Resilience and Climate

Forecasting improvement program preliminary discussion

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Forecast Reference Group July 29

Agenda

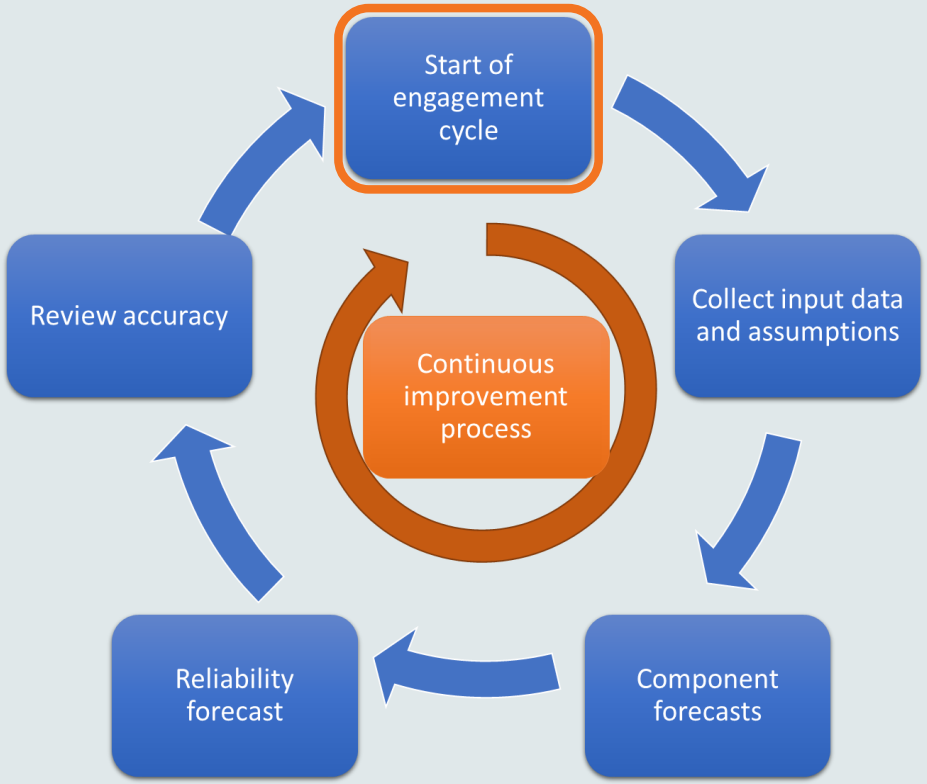
For presentation:

Electricity Sector Climate Information project update

For presentation, questions and discussion:

Proposed forecast improvements for extreme weather, climate and resilience risks

Written or verbal feedback is encouraged on these proposed improvements.



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

Electricity Sector Climate Information (ESCI) project

https://climatechangeinaustralia.gov.au/en/climate-projections/future-climate/esci/

Electricity Sector Climate Information (ESCI) Project

The Australian Government is providing $6.1 million over three years, from 2018-19, to improve climate and extreme weather information for the electricity sector, as part of a response to the Finkel review.

Objectives

1. Support NEM decision-makers to access and use tailored climate information to improve long-term climate risk planning.
2. Develop and demonstrate a best practice methodology for analysing climate change risks that can also be used by other sectors, for example, telecommunications.
3. Contribute towards a longer term vision for the next generation of climate projections and seamless climate and weather services.

This project will support improved planning and investment decisions for the electricity network.

Australian Government
Department of Industry, Science, Energy and Resources

CSIRO

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Australian Government
Bureau of Meteorology

Summary Vulnerabilities

Vulnerability (projection for NEM regions)	Impact
Temperature (Projected increases in both average and extreme temperatures)	Reduces generator and network capacity and increases failure rates or maintenance/replacement costs. Extreme temperatures are also relevant to asset design specifications.
Bushfire (Likely increases in extreme bushfire weather)	Increasing frequency of dangerous fire weather poses a threat to most assets, with a particularly high operational risk to transmission lines due to heat and smoke. It also an important consideration in transmission line route selection and design.
Wind and cyclones (Possible decrease in high wind events and cyclone frequency, possible increase in cyclone magnitude)	Wind generation is sensitive to any reduction in average wind-speed as well as to an increase in the frequency and magnitude of destructive gusts. Thus, it affects wind generation output, plant profitability and design specifications. High winds also reduce the capacity and threaten the integrity of transmission lines; making it an important consideration for network capacity assessments, design specifications and analysis of failure rates.
Rainfall, dam inflows and flooding (Likely decrease in precipitation, possible increase in extreme rainfall events)	Reduces water available for hydro generation. Increases requirement for desalination loads. Flood events require consideration for asset design specifications and expected failure rates.
Coastal inundation (Projected increase in sea level)	Increasing sea levels may impact on some low-lying generation, distribution and transmission assets.
Compound extreme events (Possible increase in frequency or magnitude)	Compound events, where extremes in multiple variables occur simultaneously or in close sequence have the potential to cause substantial disruption. These events can be compounded by associated non-climatic factors such as infrastructure failure or staff fatigue. ESCI collaboration indicates that extreme compound weather case studies should be used to explore these events.

ESCI - Tailored climate information to support industry decision-making

Target Long-term (2030-2060+) risk decisions:

- Investment risk
- Reliability risk
- Operational/Resilience planning

Key hazards:

- Temperature
- Wind
- Bushfire
- Precipitation

Trends in key climate variables affecting supply and demand:

Time series with high temporal and spatial resolution.

High-impact Weather Simulations:

Synthetic compound or coincident extreme synoptic weather events.

Regional thresholds for key climate variables:

Probability of exceedance for temperature, wind gusts, bushfire weather.

Outputs:

- Data products
- Guidance
- Training
- Case studies

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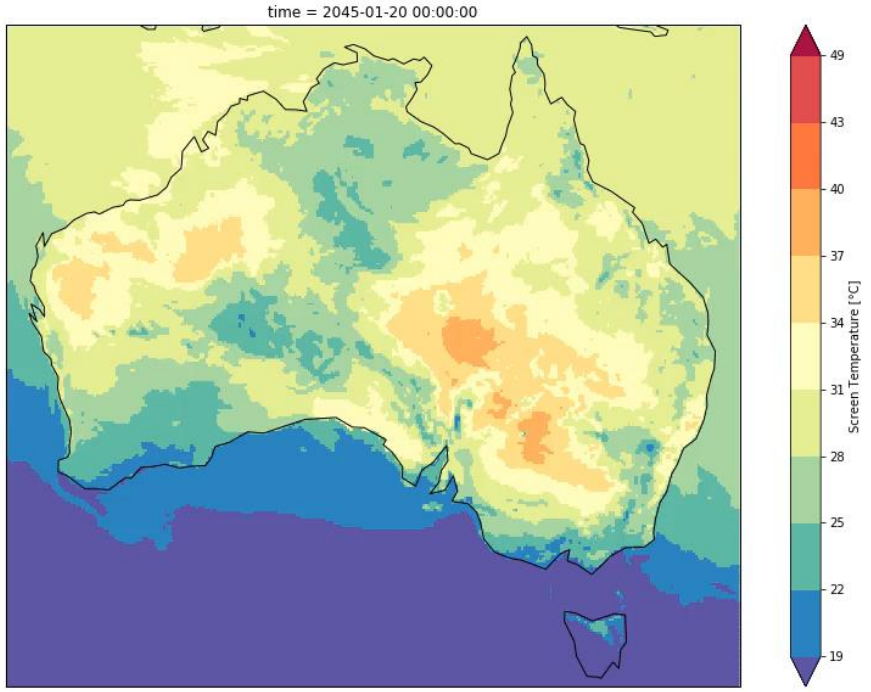
Compound extreme events

- Projections for individual climate variables can often be quantified.
- Disaster events tend to be the result of combined extremes occurring simultaneously.
- Assigning probability to compound extreme events is regarded as a significant scientific challenge.
- ESCI project advice is to develop extreme compound weather case studies to explore these events, despite the lack of probabilistic climate information.



Proposed forecast improvements

Extreme weather, climate and resilience risks

AEMO considers climate resilience in multiple ways

Risk analysis and risk evaluation

Where possible, risk analysis considers both the impact of acute and chronic hazards. Where captured, these risks contribute to the estimation of system reliability, security and calculated project market benefits. While efforts have been taken to improve risk analysis and evaluation to capture climate resilience, many acute hazards remain excluded.

Planning standards

Planning standards consider climate and resilience when developing physical designs, and technology solutions. Through this consideration, proposed risk management solutions enhance system resilience, but may not yet appropriately address all risks.

Operator flexibility and procedures

Where possible, operational controls are used to manage system resilience and security in the presence of increasing and coincident hazards. Operators are however limited by the infrastructure and systems available at the time of hazard.

AEMO applies the CIGRE definition:

"**Power system resilience** is the ability of the system to limit the extent, severity, and duration of system degradation following an extreme event."

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Improvement: Better include climate trends in quantified market modelling

Incorporate a broader selection of climate change trends in modelling input. In doing so, economic market benefits of system investments, reliability and operability assessments will capture a broader suite of climate risks when the system is operating under mostly normal conditions.

Improvement: Develop extreme weather and energy system case studies

Use this analysis to explore implications on energy system planning, optimal outcomes and system resilience. Differentiate between more and less resilient risk mitigation solutions and build an evidence base for additional changes to planning standards and risk management approaches.

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Forecasting capability uplift

The modelling of climate change and extreme events requires three things:

1. Availability of fit-for-purpose climate data based on climate science.
2. An ability to model the entire power system using weather inputs, rather than sampling history.
3. A selection of power system component models that accurately represent performance at times of extreme, not just normal operation.

Power system component models requiring uplift:

- Customer demand traces
- PVNSG & Rooftop PV
- Wind farms
- Transmission line ratings

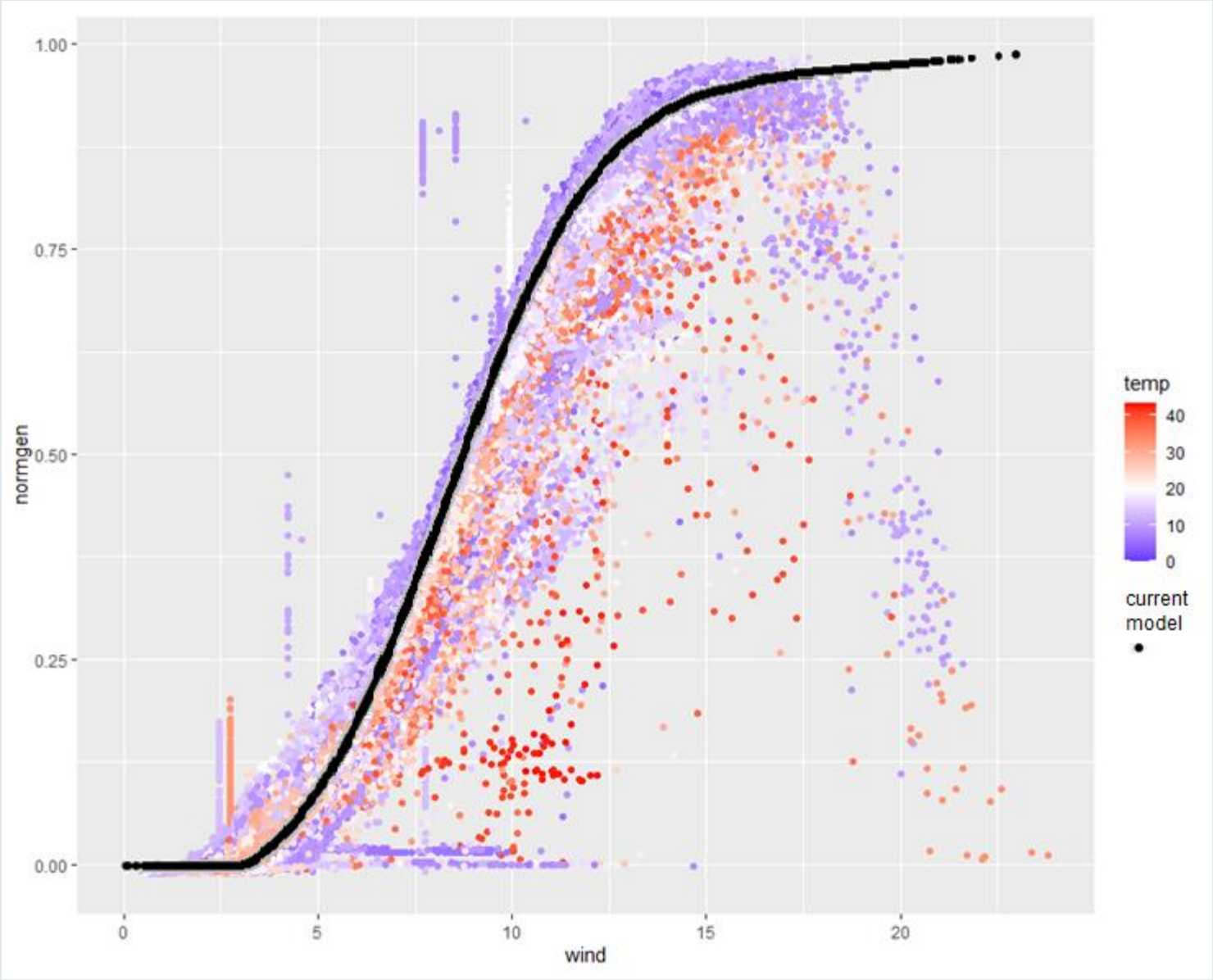
Possible new component model:

- Transmission line failures (bushfires, high wind events)

Current wind model

While history is used to develop wind traces, gaps are filled using an empirical power curve for each wind farm. Design standards for new wind farms could influence this relationship.

High wind cut-out and high temperature derating are evident but not captured when gap filling in current approach.



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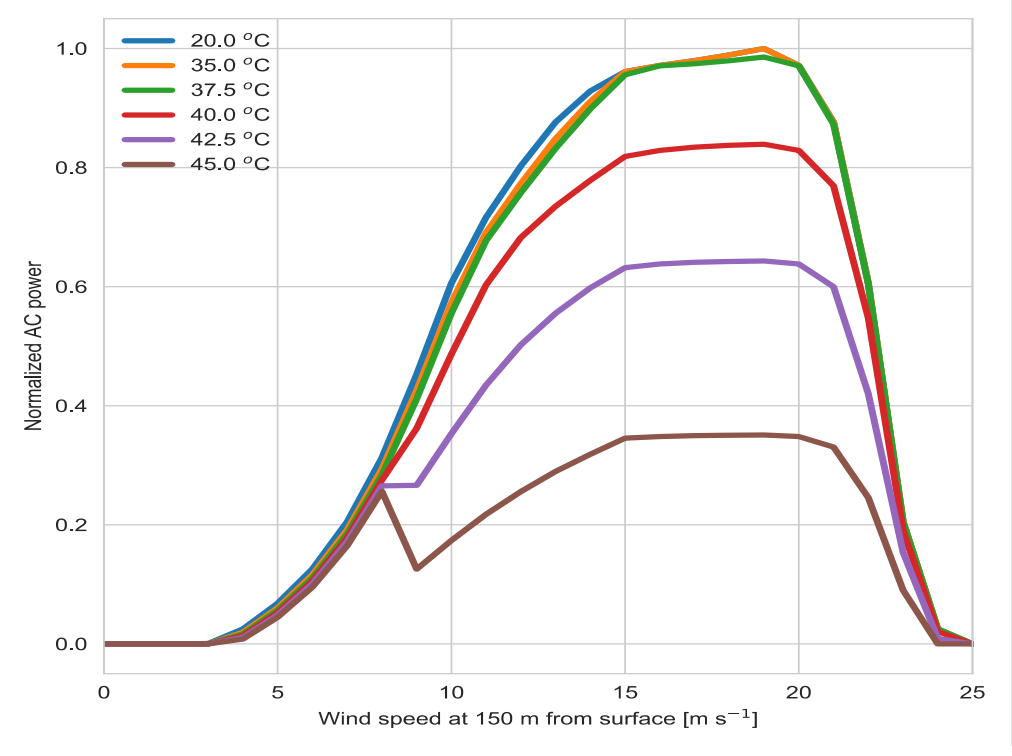
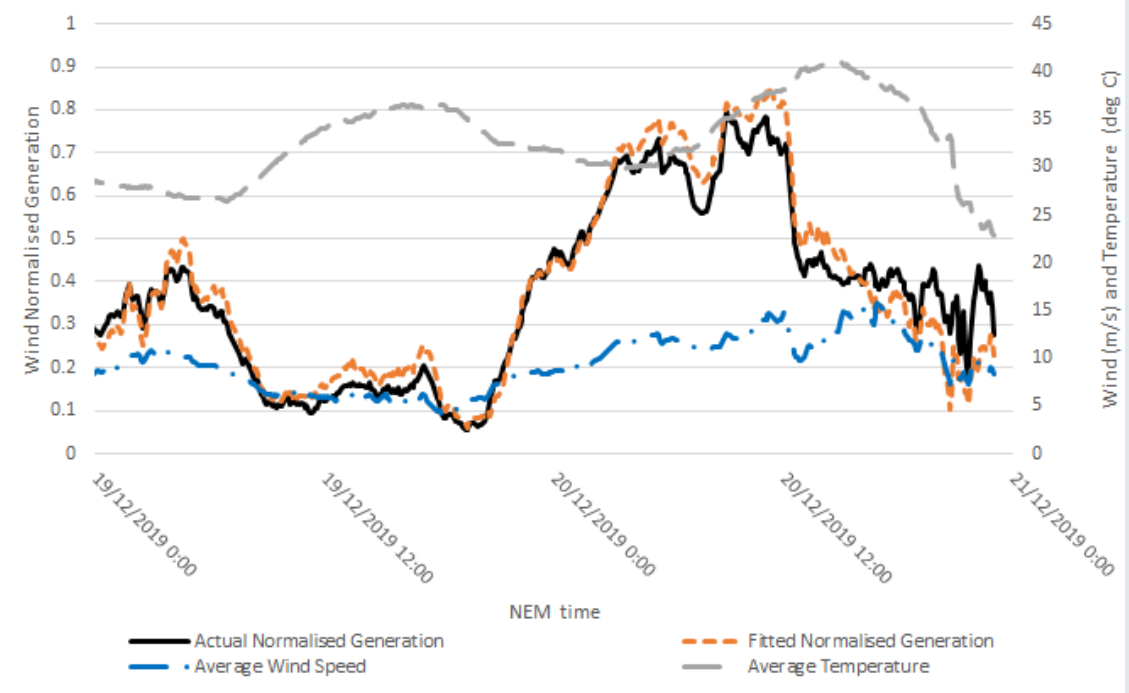
Alternate wind model

Alternate models can better capture high wind and high temperature cut outs, producing realistic traces.

These traces can be used in power system modelling of compound extreme event case studies, and in gap filling.





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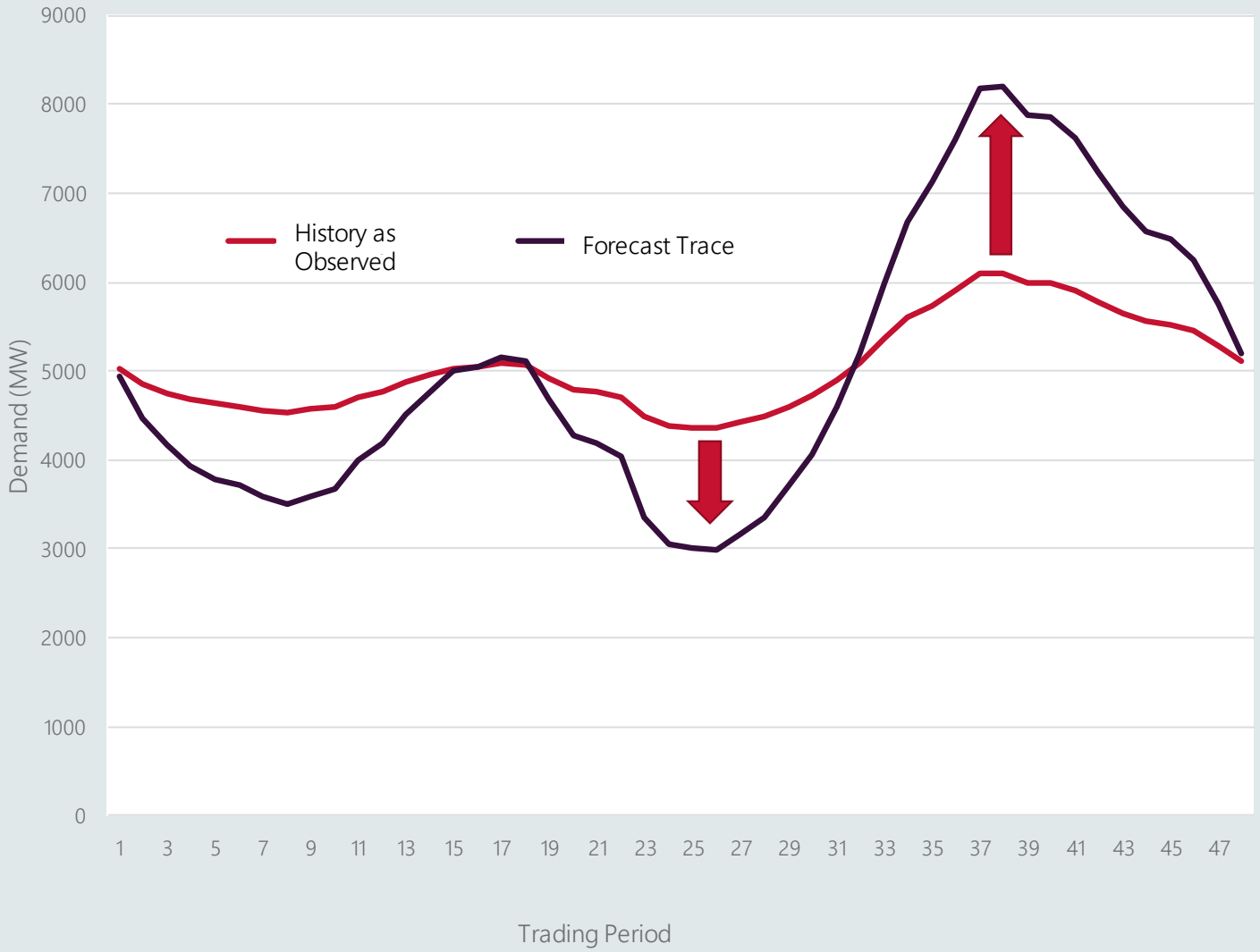
Current demand traces

Forecast demand traces are developed using complex scaling of historic demand to reach min/max and energy consumption targets.

While demand models use weather to predict the targets, the traces are still tied to weather as observed in the reference year. It can be challenging to stretch years to match demand targets that may not match underlying weather



*Dummy data for concept only.

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Alternate demand traces

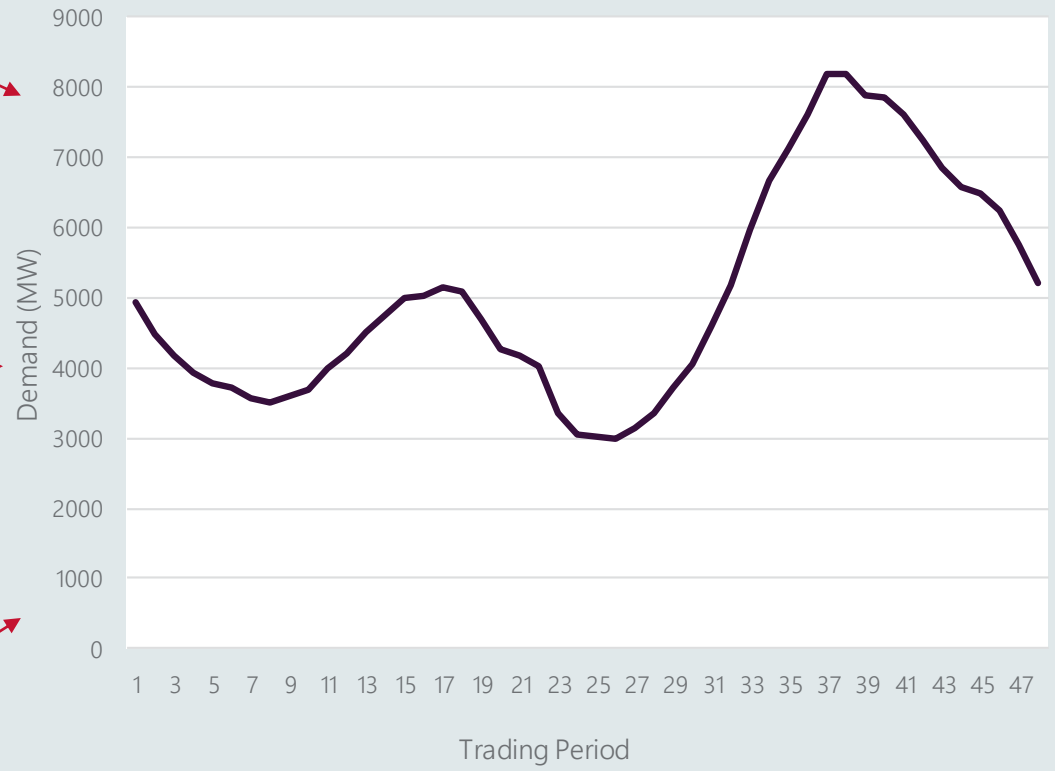
Forecast demand traces could be developed directly from weather. Coincident consumer responses to weather and non-weather inputs could be simulated.

While still at research stage, these traces can be used in power system modelling of compound extreme event case studies at a minimum, and may assist with overcoming other current limitations longer term.

Weather inputs

Scenario characteristics (GDP, PV, EV, etc.)

Coincident consumer randomness



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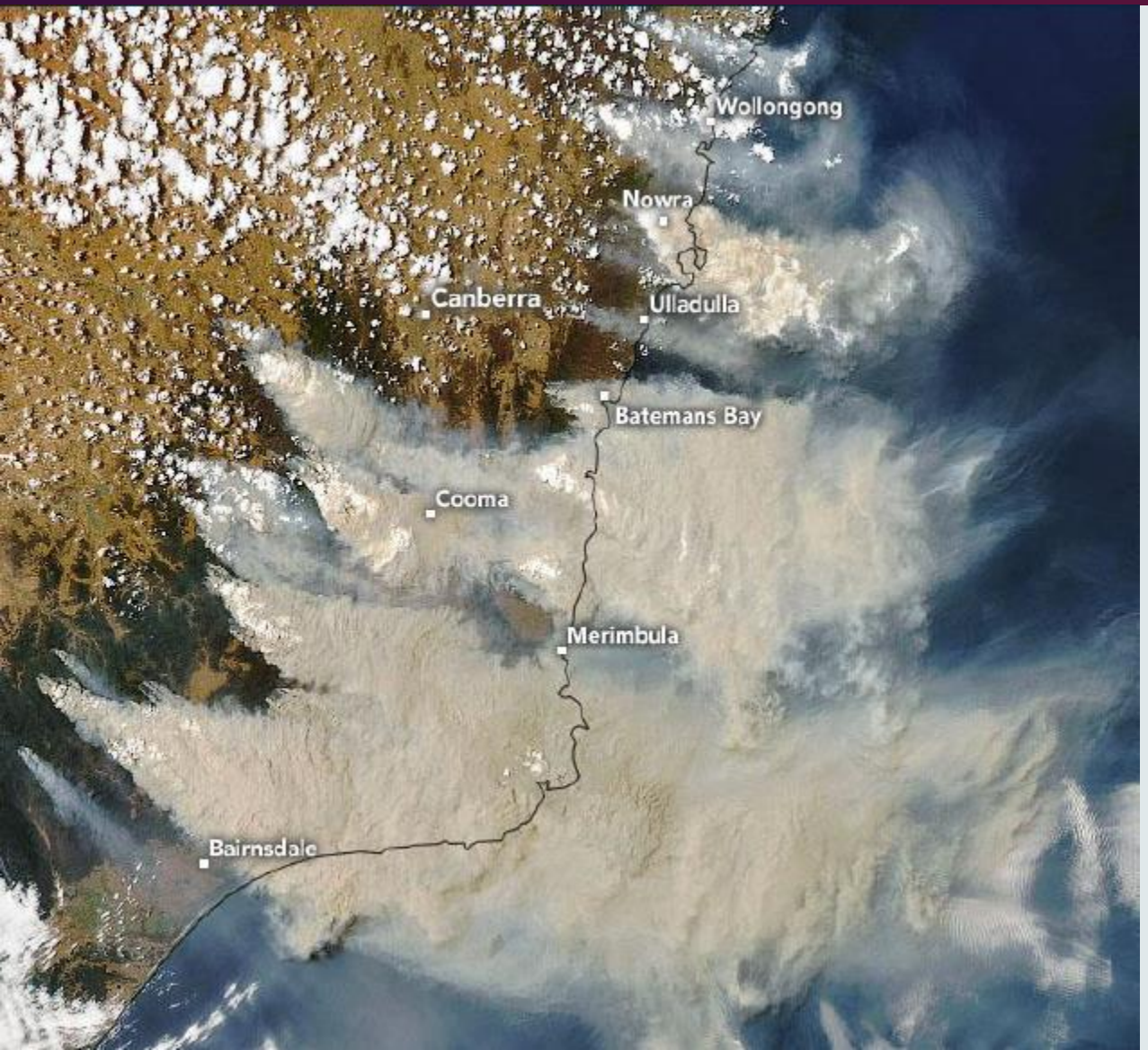
2020 ESOO Bushfire Case Study



A single case study was developed for inclusion in the 2020 ESOO based on the December 2019- January 2020 black summer bushfires, though not as part of the reliability forecast.

It explores the reliability outcomes that may occur should these weather and power system events reoccur in January - February 2024, coincident with high demand.

It demonstrates the need for further analysis of extreme events, particularly those which may not be represented in the history.

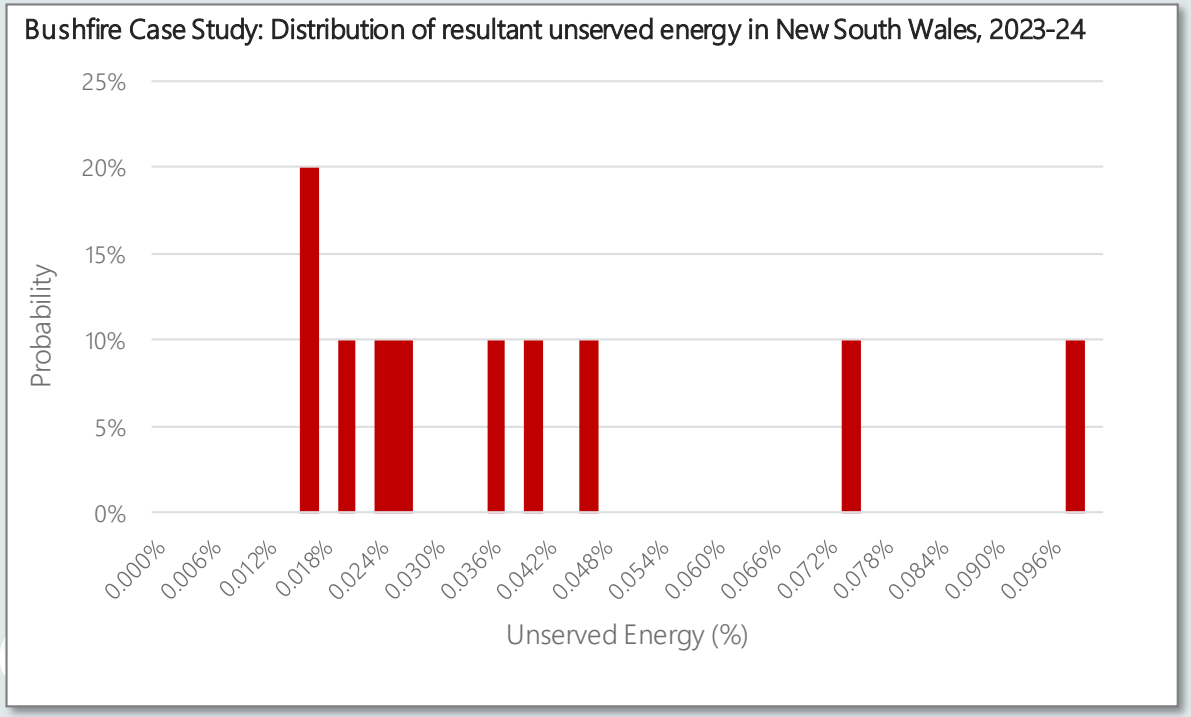
Exploring such events may be useful to identify and distinguish risk management solutions for managing power system resilience against increasingly frequent and coincident hazards.

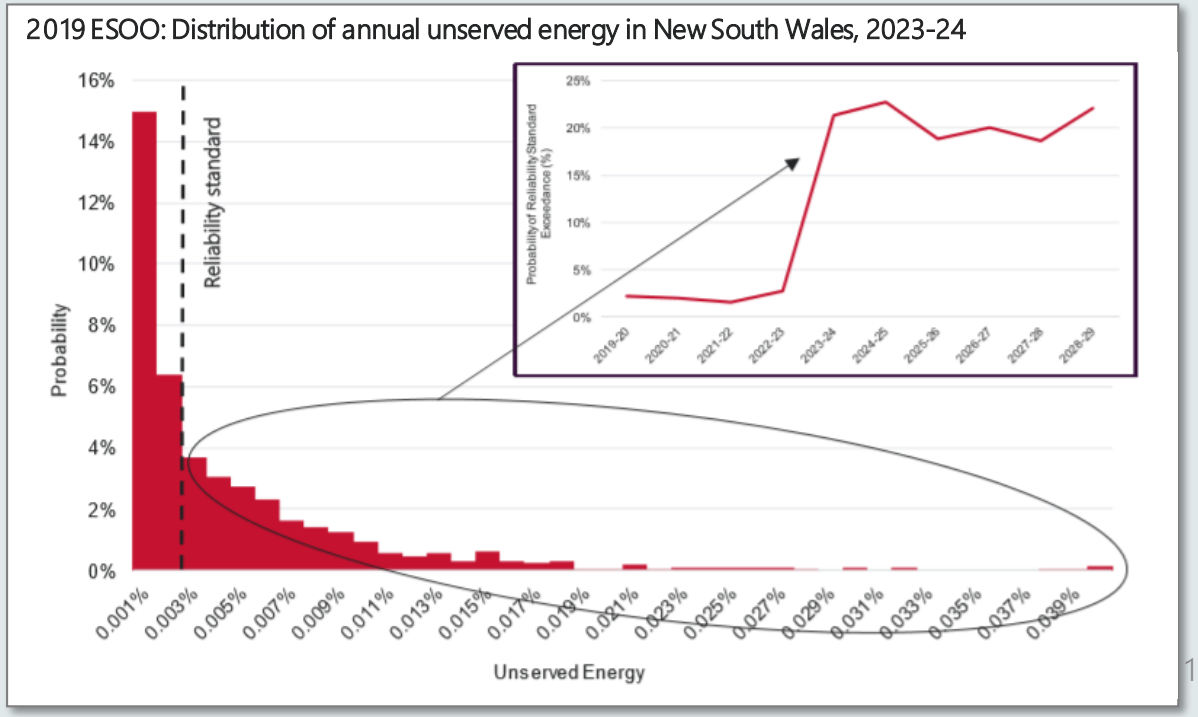
2020 ESOO Bushfire Case Study Results

Ten simulations were used to identify possible outcomes conditional on bushfire occurrence.

Preliminary USE results for NSW vary between 10,639MWh and 66,528MWh (0.016% to 0.097%).

Outcomes extend well beyond reliability tail risk typically considered.





Next Steps

From here, AEMO will:

- Enhance component models
- Develop compound extreme weather case studies

Subject to acceptance criteria that can demonstrate accuracy:

- Consult again with FRG for standard 'reference year' trace development
- Deploy in production

Developments proposed
1. Demand traces Development of synthetic demand traces in response to input weather and simulated coincident consumer behaviour.
2. Wind generation model Development of an enhanced wind generation model that better represents extremes and can be used to generate a trace without history.
3. Rooftop PV and PV NSG trace Development of enhanced solar generation models that can be used to generate a trace without history.
4. Line rating traces Development of enhanced line rating models that better represents extremes and can be used to generate a trace without history.
5. Compound extreme weather case studies Used to complement fully quantified risk analysis.

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