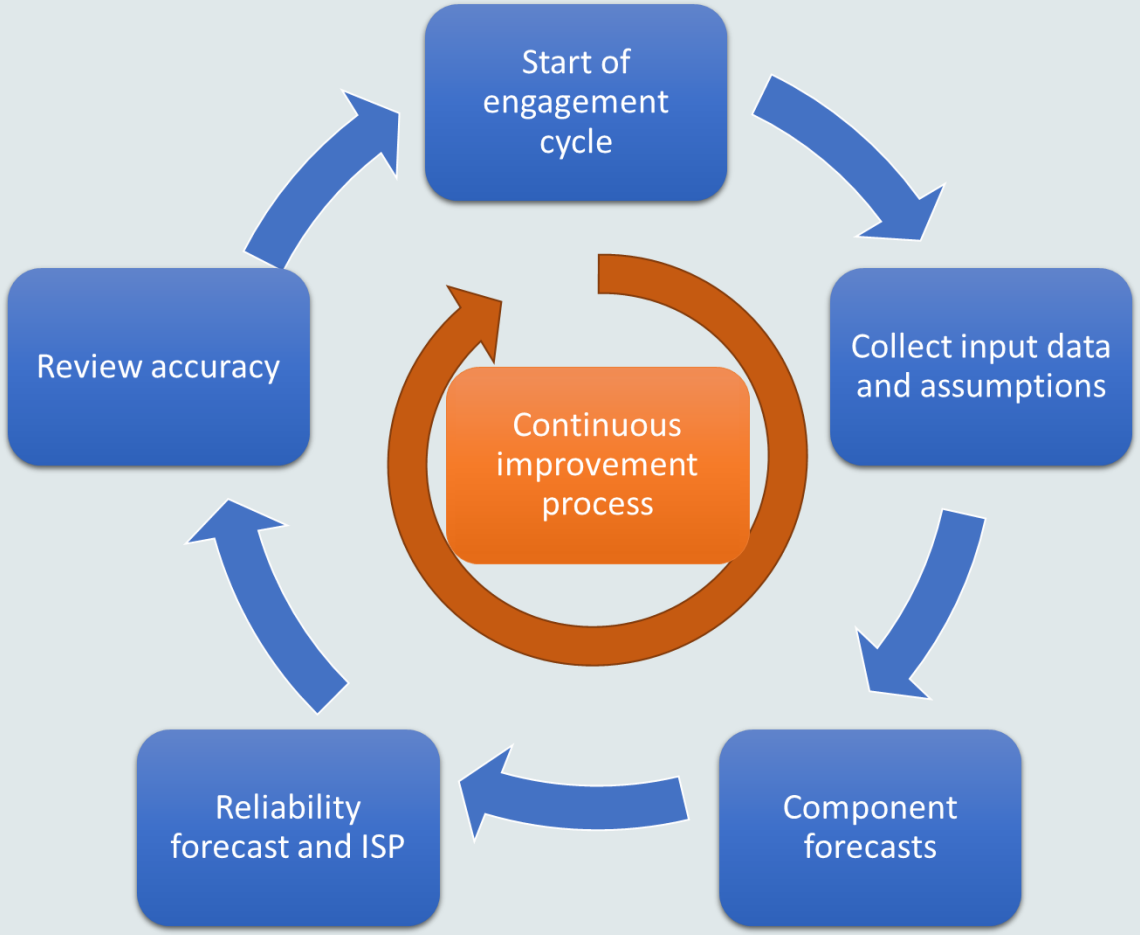
Agenda

For presentation, questions and discussion:

- Draft forecast accuracy report
  - Input drivers
  - Consumption forecasts
  - Extreme demand forecasts (max/min)
  - Supply forecasts
  - Reliability forecasts
- Draft Forecast improvement program

The latter will be subject to short term consultation once published

This assessment considers AEMO's National Electricity Market forecasts only.



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

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Draft Forecast Accuracy Report

For the 2019 Electricity Statement of Opportunities

Forecast accuracy report

What

- The 2020 Forecast Accuracy Report (FAR) assesses the year-ahead accuracy of AEMO's 2019 ESOO, i.e. 2019-20 financial year, for each region in the NEM.

Why

- To meet the Retailer Reliability Obligations (RRO) requirements in the National Electricity Rules, AEMO assesses the accuracy of input, demand and supply forecasts; discusses implication for reliability forecast findings and provides information on improvements that will apply to the next ESOO.

How

- AEMO approach is developed from:
  - A comprehensive review of AEMOs forecast accuracy metrics undertaken by University of Adelaide in 2019, which suggested that "broadly, current AEMO practises are appropriate and well-supported"
  - Completing formal consultation in 2020 on AEMO's methodology used to assess forecast accuracy, building on the recommendations by University of Adelaide.

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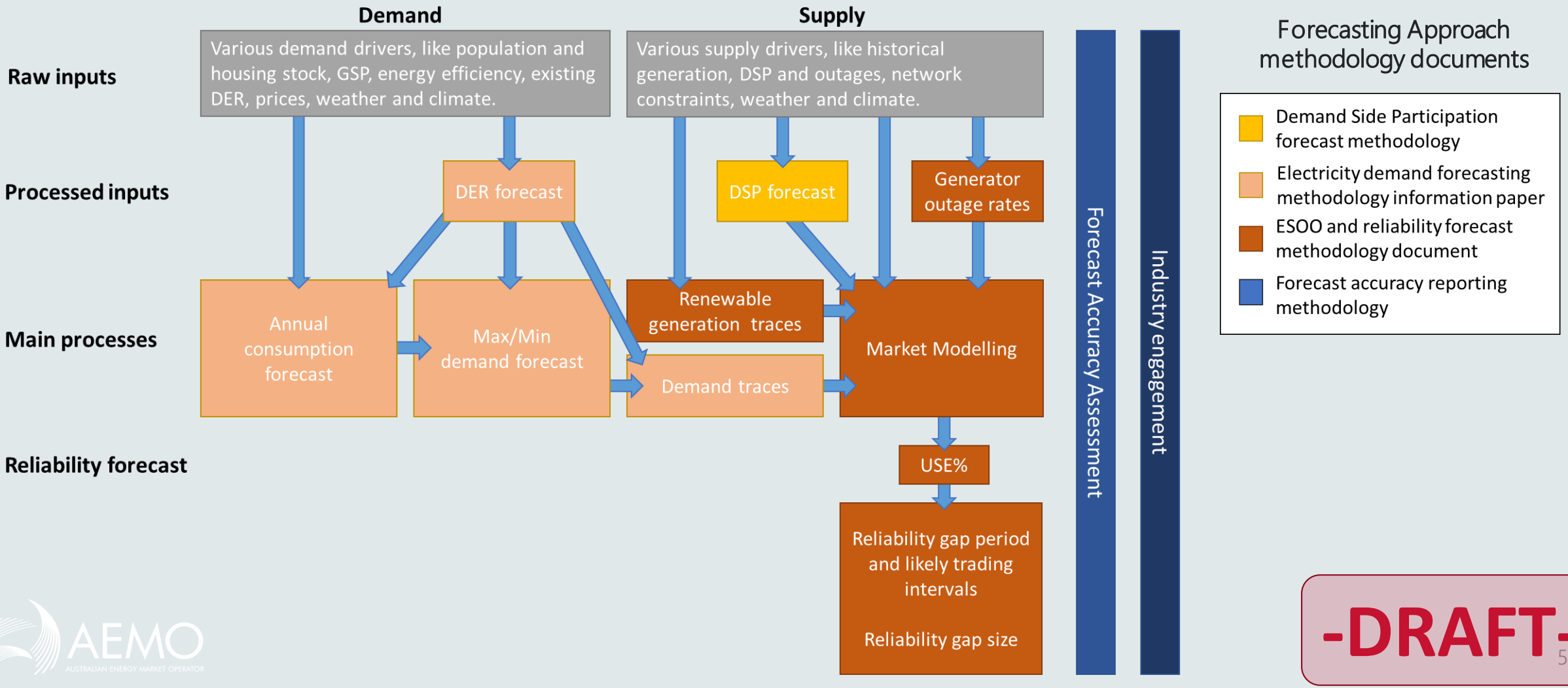
High-level overview of reliability forecast



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Assessability of forecast accuracy

Forecasting is the estimation of future values of a variable of interest. However, just because a variable of interest can be forecast, it doesn't mean that it can be rigorously assessed.

There are three broad categories of forecasts:

- **Strongly assessable** - Exact and indisputable actual values for the variable of interest exist at the time of forecast performance assessment. This allows definitive comparison with forecasts.
  - Example: Operational demand/consumption as-generated
- **Moderately assessable** - Reasonable estimates for the actual variable of interest are available at the time of forecast performance assessment. Reader of forecast performance should be aware that the forecast performances quoted are estimates.
  - Example: Installed PV capacity and annual generation
- **Weakly assessable** – No acceptable actual values of the variable of interest at the time of forecast performance assessment. Inappropriate to produce forecast accuracy metrics for this category.
  - Example: Savings from Energy Efficiency schemes

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Accuracy summary

Forecast Component	NSW	QLD	SA	TAS	VIC	Comments
Drivers of demand	🔴	🟡	🔴	🟢	🟡	Installed PV capacity significantly above forecast in most regions. A new methodology has already been developed and used in the 2020 ESOO to better capture recent PV sales history in forecasts.
Energy consumption	🟢	🟢	🟡	🟡	🟢	SA consumption more than 3% lower than forecast. Not fully explained by drivers or COVID-19. Tasmania also lower than forecast driven by lower large industrial loads (LIL).
Summer maximum demand	🟢	🟢	🟢	🟡	🟢	All mainland regions sit well within distributions and are consistent with forecast drivers. Tasmania is at the very low end of the distribution, driven by lower LIL than forecast.
Winter maximum demand	🟢	🟢	🟡	🟡	🟢	Winter maximum demand in SA is above forecast distribution. Likely due to change in consumption behaviour due to COVID as both offices and homes are heated. TAS lower than forecast driven by LIL.
Annual minimum demand	🟢	🟡	🟡	🟡	🟢	Due to under-forecast PV capacity, QLD and SA actual minimum demand fell below forecast distribution, with the other regions in the lower end. TAS was low as well, but driven by LIL rather than PV.
Demand Side Participation	🟡	🟢	🟢	🟢	🟡	Both NSW and VIC had responses from loads that had not been considered in the forecast, underestimating the DSP response in NSW in particular, less so in VIC. .
Installed generation capacity	🟢	🟢	🟢	🟢	🟡	New generator installations matched expectation, except in VIC where delays impacted availability compared with what was modelled.
Summer supply availability	🟢	🟡	🟢	🟢	🟢	Planned and unplanned outages in QLD reduced availability against forecast, which was accommodated due to the volume of dispatchable capacity.

🟢 Forecast has performed as expected

🟡 Inaccuracy observed in forecast is explainable by inputs and assumptions. These inputs should be monitored and incrementally improved, provided the value is commensurate with cost.

🔴 Inaccuracy observed in forecast needs attention, and should be prioritised for improvement.

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Input drivers of demand

Demand forecasts incorporate numerous forecast elements, including:

- Economic and demographic variables
- Rooftop photovoltaics (PV)
- Network losses
- Auxiliary load
- Behind-the-meter batteries and electric vehicles (EVs)
- Energy efficiency and appliance mix

Actuals measurable allowing accuracy to be assessed

Input variables that impact year-ahead accuracy were assessed. Cases with various degrees of mis-alignment between forecasts and actuals were found.

Some mis-alignment is expected, particularly on longer-term variables that tend to have weak relationships with year-ahead changes in demand.

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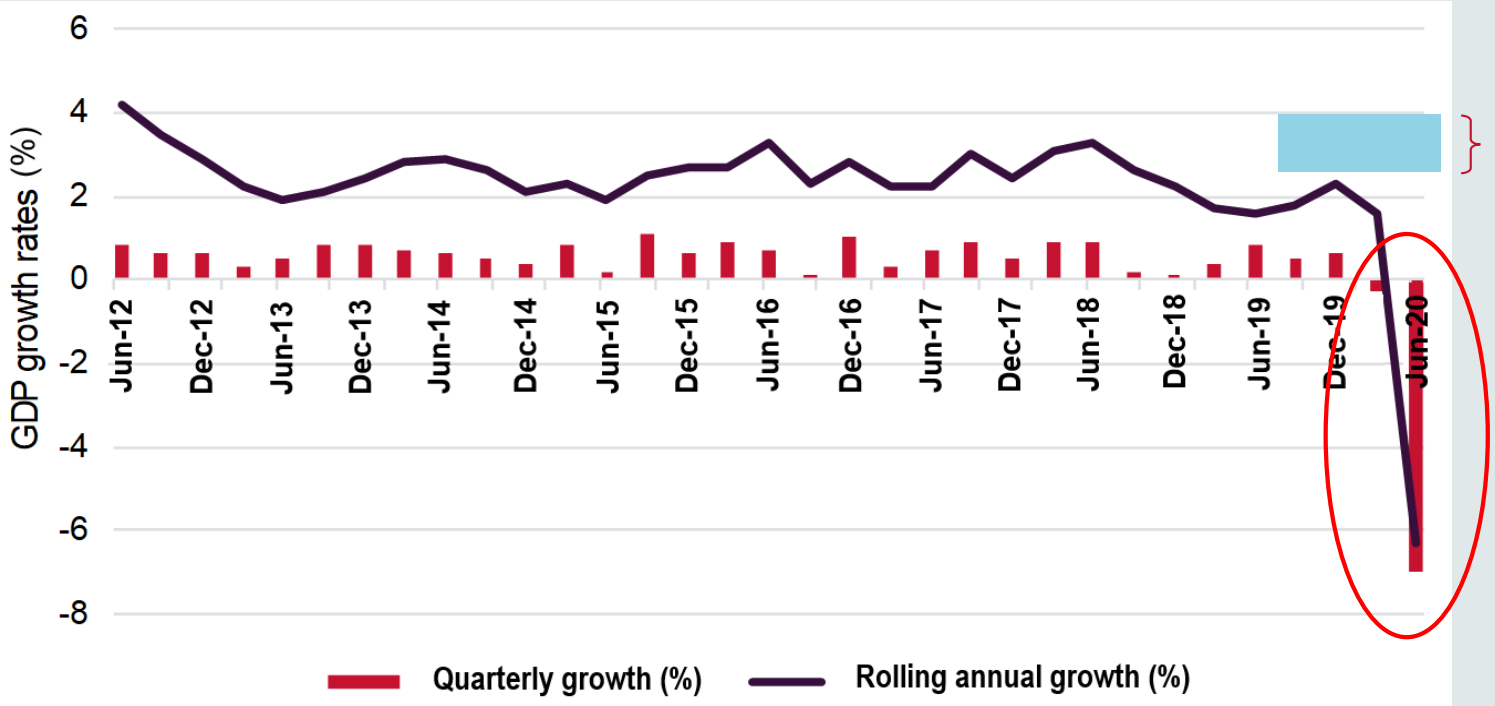
Input drivers: Economic growth

- The 2019 ESOO Central scenario incorporated consultant economic forecasts. Average real growth in Gross Domestic Product (GDP) for the first five years of the forecast was between 2.6% and 4.0% p.a.
- Actual growth in GDP in 2019-20 fell 6.3% due to COVID-19.



Forecast band

Severe COVID-19 impact on the economy. Impacts on consumption have been relatively modest, with growth in residential demand offsetting most of the decline in business consumption.

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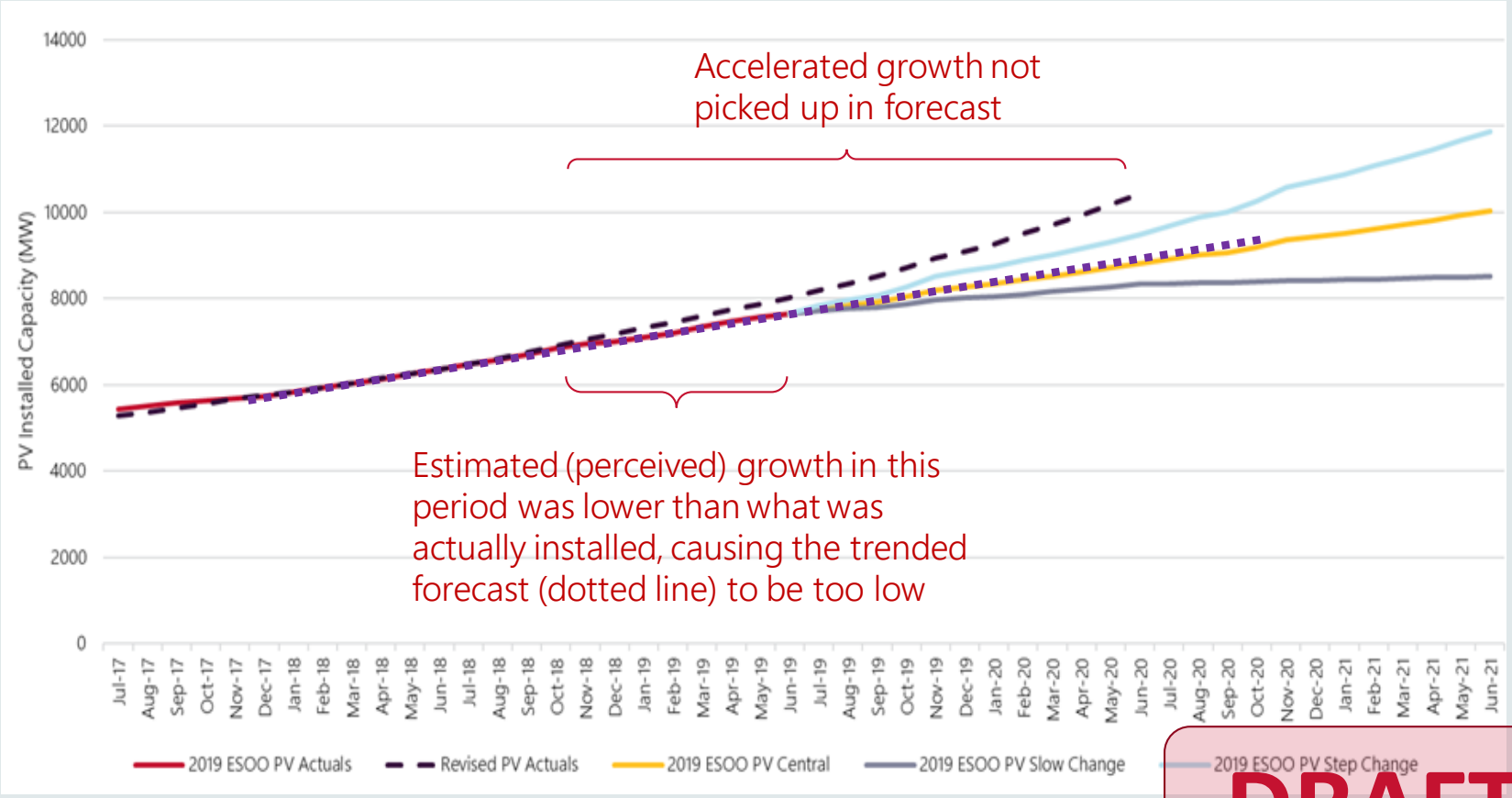
Input drivers: PV accuracy overall

- In aggregate, PV installations were under-forecast with variation between regions.

- Two key reasons:
  - Inaccurate actuals which were used as forecast trend
  - Not picking up potential for accelerated growth

- Both rooftop PV and PVNSG forecasts were affected.



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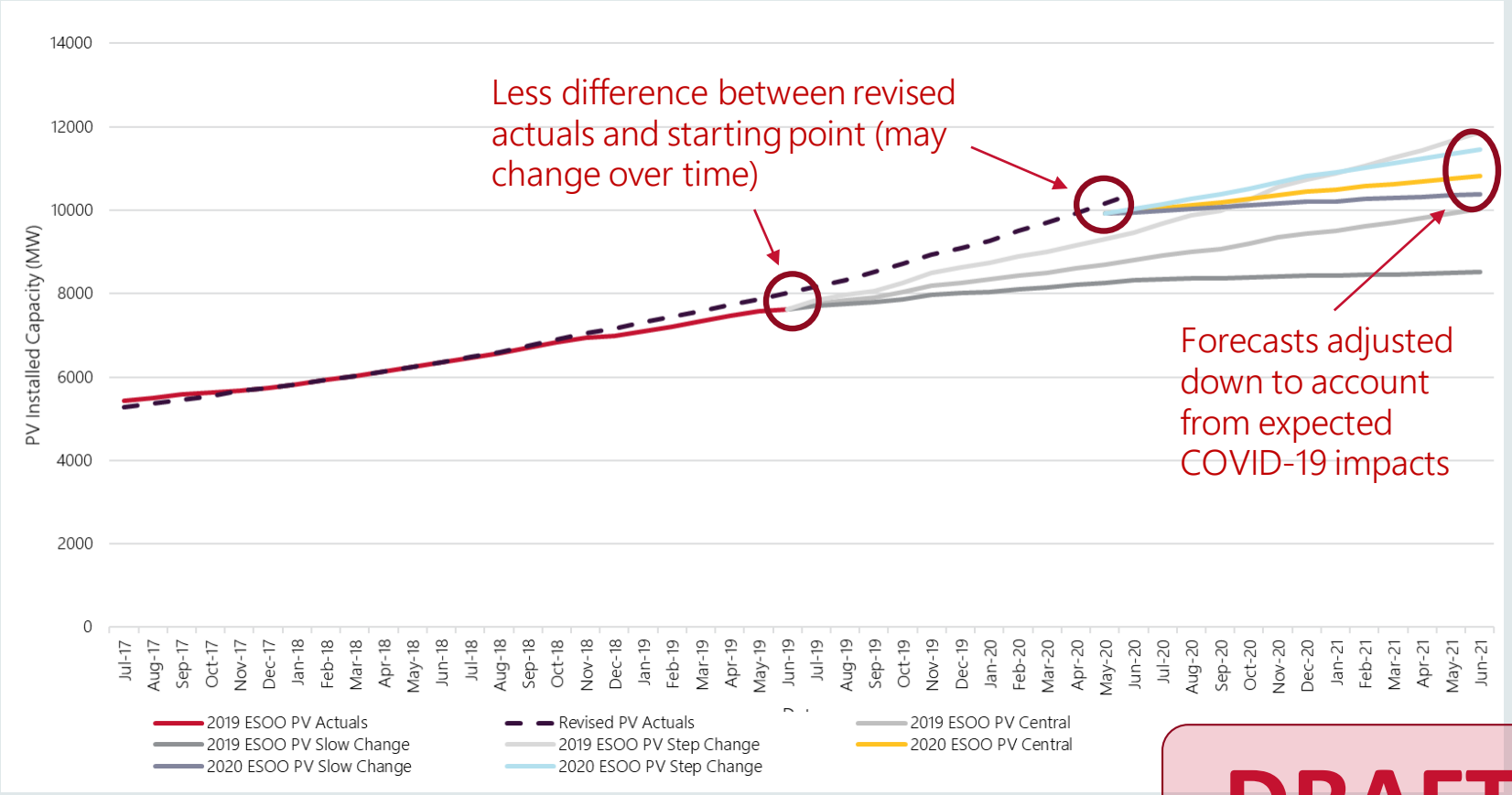
Input drivers: PV accuracy overall

- Adjustments implemented for 2020 ESOO improve, but do not fully address issues.

- Visibility of actuals still problematic, though indications show an improvement.
- COVID-19 adjustments were at the time of the forecast expected to lead to a slowdown in installations.
  - Instead installation rate has increased



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NEM wide year-one consumption forecast variance by component

NEM wide, the largest sources of year-one variance are:

- Auxiliary load
- Rooftop PV
- Losses

Variance from auxiliary load driven by change in source of data.

Variance from Rooftop PV is the greatest concern, as likely to accumulate over time.

NEM-wide forecast variance by component (waterfall diagram)

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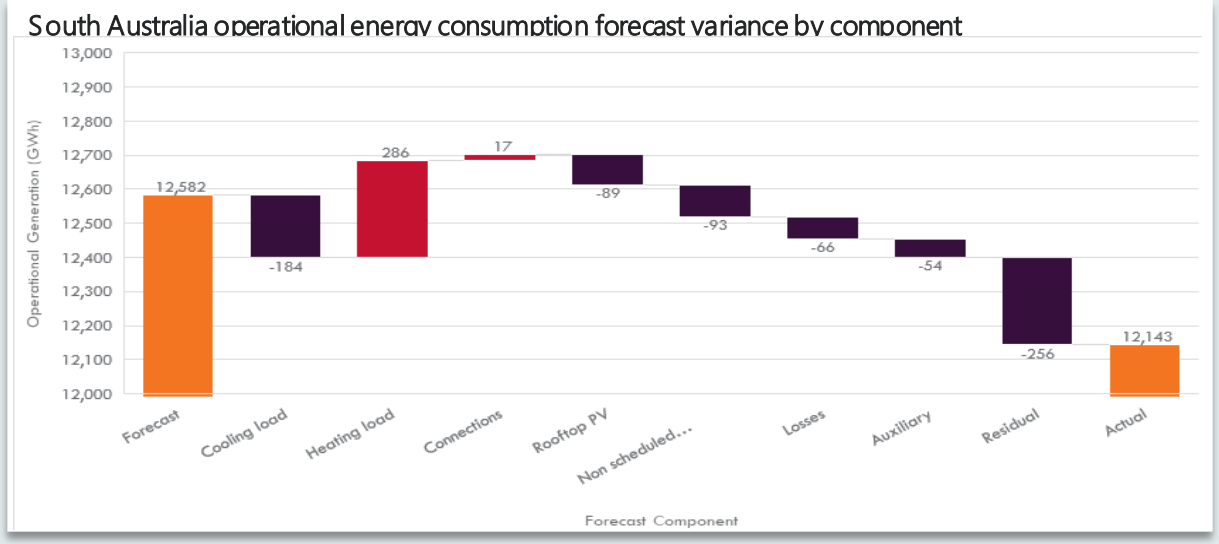
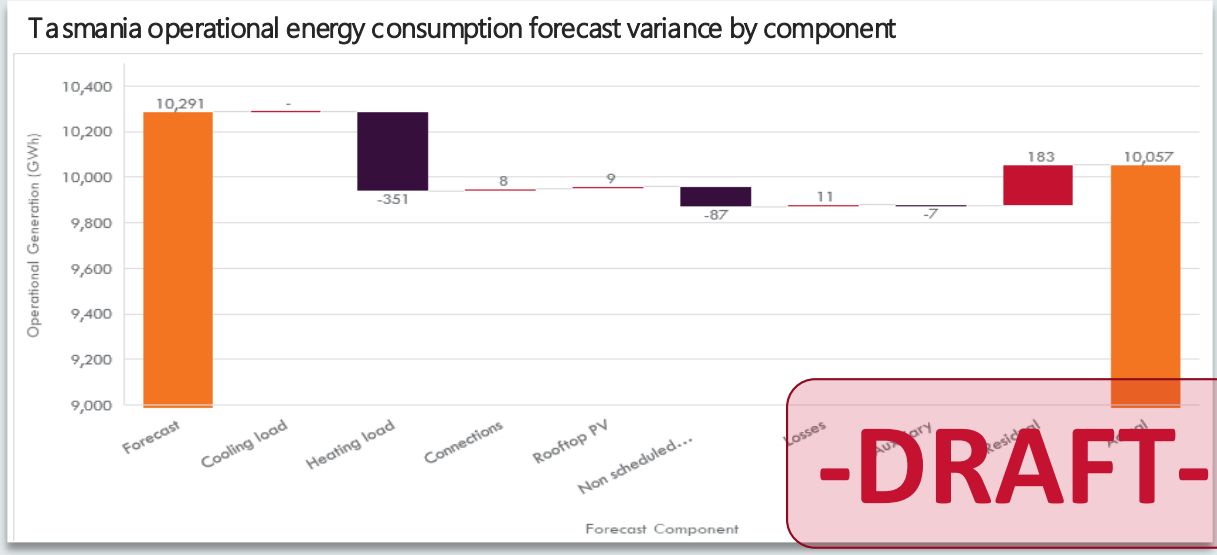
Regional year-one consumption forecast variance by component

- For South Australia, the largest regional variance was observed. It is partly explained by lower cooling load and higher PV generation.
  - Initiative to improve explainability of forecast variance (including COVID-19 impacts) by more granular data
- Tasmania had the second largest variance. This is driven by lower heating demand and lower large industrial load than forecast (latter not shown).
- Once variations in model inputs were considered for other regions, energy consumption models performed well, although there is some evidence of minor misalignment.





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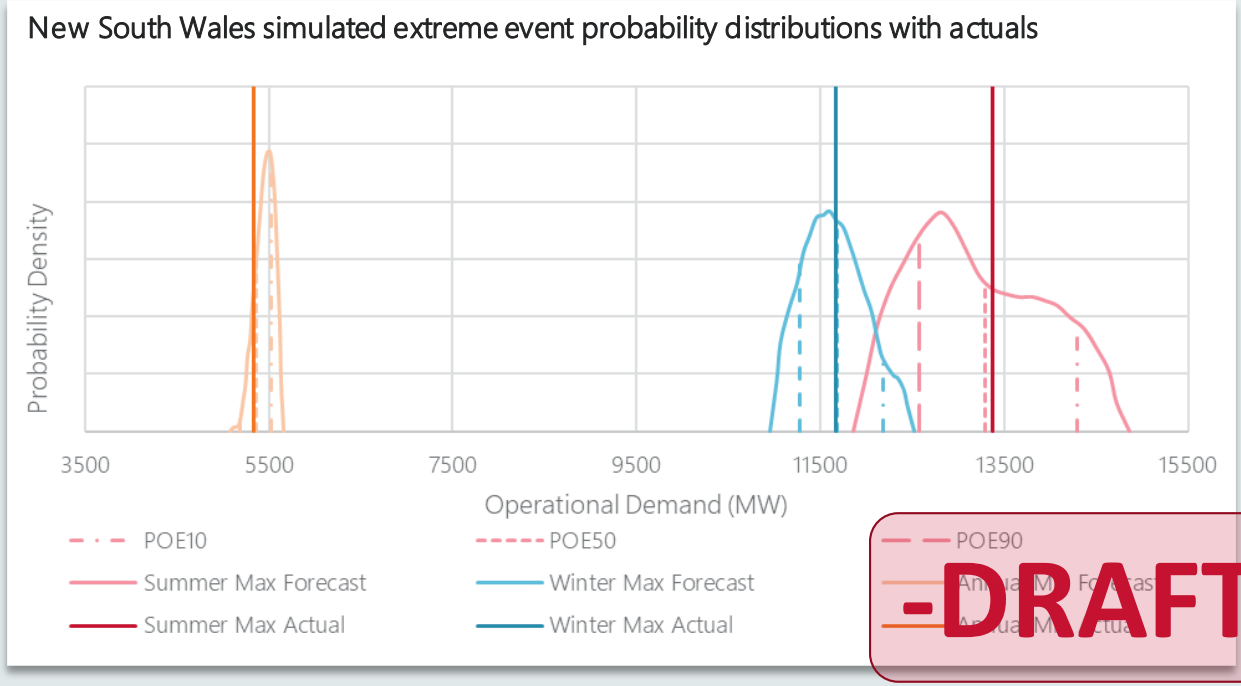
Maximum and minimum demand

- The summer and winter maximum demand forecasts generally performed well. The Tasmanian outcomes were affected by lower large industrial load (LIL) than forecast, while the South Australian actual winter maximum exceeded expectation, possibly due to COVID.
- The annual minimum demand forecasts did not perform particularly well with actuals below forecast in Queensland and in South Australia in particular, driven by the underforecast of PV capacity.
  - Improvement initiatives: PV capacity forecast and continue monitoring the impacts of COVID-19, including on large industrial loads.

Forecast Component	NSW	QLD	SA	TAS	VIC
Summer maximum demand *	🟢	🟢	🟢	🟡	🟢
Winter maximum demand	🟢	🟢	🟡	🟡	🟢
Annual minimum demand	🟢	🟡	🟡	🟡	🟢

*Summer maximum demand actuals have two years in a row been in the upper end of the distribution for both South Australia and Victoria. These should be monitored over the next summer.



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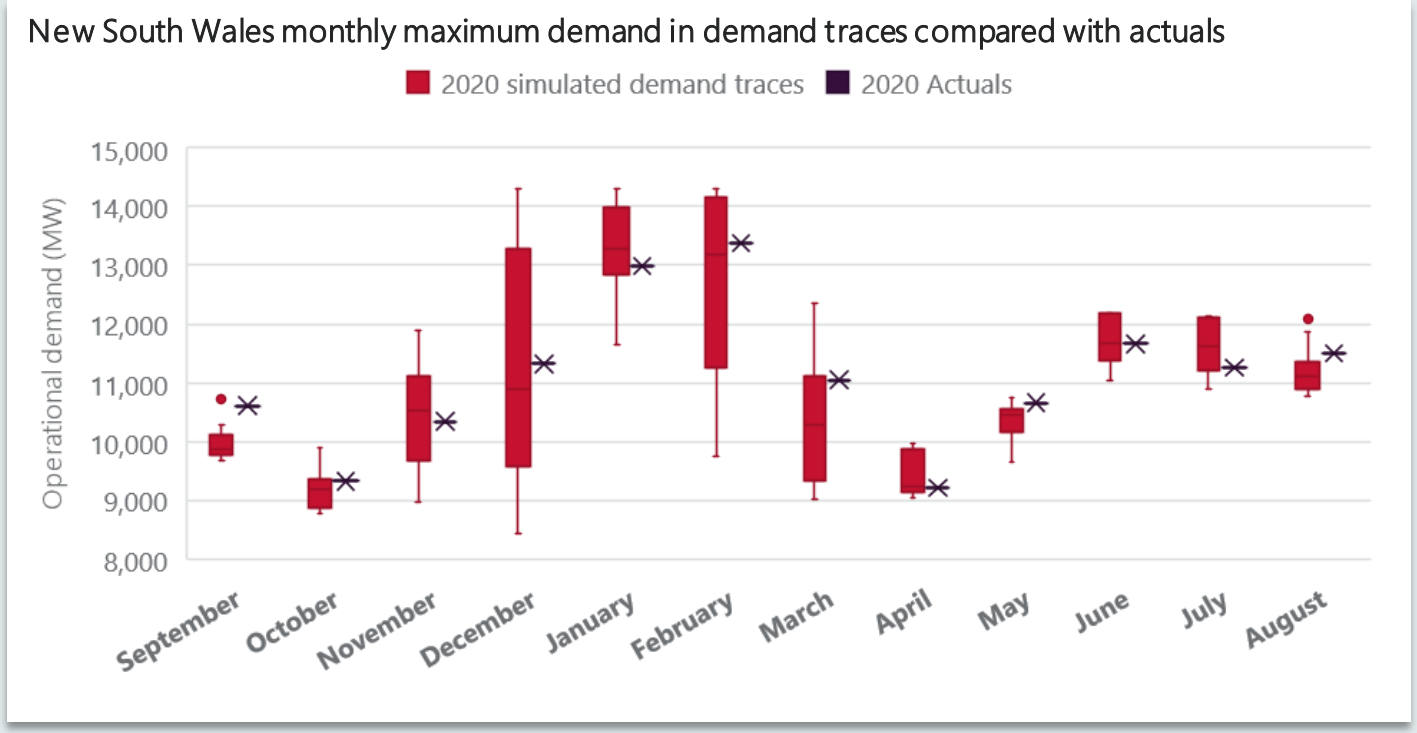
Demand traces

- Half hourly demand traces are developed using historical demand years, adapted to meet the operational energy consumption and extreme demand forecasts.
- To evaluate their impact on monthly reliability, the actual monthly maximum was compared to the range of monthly maximums taken from the reference year traces.
- In all cases, the accuracy observed in the demand traces is consistent with the accuracy observed in the energy consumption and extreme demand forecasts.



* The box plot contains both POE50 and POE10 traces.

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Demand Side Participation

- Good alignment between forecast and estimated actuals in Queensland, Tasmania and South Australia
- For Victoria and New South Wales, major loads that had been assumed to not respond, were actively providing DSP on a number of occasions.
- Excluding those loads, DSP was overforecast, but including them saw a:
  - Significant underforecast in New South Wales of 190 MW
  - Minor underforecast in Victoria of 28 MW
- This has been corrected in the 2020 ESOO.

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Generator new entrant and capacity information

- A number of new projects in Victoria were forecast to be operational but were not operating during the key summer months.
- AEMO is monitoring commissioning dates and how these are incorporated into plant availability.

Forecast and actual generation count and capacity, February 2020

	Facilities actually operating		Facilities forecast to operate		Difference in Capacity (actual - forecast)	
	Count	MW	Count	MW	MW	%
New South Wales VRE	25	2,223	26	2,498	-275	-12.40%
New South Wales all generation	78	16,971	79	17,246	-275	-2%
Queensland VRE	24	2,249	23	1,919	330	14.70%
Queensland all generation	80	14,785	79	14,455	330	2%
South Australia VRE	25	2,387	25	2,387	0	0.00%
South Australia all generation	87	5,795	87	5,780	15	0%
Tasmania VRE	3	462	3	462	0	0.00%
Tasmania all generation	52	2,810	50	2,687	123	4%
Victoria VRE	22	2,494	27	3,715	-1221	-49.00%
Victoria all generation	88	11,795	94	13,036	-1241	-11%

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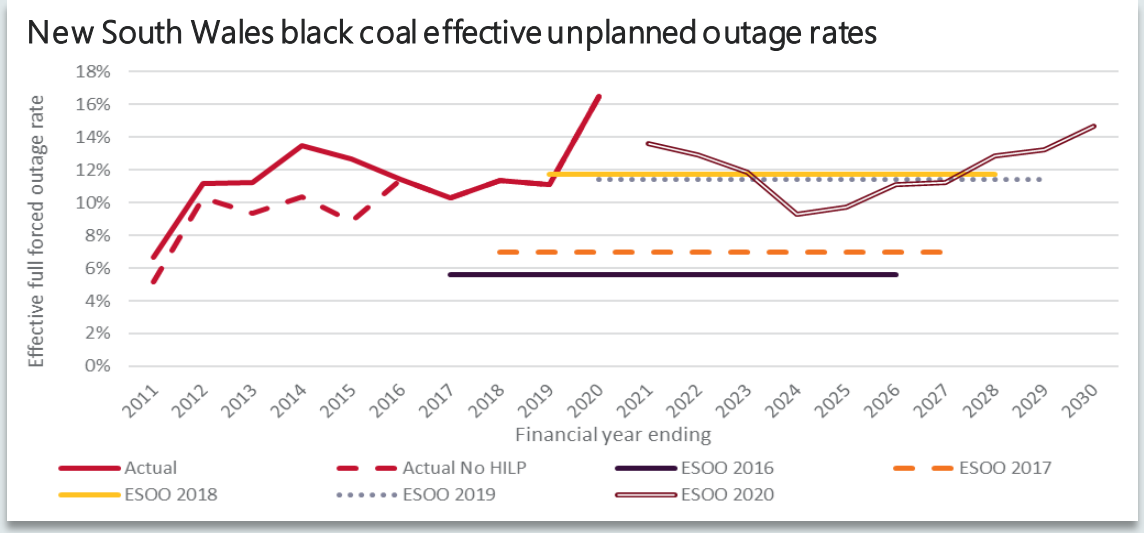
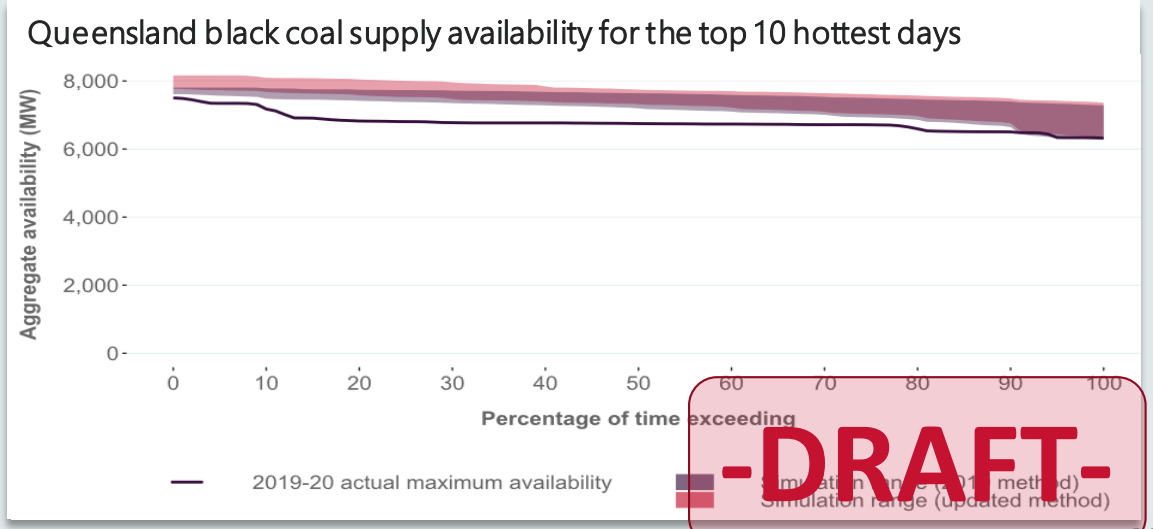
Thermal generation availability

- Generator forced outage rates for coal-fired generators continued to worsen but were mostly aligned with the ESOO 2019 assumptions, except for New South Wales black coal-fired generators, which suffered worse than expected performance.
  - An updated methodology used in the 2020 ESOO now uses participant and consultant forecasts of forced outage rates to better capture trends in performance and maintenance.
- The supply availability of Queensland coal-fired and gas generation was below the simulated range, due to higher than expected outages. For New South Wales it was below for one hot day with multiple concurrent outages.





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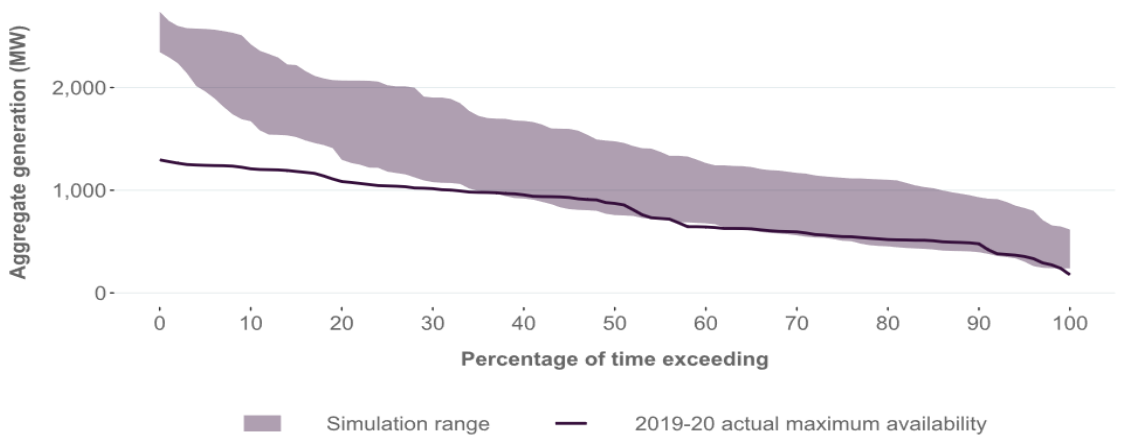
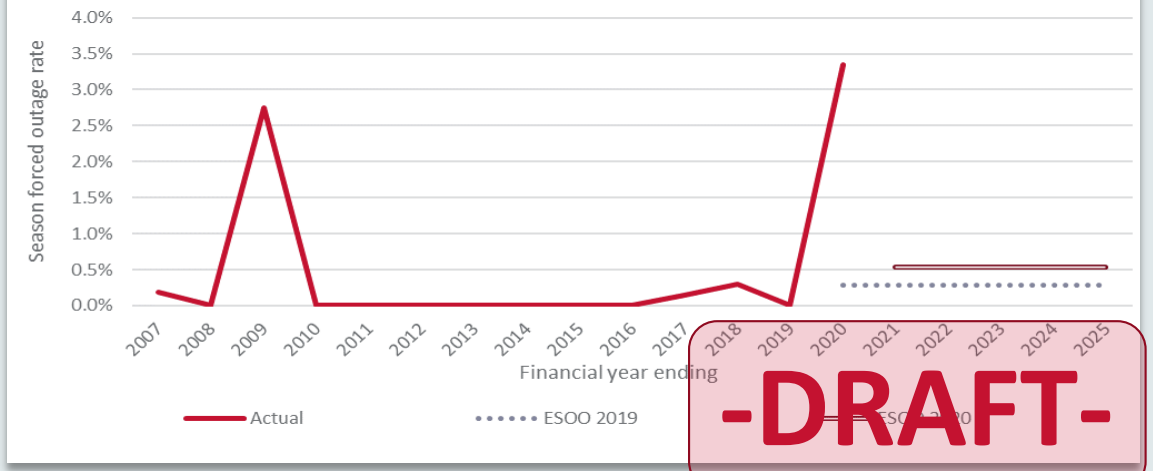
Variable renewable energy (VRE) and network availability

- VRE generation was **over-forecast** in Victoria during some high temperature periods where wind capacity was derated.
  - Capturing temperature dependency is increasingly important with a growing penetration of wind capacity.
- Wind generation was **under-forecast** in South Australia as high wind speed was observed on high temperature days.
  - Inconsistent with observed behaviour from 2011 to 2019.
- Since the 2019 ESOO, unplanned outages on key inter-regional transmission elements have been considered. Weather plays a key role and in 2019 bushfires and wind damage caused significant outages of inter-regional transmission elements.
  - Better capturing impacts of weather events is required to model the more extreme weather forecast for future years.

Victoria VRE supply availability for the hottest 10 days



Victoria - New South Wales transmission forced outage rates



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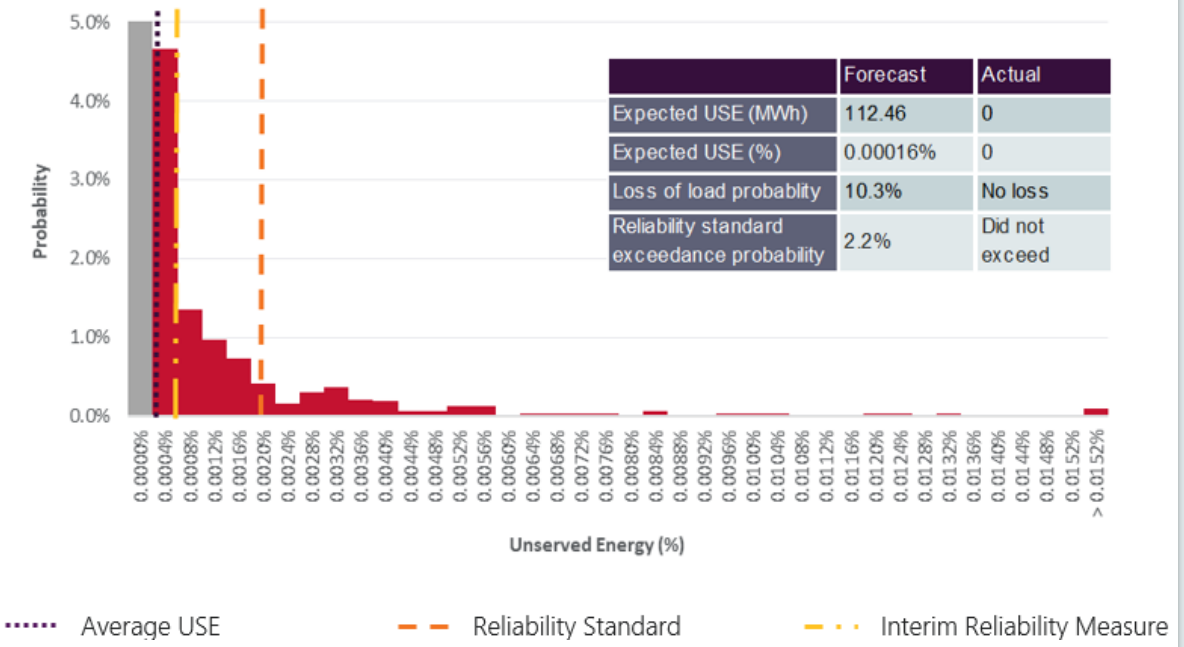
Reliability

- No region experienced loss of load (based on credible contingencies).
- Unserved Energy (USE) risk is forecast as a probability distribution which is long-tailed. Most simulations have no USE, while a small number have large USE events.
- Similarly, most years would not have any regions experiencing loss of load.
- Lower supply availability than forecast (New South Wales and Victoria in particular) combined with reduced interconnection and for Victoria very high demand did cause a number of cases with Lack-of-Reserve 2 being declared, with 8 such events across New South Vales, South Australia and Victoria combined. Risks were managed though RERT.

New South Wales forecast USE distribution for 2019-20 summer



	Forecast	Actual
Expected USE (MWh)	112.46	0
Expected USE (%)	0.00016%	0
Loss of load probablity	10.3%	No loss
Reliability standard exceedance probability	2.2%	Did not exceed

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Forecast Improvement Program

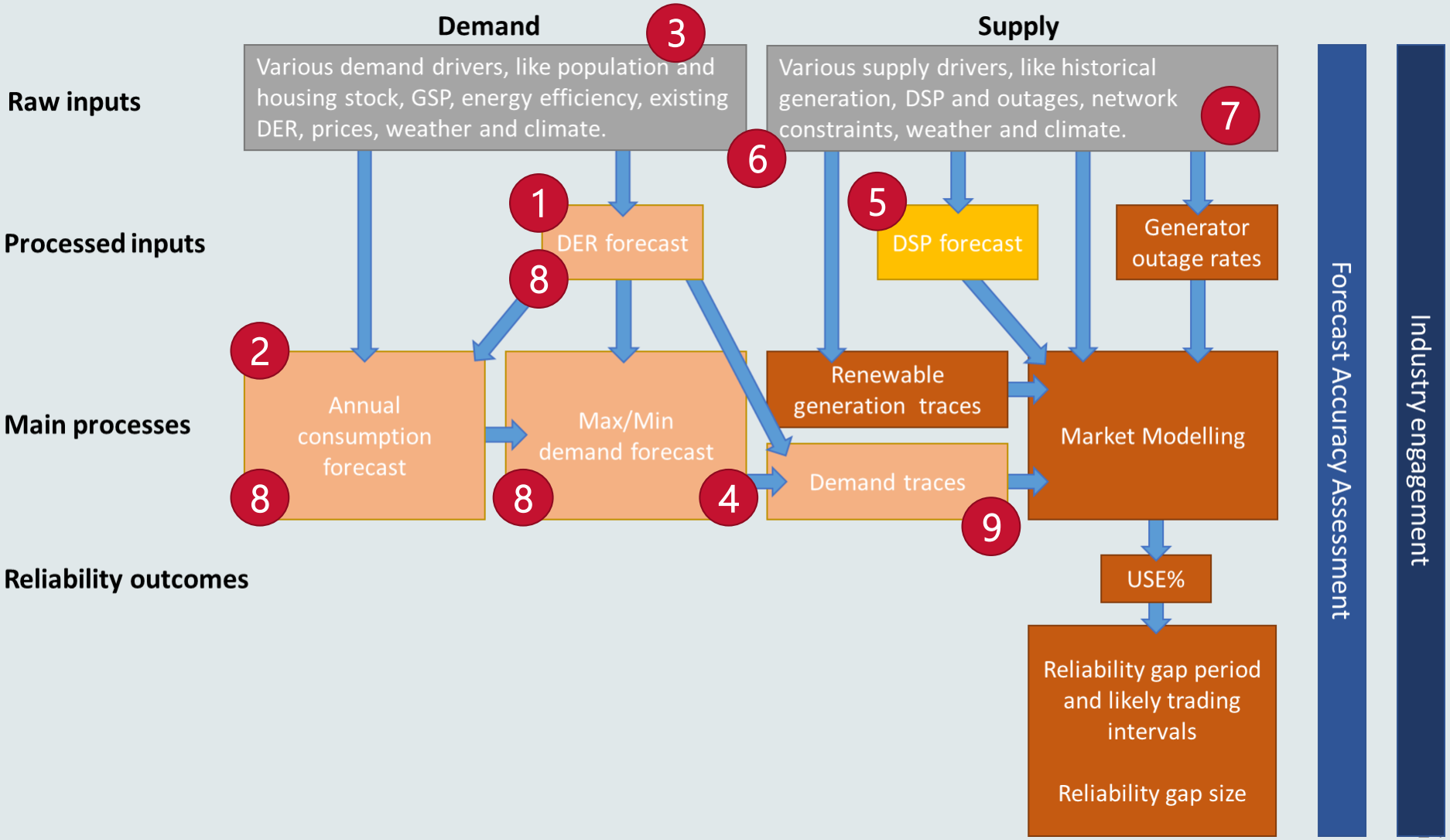
DRAFT, subject to confirmation in the FAR publication

Forecast improvements already implemented

Already implemented in ESOO 2020:

1. PV forecast
2. Consumption ensemble forecast
3. Connections forecast
4. Publication of shoulder mins
5. DSP including peakers
6. Auxiliary load
7. Two summer capacity ratings
8. COVID-19*
9. Dynamic EV charging*

* Not flagged in 2019 FAR



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Update on key improvements from the 2019 Forecast Improvement Plan

Improvement	Stakeholder engagement	Status
PV forecasts: Use of DER register and work closely with Clean Energy Regulator (CER) to ensure historical installations are captured in short-term trends.	Discussed at the January 2020 FRG. Updates given along with subsequent FRG presentations on the 2020 DER forecast.	**Partially implemented.** Delayed implementation of the DER register precluded its use in underpinning these forecasts.
Operational energy consumption forecast methodology: Develop multi-model ensembles of energy consumption	Discussed at the January 2020 FRG. Written feedback suggested broad support.	**Implemented.** Improvements have been implemented and demand methodology documents have been updated to provide requested clarity.
Customer connection forecast: Connections model to be developed include greater visibility/consideration of history and dwelling type characteristics.	Discussed at the January 2020 FRG.	**Implemented.** Demand forecasting methodology document has been updated to reflect the changes to the connection model that better capture short-term trends.
Forecasting portal: Publish shoulder seasonal minimums in addition to summer/winter	Discussed at the January 2020 FRG.	**Implemented.** Shoulder demand forecasts are now available on the portal.

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Update on key improvements from the 2019 Forecast Improvement Plan

Improvement	Stakeholder engagement	Status
Demand side participation: Include responses from peaking type non-scheduled generators in DSP forecast.	Discussed at the January 2020 FRG.	**Implemented.** DSP methodology documents have been updated.
Auxiliary load: Estimations of auxiliary load will be requested from generators directly through the GenInfo data collection process.	Discussed at the January 2020 FRG.	**Implemented.** Market modelling has been updated with generator provided auxiliary rates.
Generator derating during summer heat: AEMO to apply two summer capacity ratings (normal and hot weather)	Discussed at the November 2019 and January 2020 FRG.	**Implemented.** The 2020 ESOO and Reliability Forecasting Methodology document has been updated.

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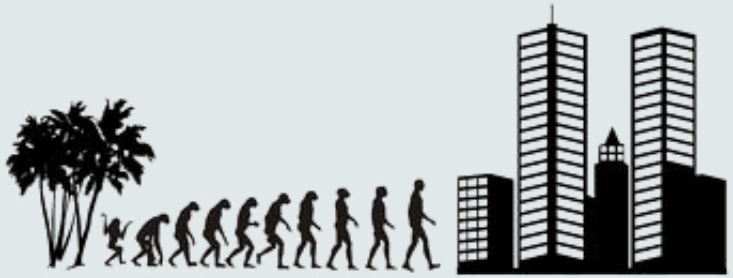
Three drivers for improvements

- Forecast accuracy assessment
  - As per AEMO's continuous improvement process
  - Note accuracy assessments are made all year, not just for the FAR

- Evolution of the energy system:
  - Update to reflect new sectors/technologies
  - Examples include LNG, electric vehicles and battery storage



- Regulatory requirements:
  - Changes to what AEMO must do
  - Examples include Actionable ISP and wholesale demand response

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Proposed forecast improvement program for FY2020-21

Priority initiatives:

1. Improve PV forecasts (affects consumption, demand and reliability outcomes)
2. Gain increased visibility of consumption drivers and trends through data analytics
3. Develop improved wind generation traces accounting for cut-offs
4. Improved modelling of inter-regional transmission element outage risk

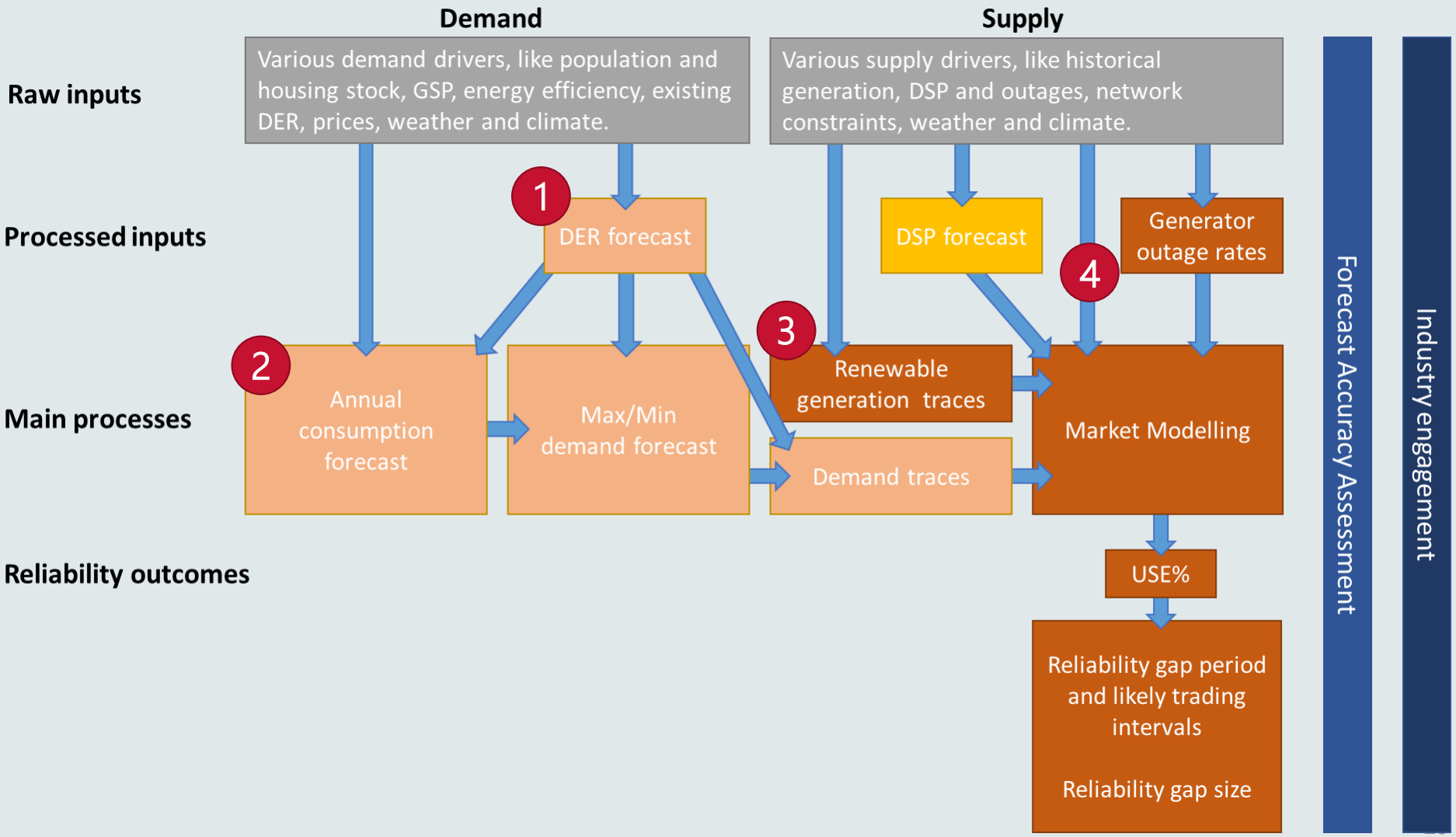
Further initiatives:

1. Developments to support ISP 2022 (to be consulted on in 2021)
2. Update reliability gap calculation method (will be consulted on together with the Reliability Forecast Guidelines)

Proposed forecast improvement program for FY2020-21 - Priority

Priority initiatives:

1. PV forecast
2. Consumption drivers
3. Wind generation traces
4. Network outage rates



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Proposed forecast improvement details

Priority: PV forecast improvements

Purpose: Improve accuracy of PV forecast short-medium term and better reflect uncertainty longer term. Some improvements were made for the 2020 ESOO, but additional initiatives are required:

- Improved visibility of installed capacity. Finalised verification of DER register data and use this as primary source.
- Better consideration of short-term trend.
  - One consultant used the 3-year trend as a starting, but a shorter term trend may better capture the accelerated growth trajectory.
  - Relies on good estimates of actuals (as per point above).
- Improved spread of scenarios and sensitivities, including upper and lower bounds of trends. A range of central-downside sensitivities were published with the ESOO 2020.

DER register:
Max 20 days after installation

CER database:
Up to 365 days after installation

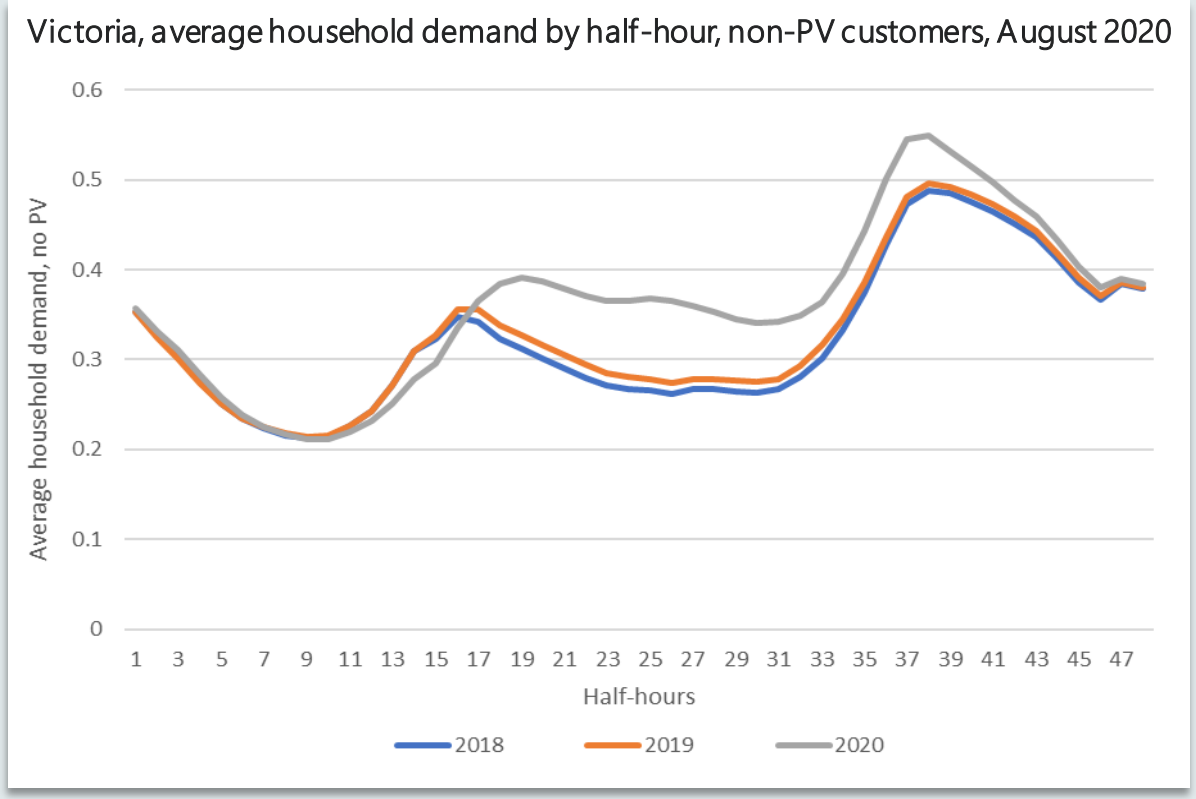
Priority: Improved visibility of consumption drivers and trends

Purpose: Improve understanding of consumption and demand drivers and trends through data analytics on smart meter data to:

- Improve residential/business sector split through sampling of smart meter data, allowing up-to-date estimates of sector split:
  - This allows better models to be built, as based on more recent estimates
  - It also improves the explainability of forecast variances
- Better understand COVID-19 impacts by region, sector and time-of-day

Priority: Improved visibility of consumption drivers and trends

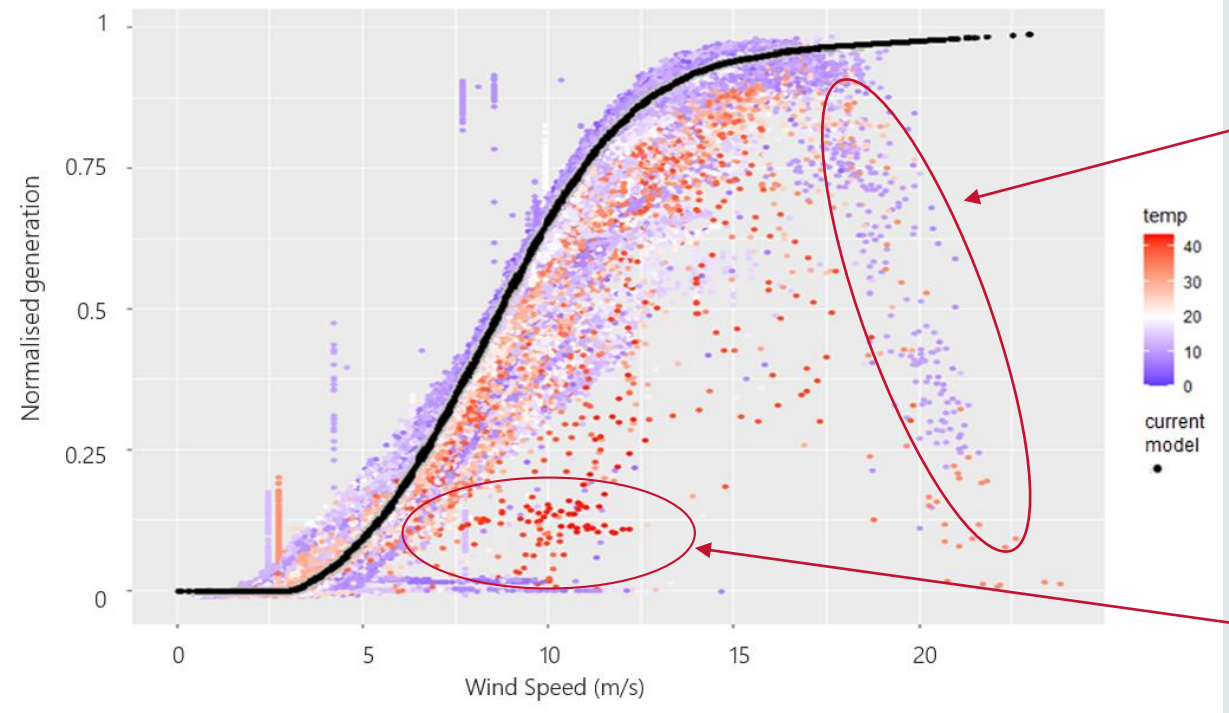
- For example, by sampling of smart meter data from different regions and customer types, AEMO can identify changes to customer load profiles. By including control groups (like customers without PV) changes in consumption over time can be estimated, to assess the consumption changes due to COVID-19 and similar cases.
- Through the NEAR project, AEMO gain additional insights from data analytics work undertaken by CSIRO.



Priority: Wind generation trace development

Purpose: Avoid overestimating wind generation, and thus underestimate potential unserved energy, by creating better wind generation traces.

An empirical power curve is currently used to fill gaps in wind generation data.



Example of power curve used

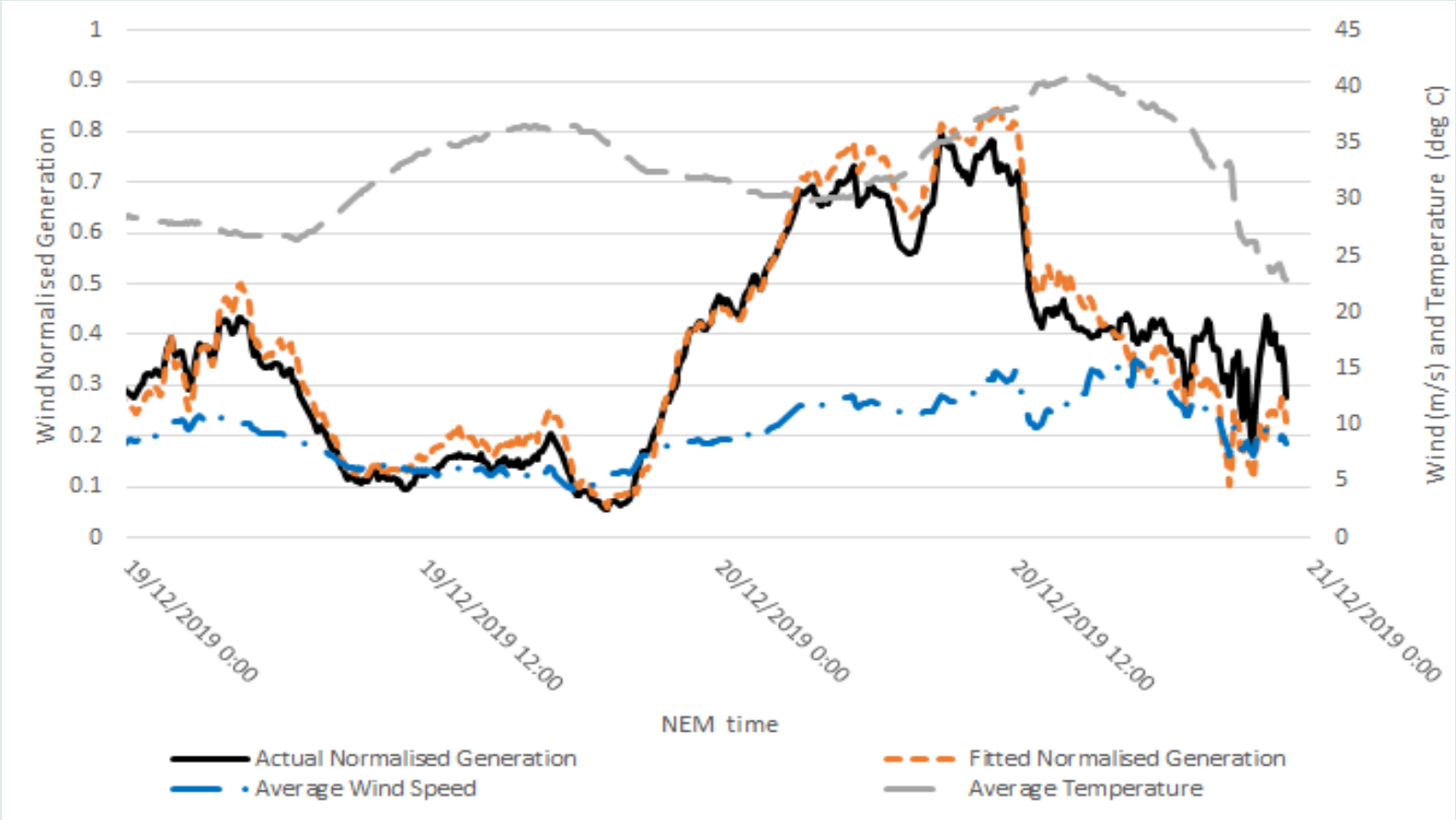
High wind speed cut-off not captured, overestimating wind generation

High temperature cut-off not captured overestimating wind generation

As reliance of wind power generation increase, and climate change increase temperatures, improving wind traces is becoming important.

Priority: Wind generation trace development

Prototype wind generation model – high temperature day



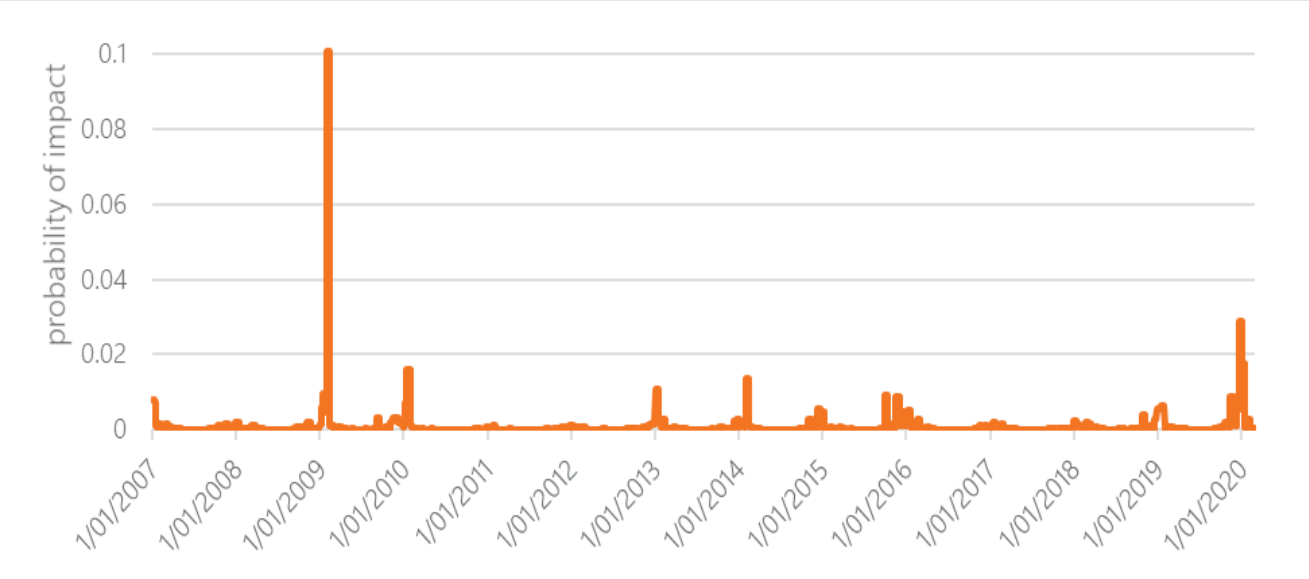
Priority: Inter-regional network outages

Purpose: AEMO's current approach does not capture weather impacts on inter-regional transmission elements well. Given that weather is increasingly the cause of transmission outages, as observed in 2019-20, improving the representation of such transmission outages is important for accurate forecasts.

AEMO intends to develop and implement new transmission failure models, that predict failure as a function of weather, where relevant.

Prototype model for VIC-NSW inter-regional transmission elements

Prototype model to predict bushfire impact probability as a function of daily bushfire weather, expressed as Forest Fire Danger Index (FFDI).



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Next steps

- The Forecast Accuracy Report will be published early to mid November
- This will include the proposed Forecast Improvement Plan, which will be subject to short form consultation, with submissions due before Christmas.
- Note additional improvements will be discussed in other consultations too:
  - A proposed changes to the calculation of reliability gap will be consulted on along with the Final Reliability Forecast Guidelines (to be completed by the end of February 2021)
  - The ISP 2022 process will lead to additional consultation on methodologies during 2021 beyond what has been discussed here.

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