Weathering Uncertainty

Operational Forecasting Innovations for Australia's Energy Transition

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Agenda

1. About AEMO & Operational Forecasting
2. The Importance of Weather in the NEM (National Electricity Market)
3. Weather Ensembles & Scenarios for Demand Forecasting

About AEMO

AEMO and the Australian electricity network

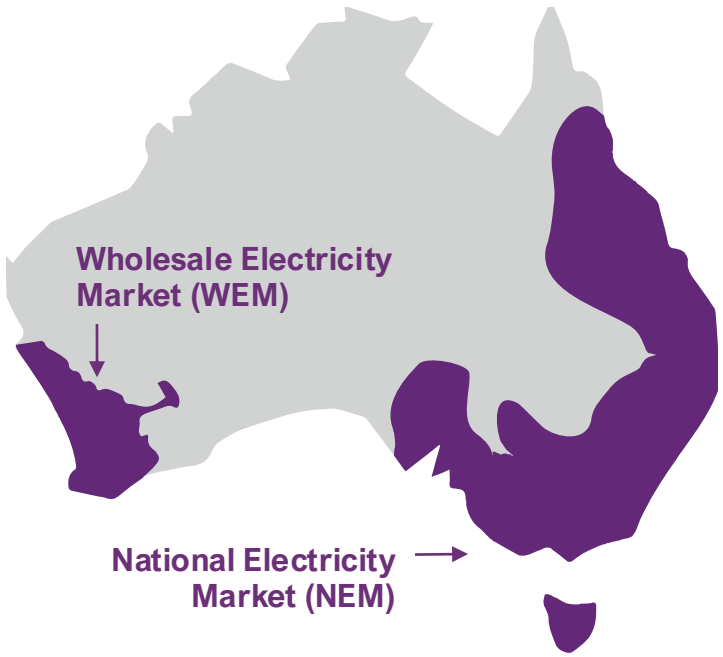
About AEMO

- AEMO is a member-based, not-for-profit organisation.
- We are the independent energy market and system operator for the National Electricity Market (NEM) and the WA Wholesale Electricity Market (WEM), and system planner for the NEM.
- We also operate retail and wholesale gas markets across south-eastern Australia and Victoria's gas pipeline grid.

AEMO SERVICES

AEMO Services is an independent subsidiary of AEMO, established in 2021 to enable the transparent provision of advisory and energy services to National Electricity Market jurisdictions.

Electricity



Gas

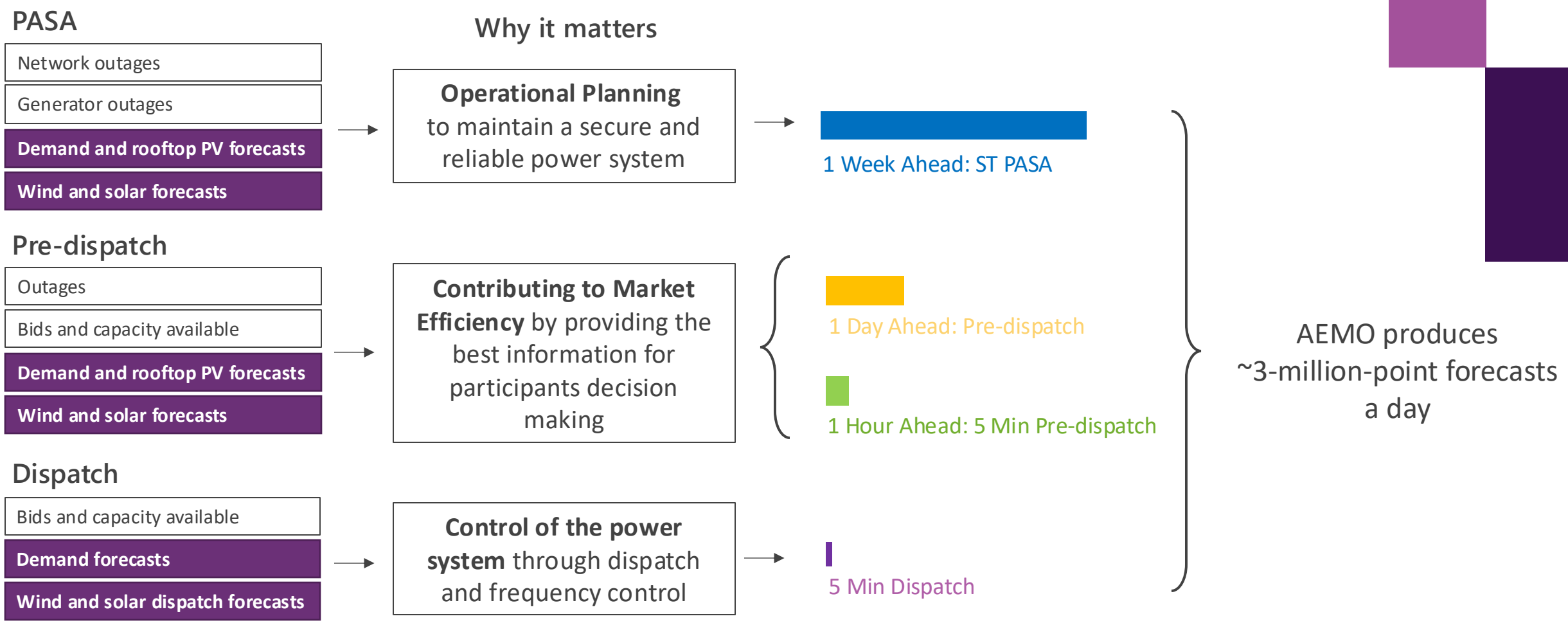
Declared Wholesale Gas Market (DWGM)

Short Term Trading Market (STTM)

and

Gas Supply Hub (GSH)

Operational Forecasting at AEMO



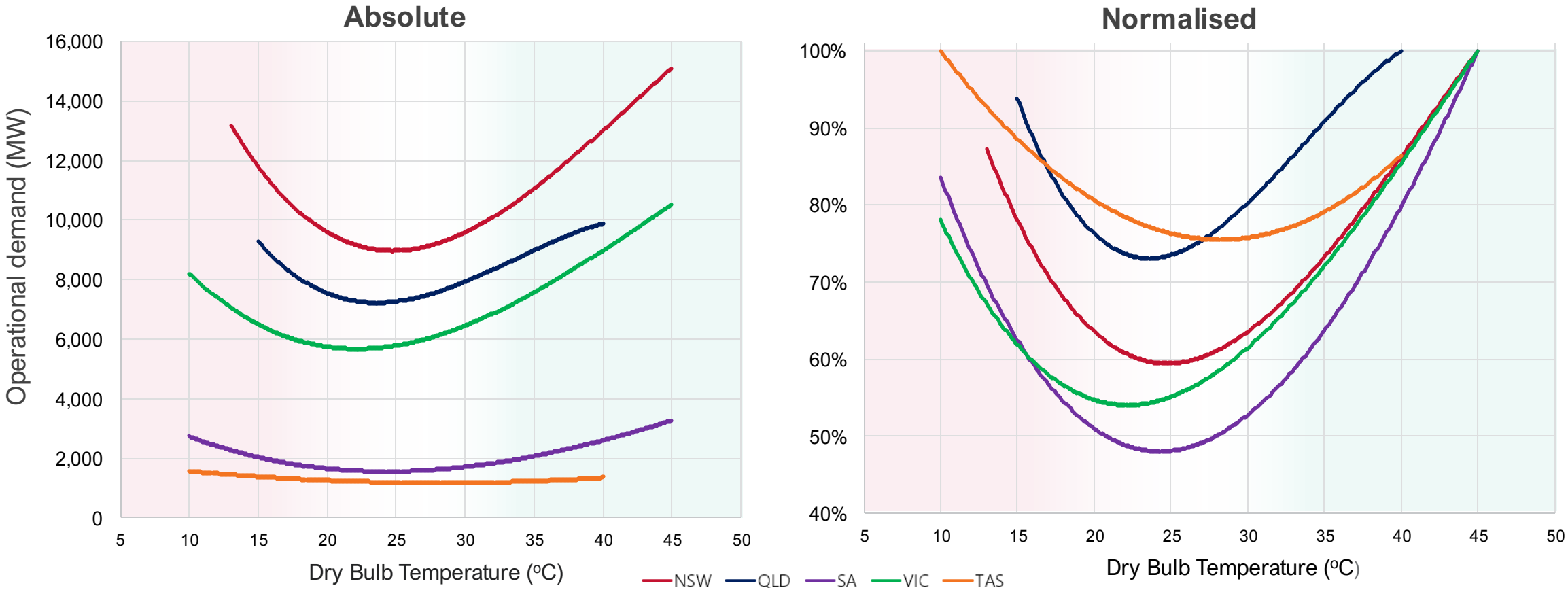
Why Weather Matters

The emergence of weather dependent resources and impact of severe weather on the NEM.

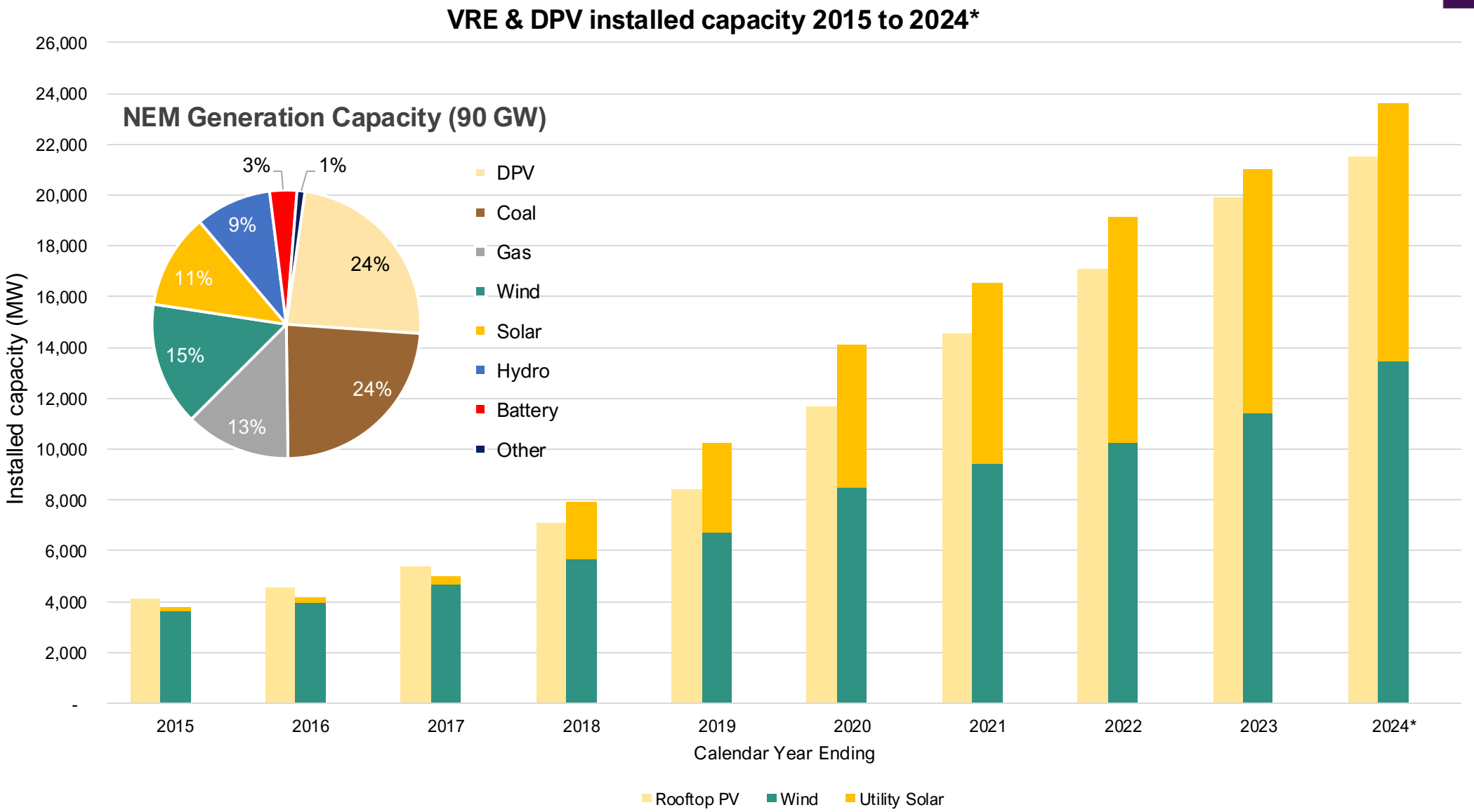
Operational Load & Temperature

Temperature has the largest impact on weather-sensitive demand. Operational Demand increases under both cold and hot conditions due to the requirement for heating and cooling.

Daily peak operational demand by NEM region against daily maximum temperature

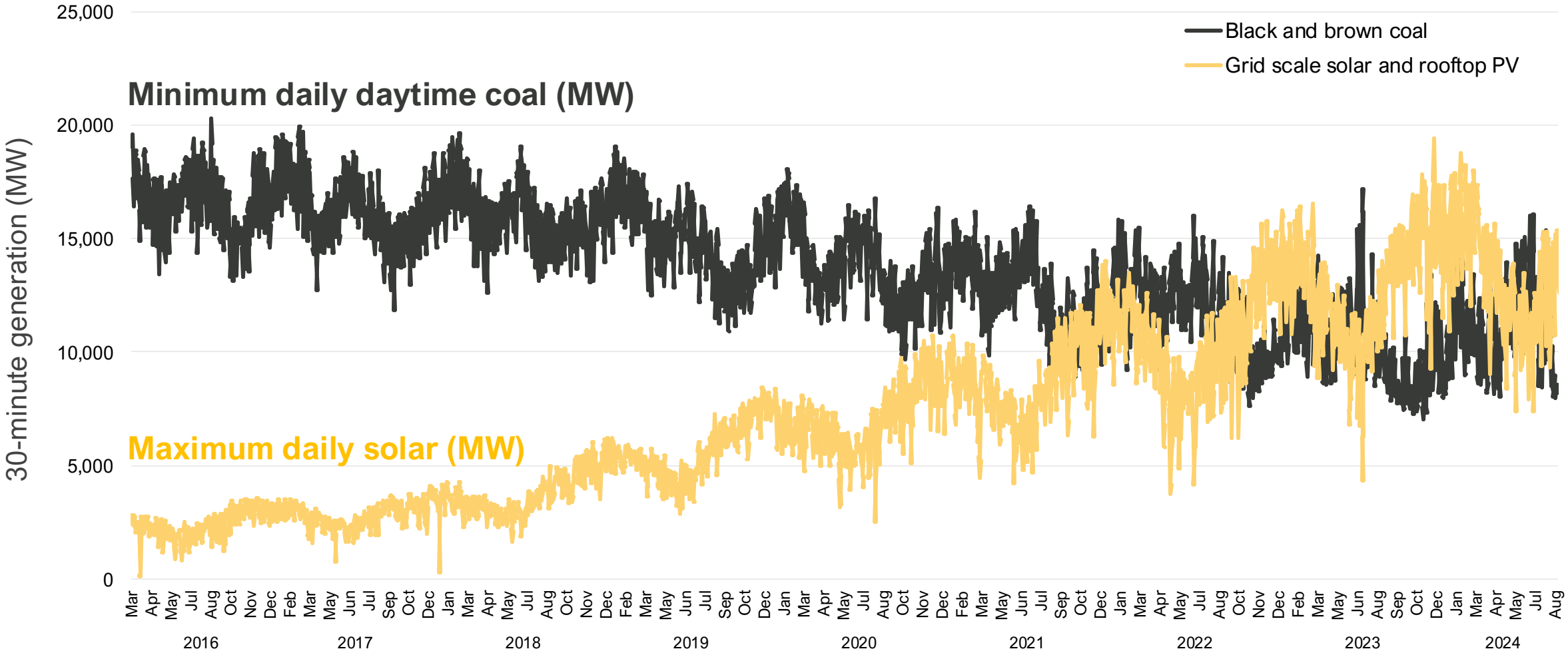


Growth in Variable Renewable Energy



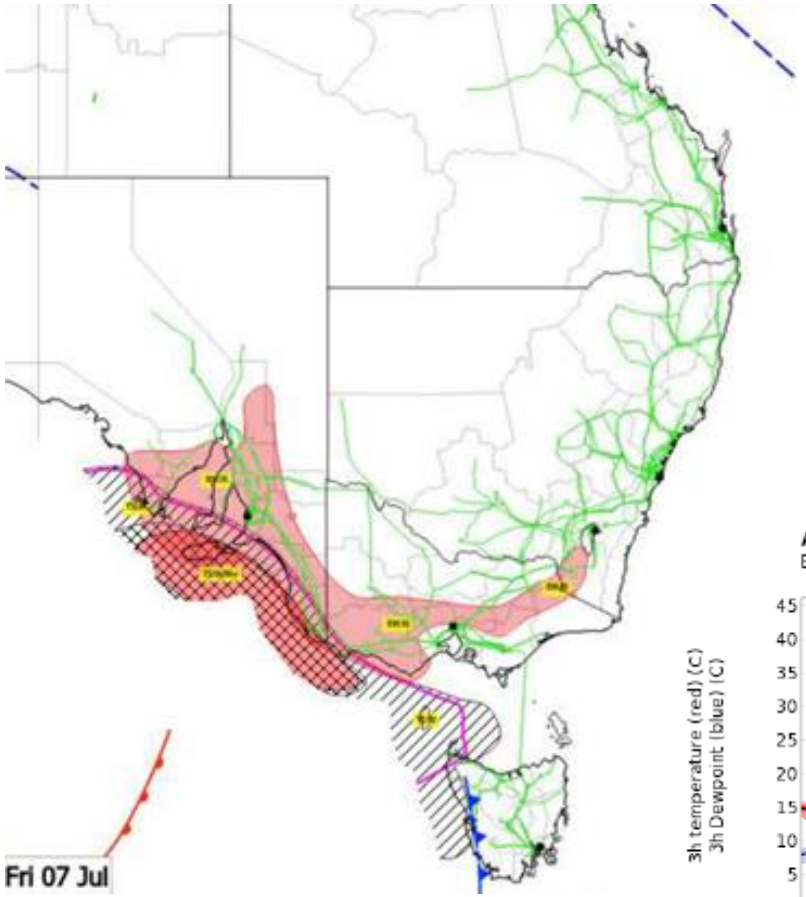
Growth in Variable Renewable Energy

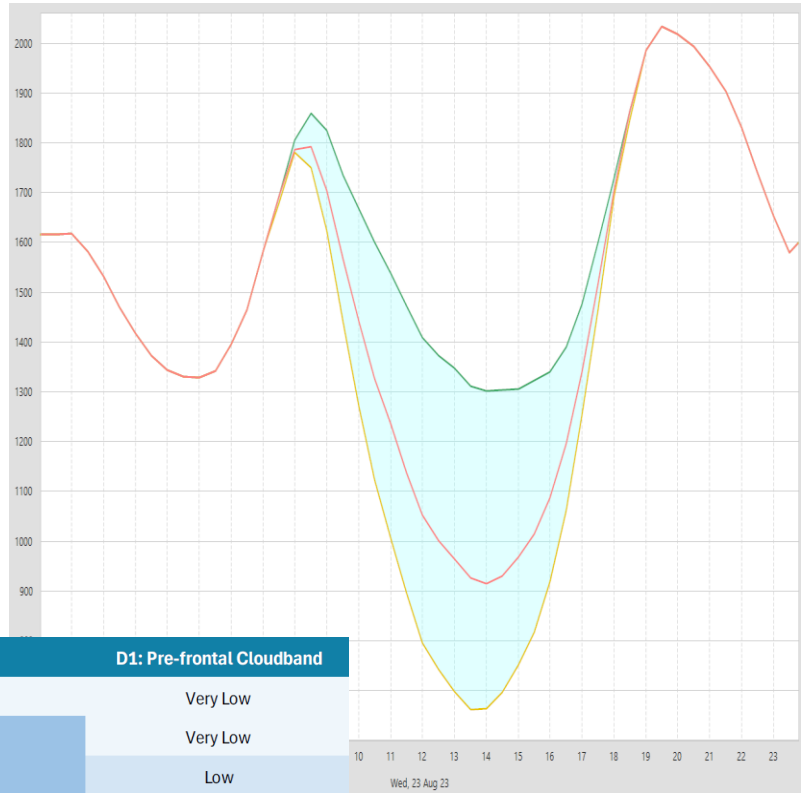
Combined large scale solar and distributed rooftop PV is becoming the predominate generation source during the middle of the day across the NEM.



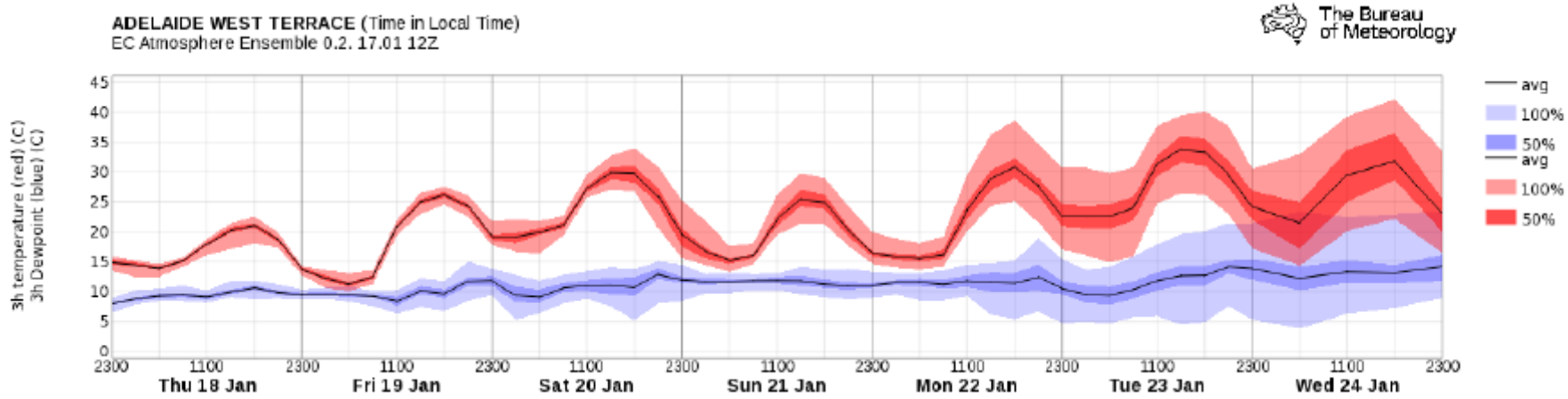
Situational Awareness

Supporting the Uncertainty





Hazard	D0: Ridge	D1: Pre-frontal Cloudband
Cloud Ramp Risk	Very Low	Very Low
Cloud Volatility Risk	Moderate	Very Low
Slow Cloud Clearance Risk	Moderate	Low



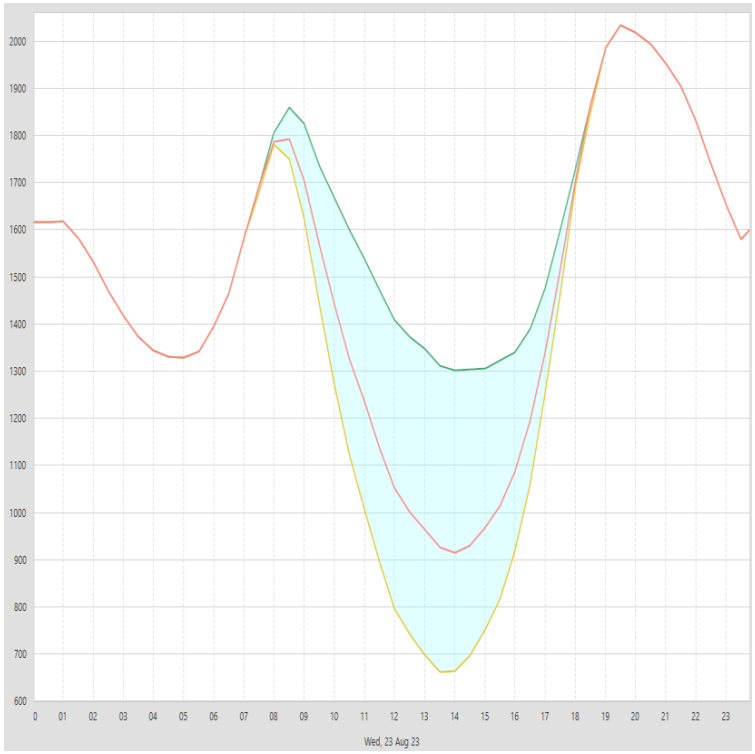
Weather Ensembles for Demand Forecasting

Maintaining performance and reliability of several operational weather providers and adopting models to capture a wider range of possible scenarios

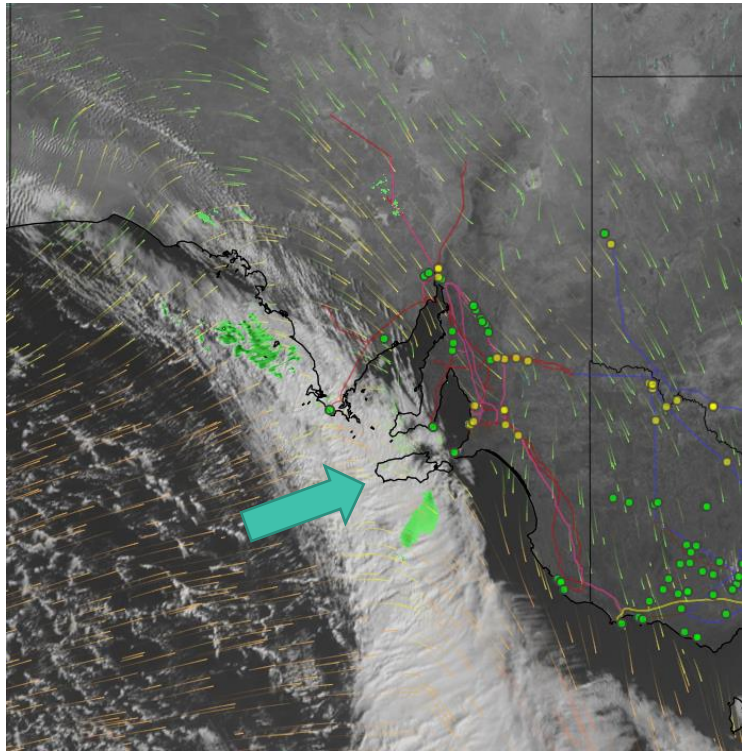
Addressing Uncertainty

We can't forecast our way out of uncertainty – operational envelopes, situational awareness and real-time monitoring are required to navigate forecast uncertainty

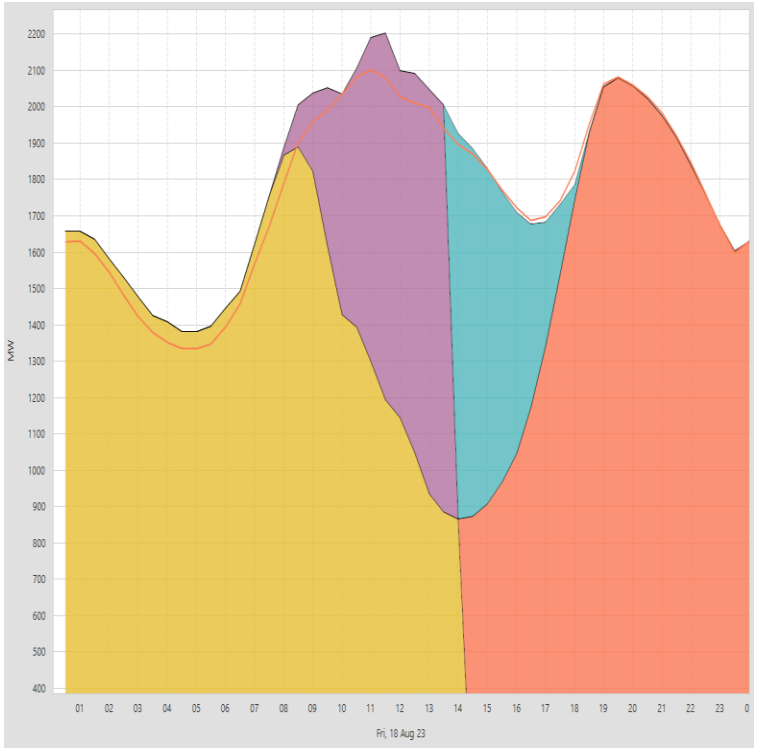
Communicate probabilistic envelopes and uncertainty day-ahead



On-day weather monitoring & situational awareness



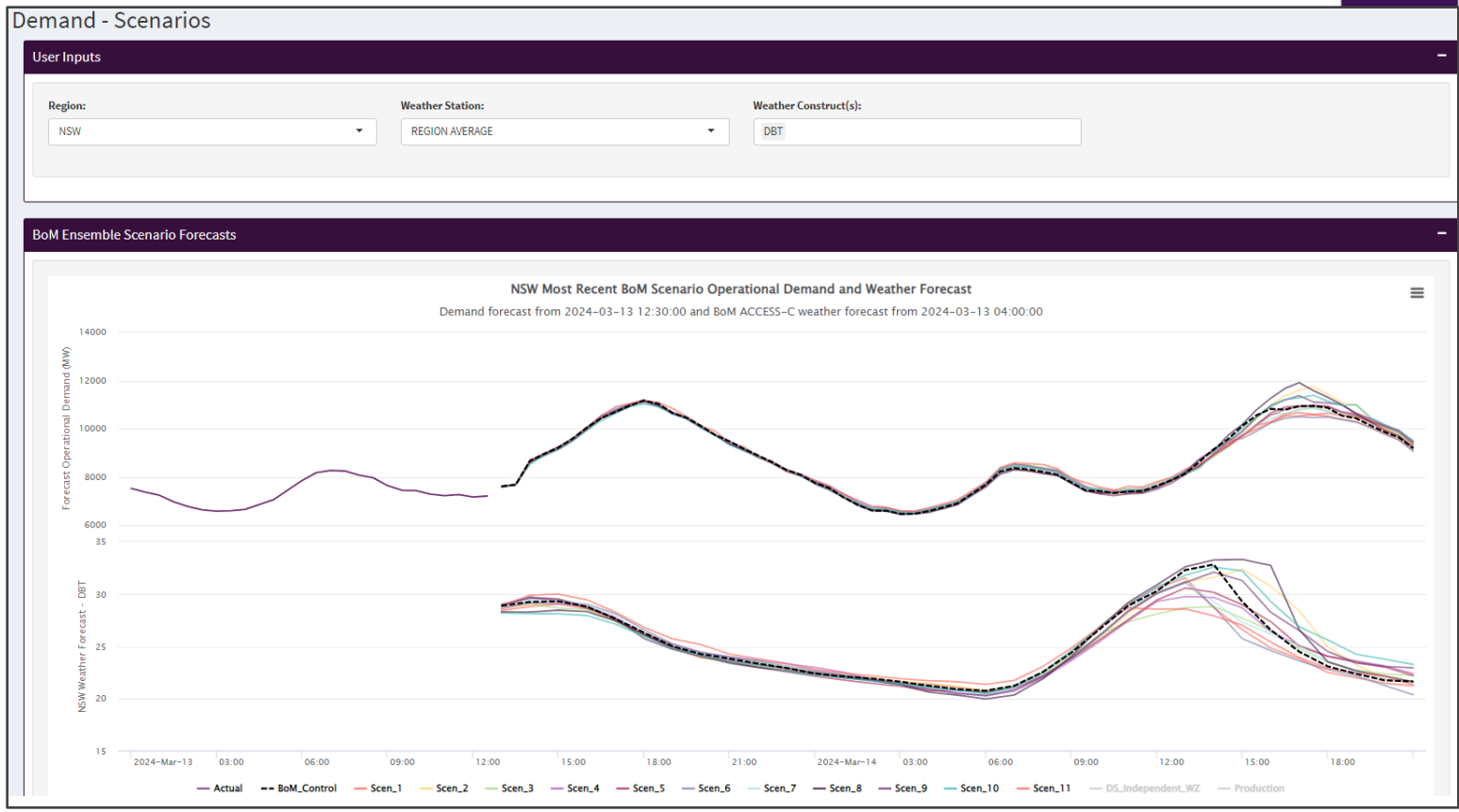
Assess impact on underlying demand & attribute error



Weather Scenario Tool

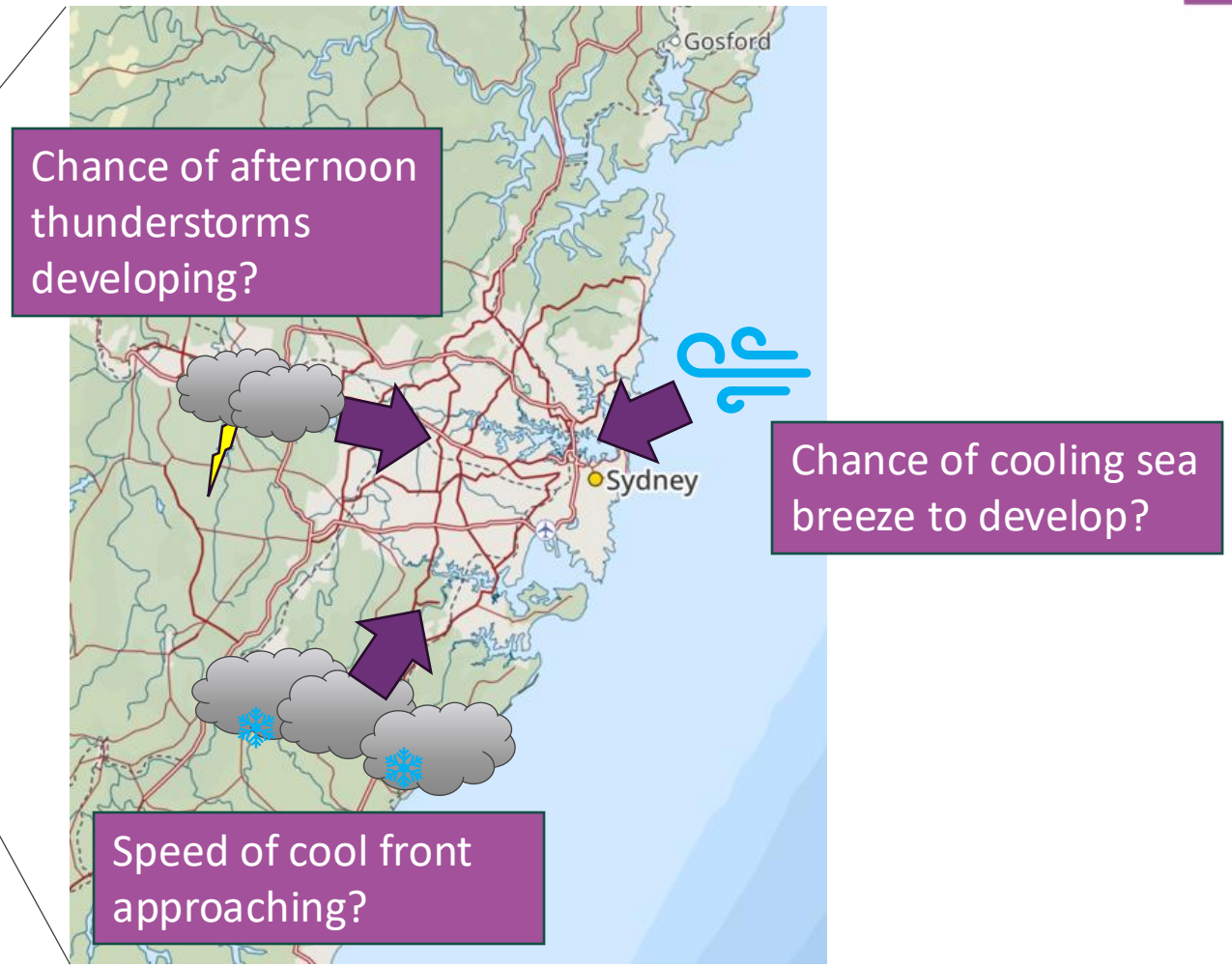
A novel method to translate the operational impact of each weather scenario for increased situational awareness and preparedness.

- High-resolution gridded forecasts for 12 ensemble members (including control).
- Updated every 6 hours, covering 36 hours of the horizon for 8 interdependent weather concepts.
- Highly tailored for 38 DFS point forecasts for direct input into demand models.
- Passed into best performing Machine Learning model to translate weather spread into demand spread.
- Provides a physically representative spread of possible weather outcomes.

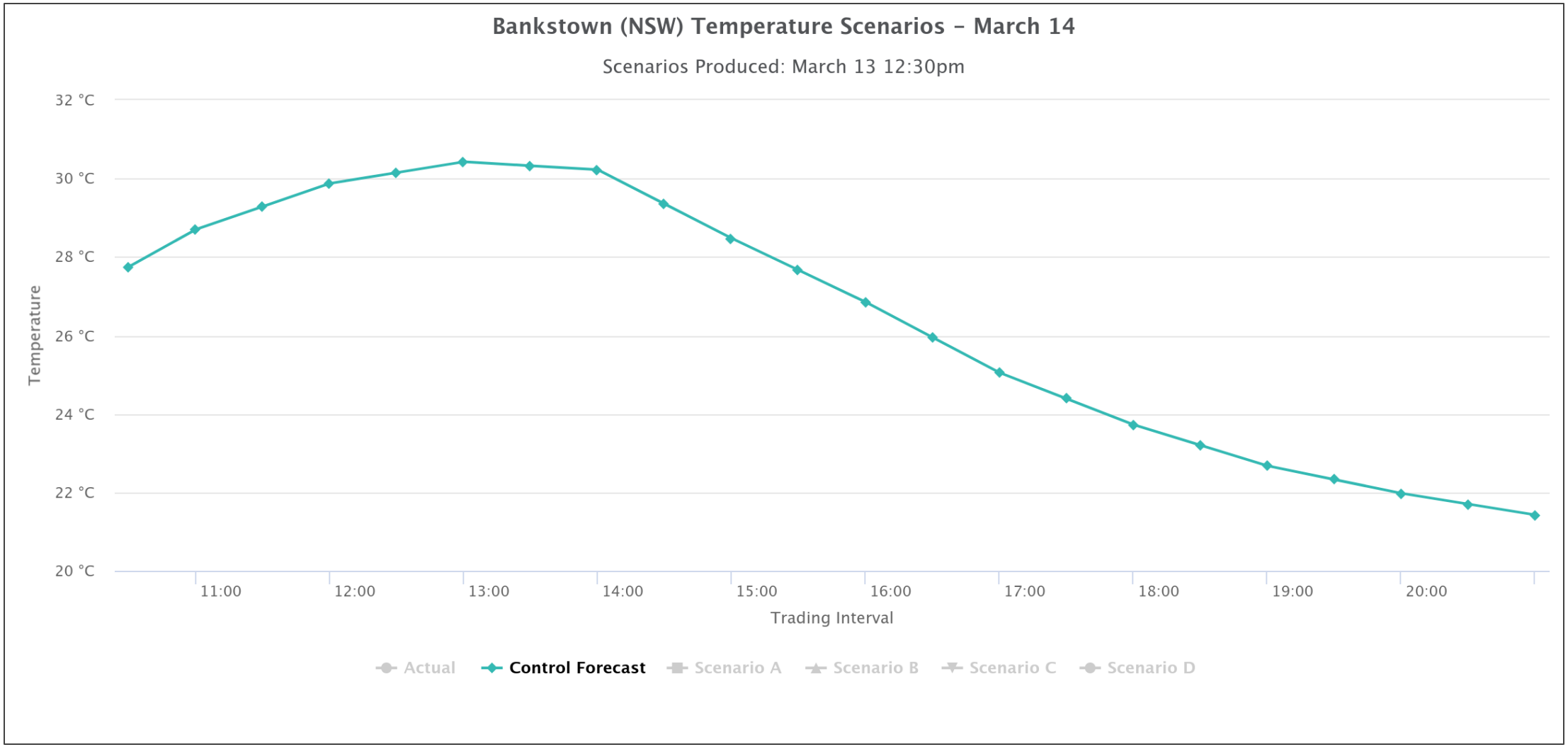


Weather uncertainty and demand risks: New South Wales example

Sydney is the largest city in New South Wales (NSW) and its weather the key driver for the demand in the state. On hot summer demand days, weather risks are often significant, with some examples shown to the left.



Weather Scenario Case Study
New South Wales – 14th March 2024



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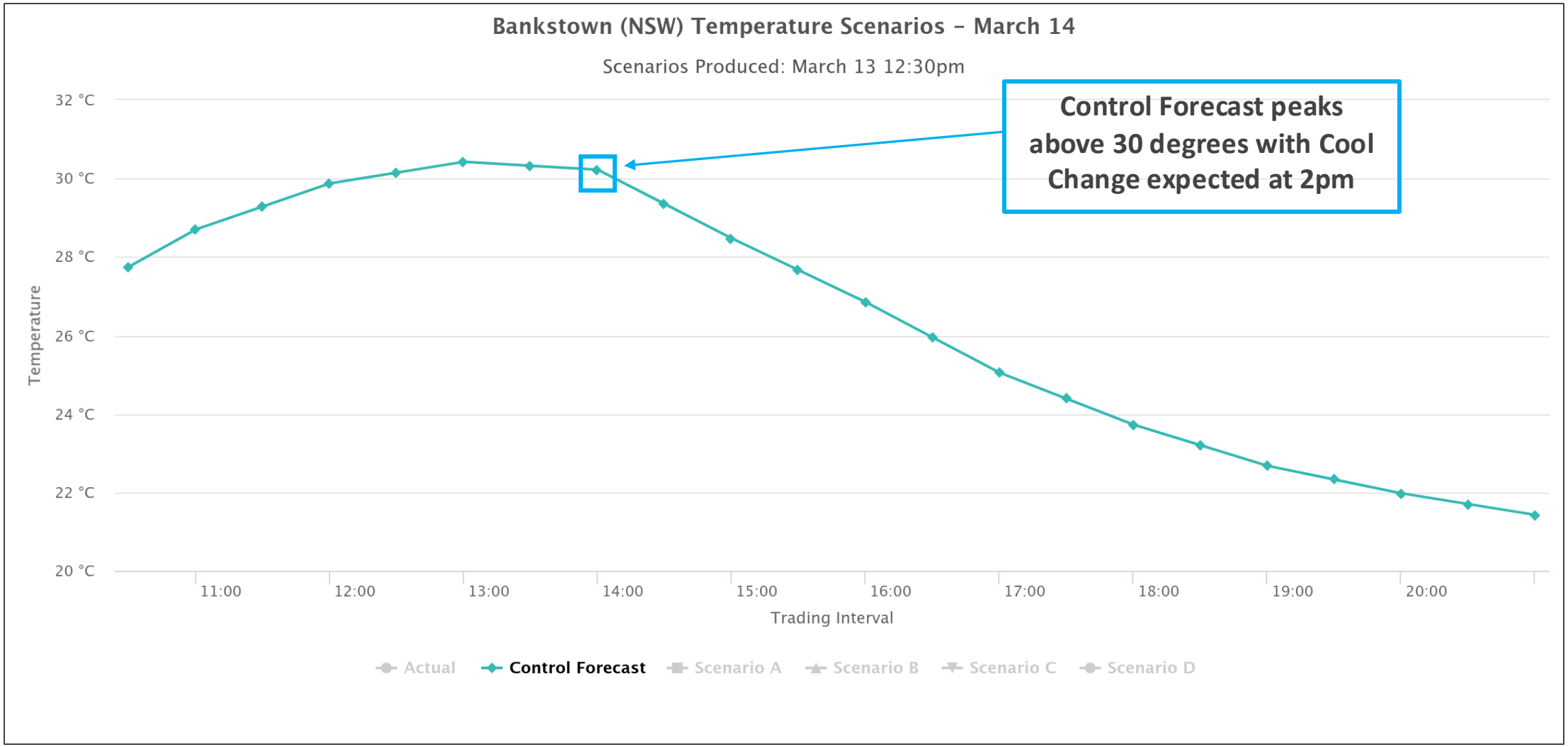

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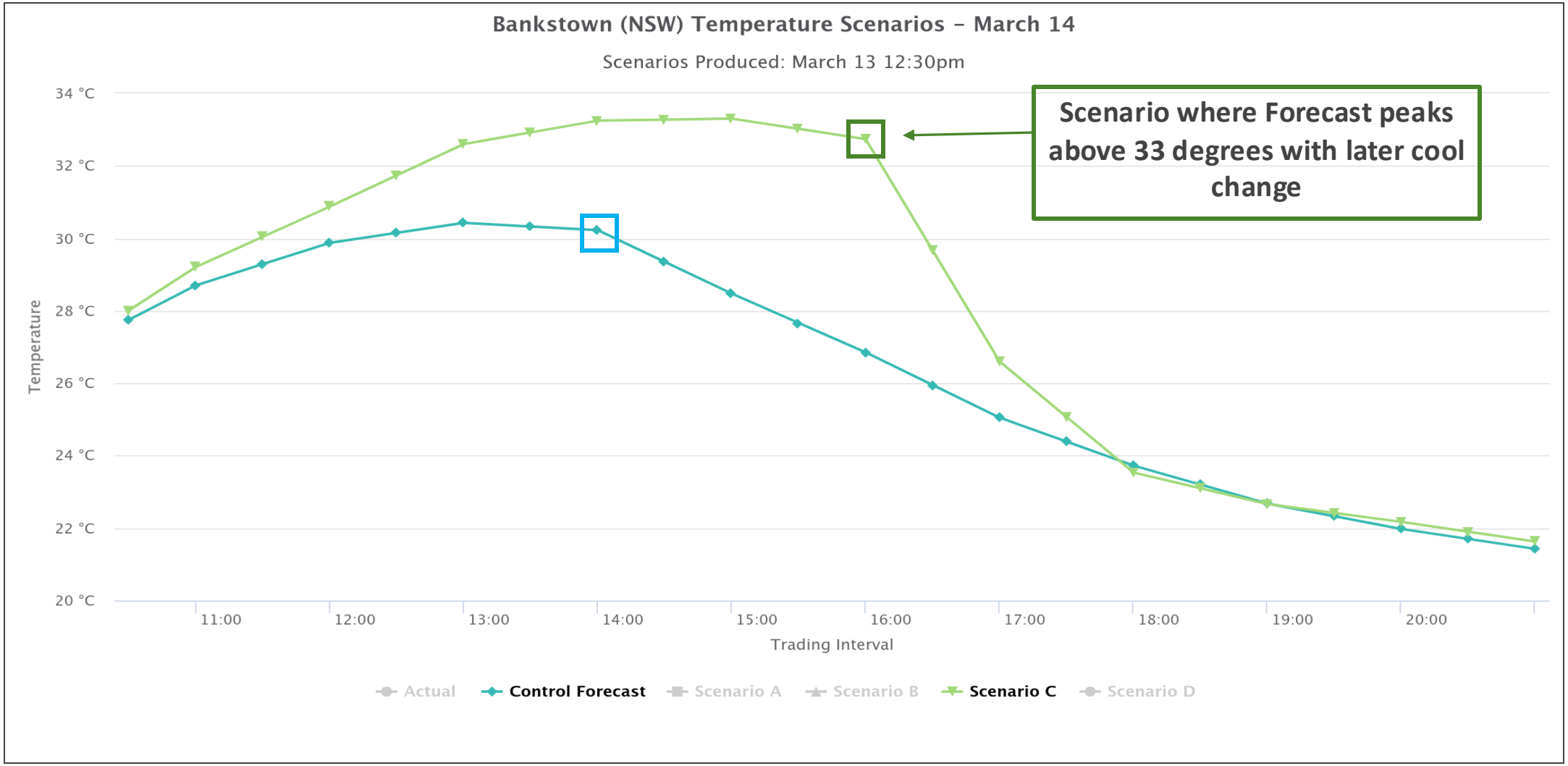

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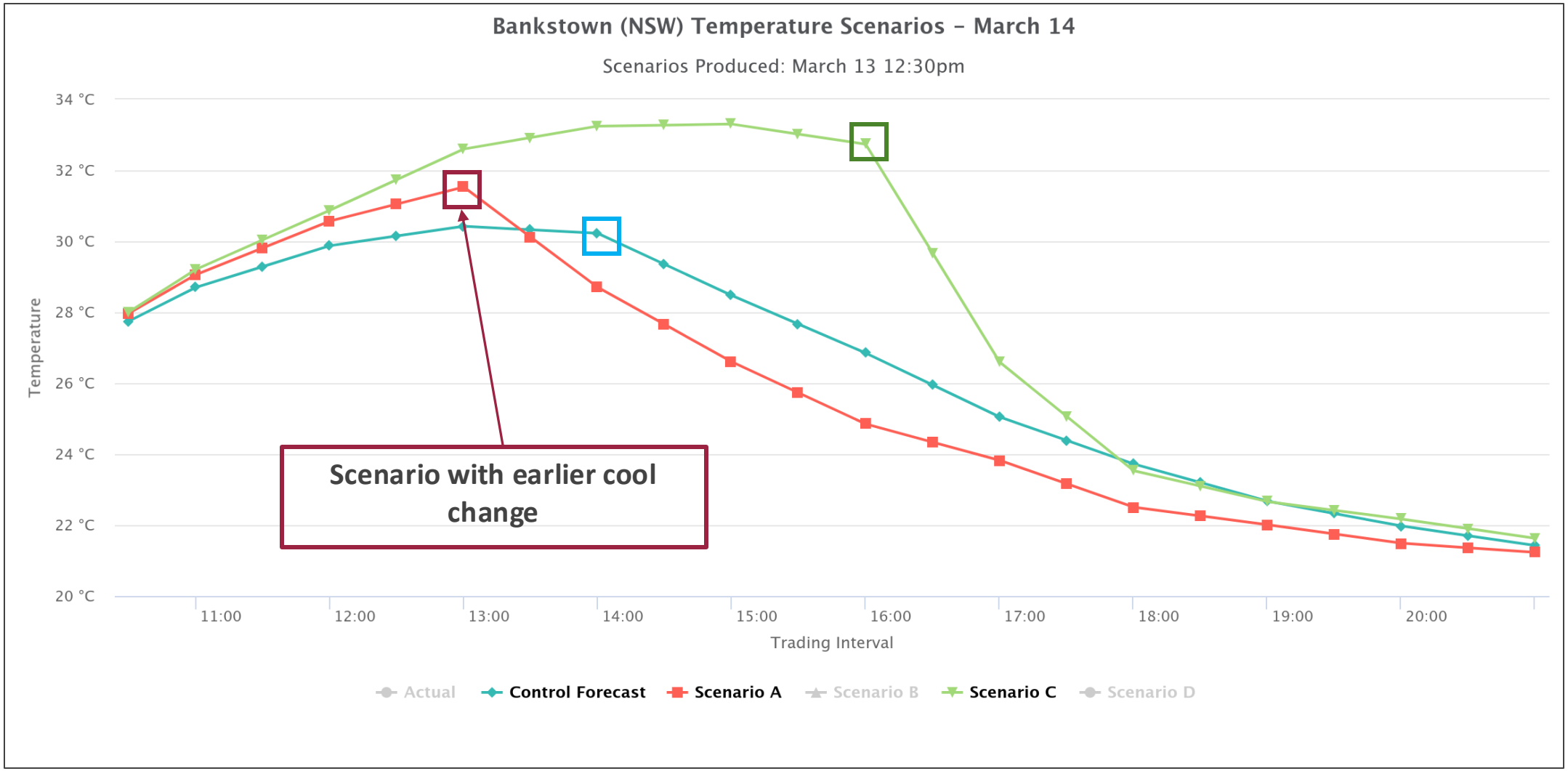

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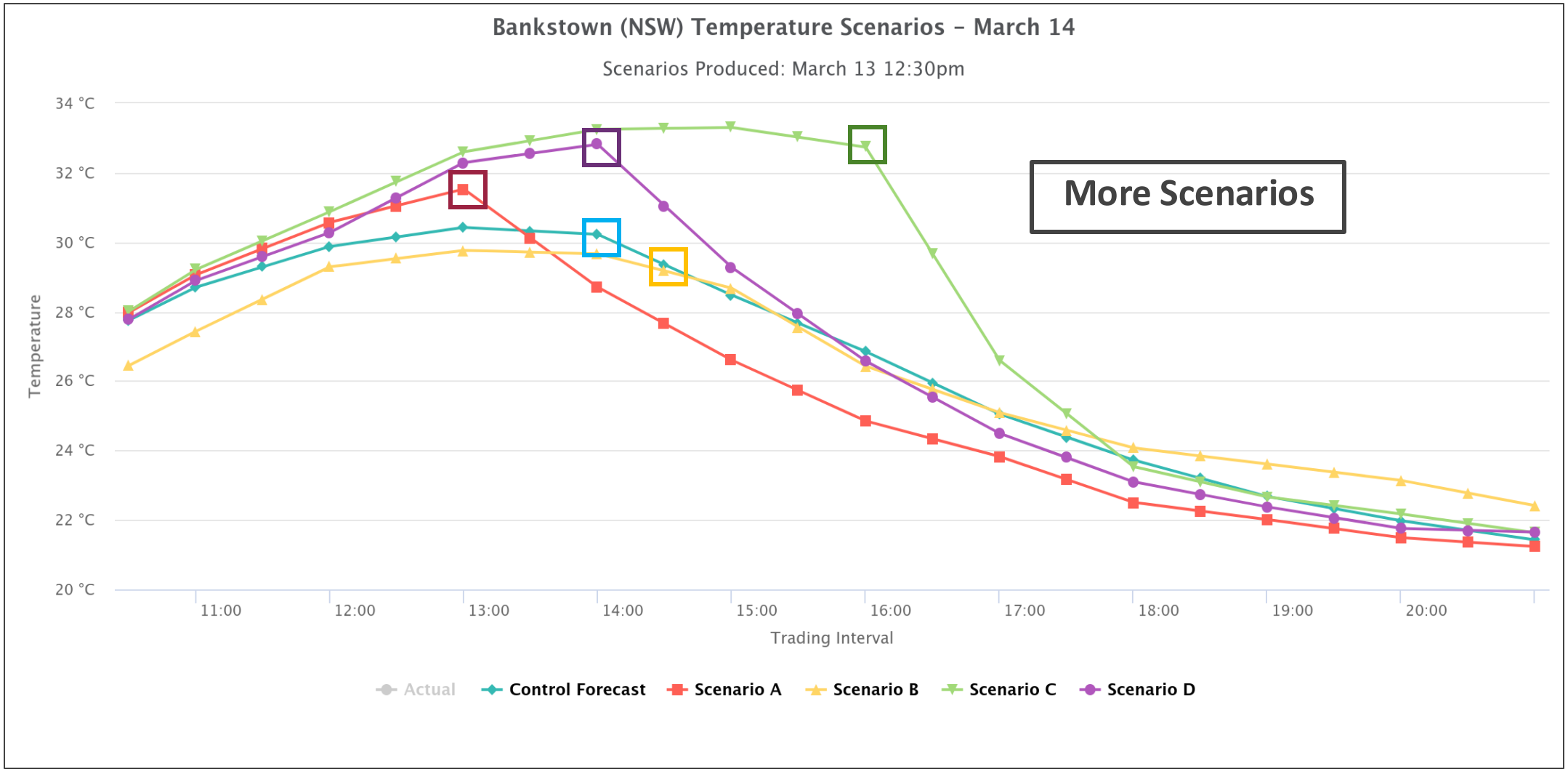

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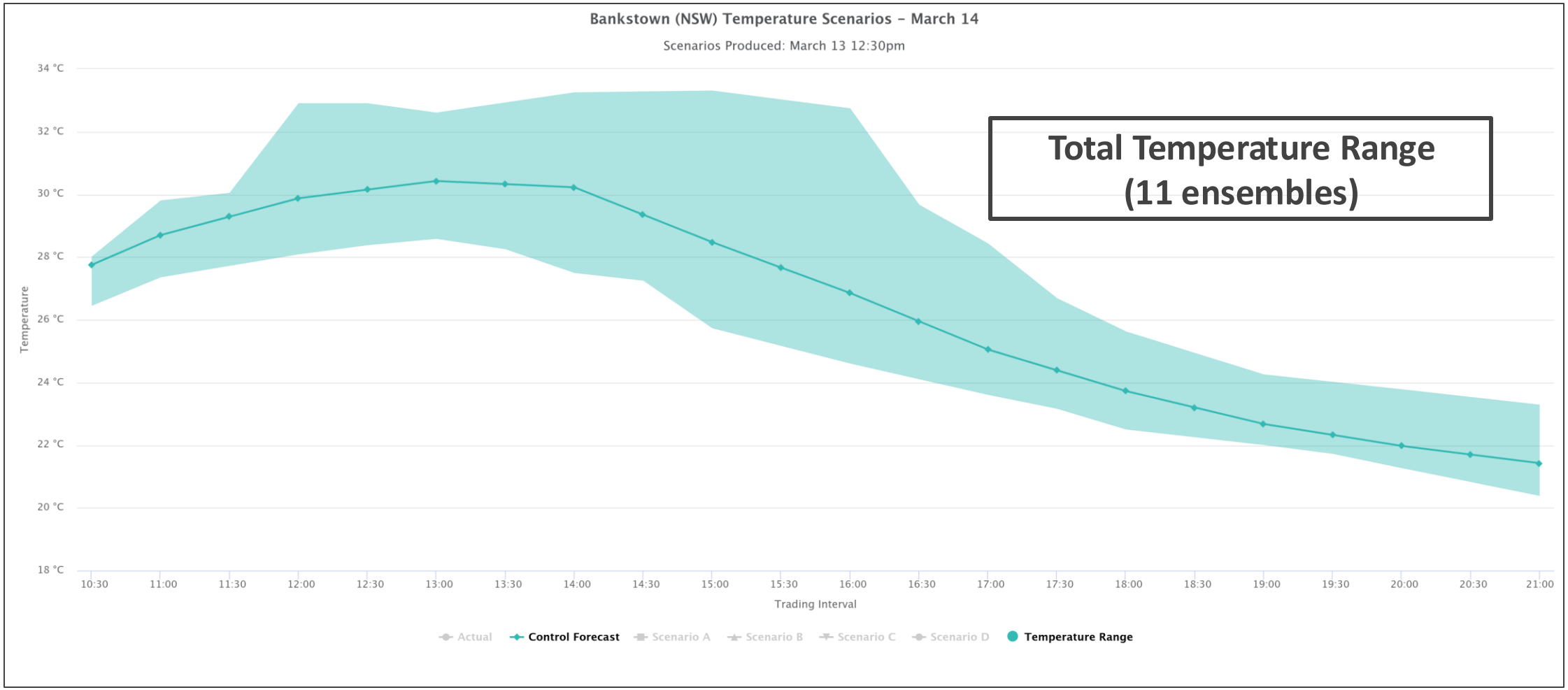

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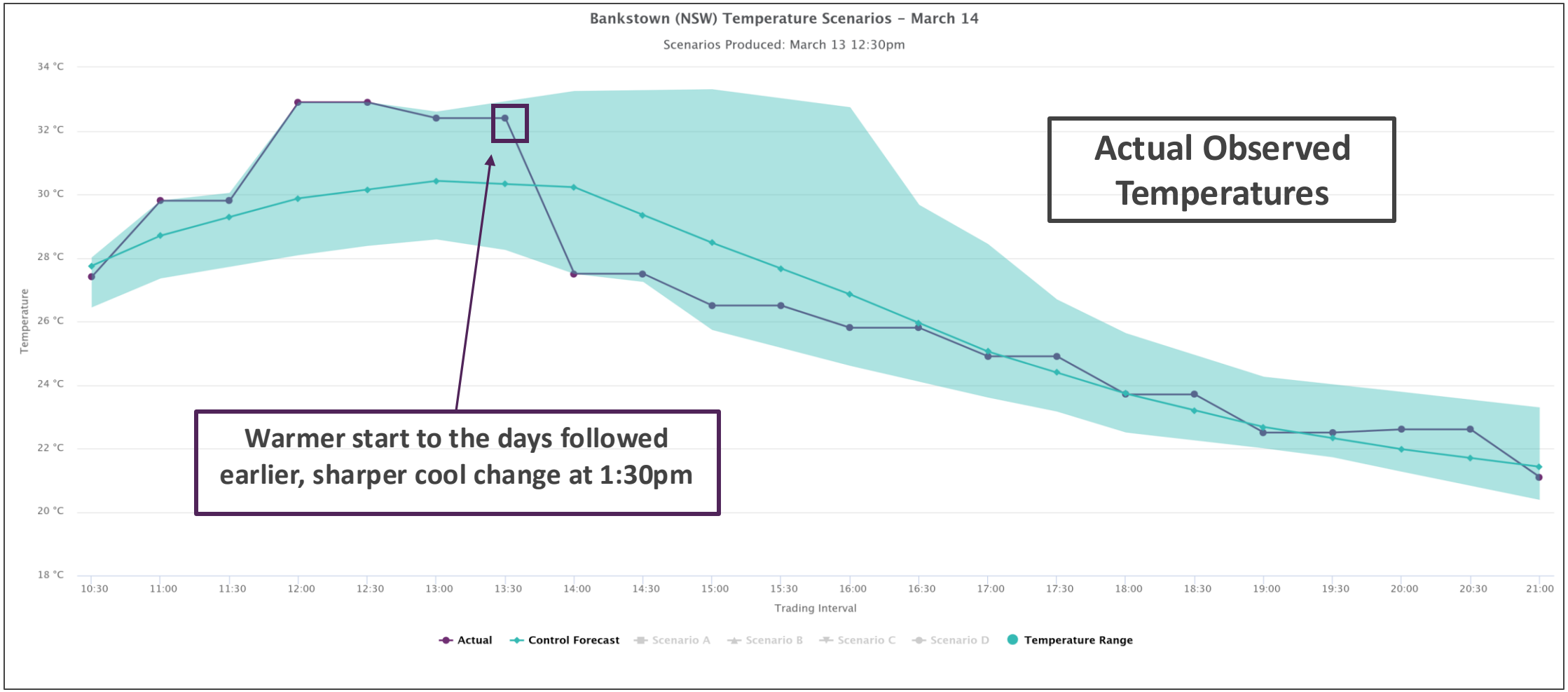

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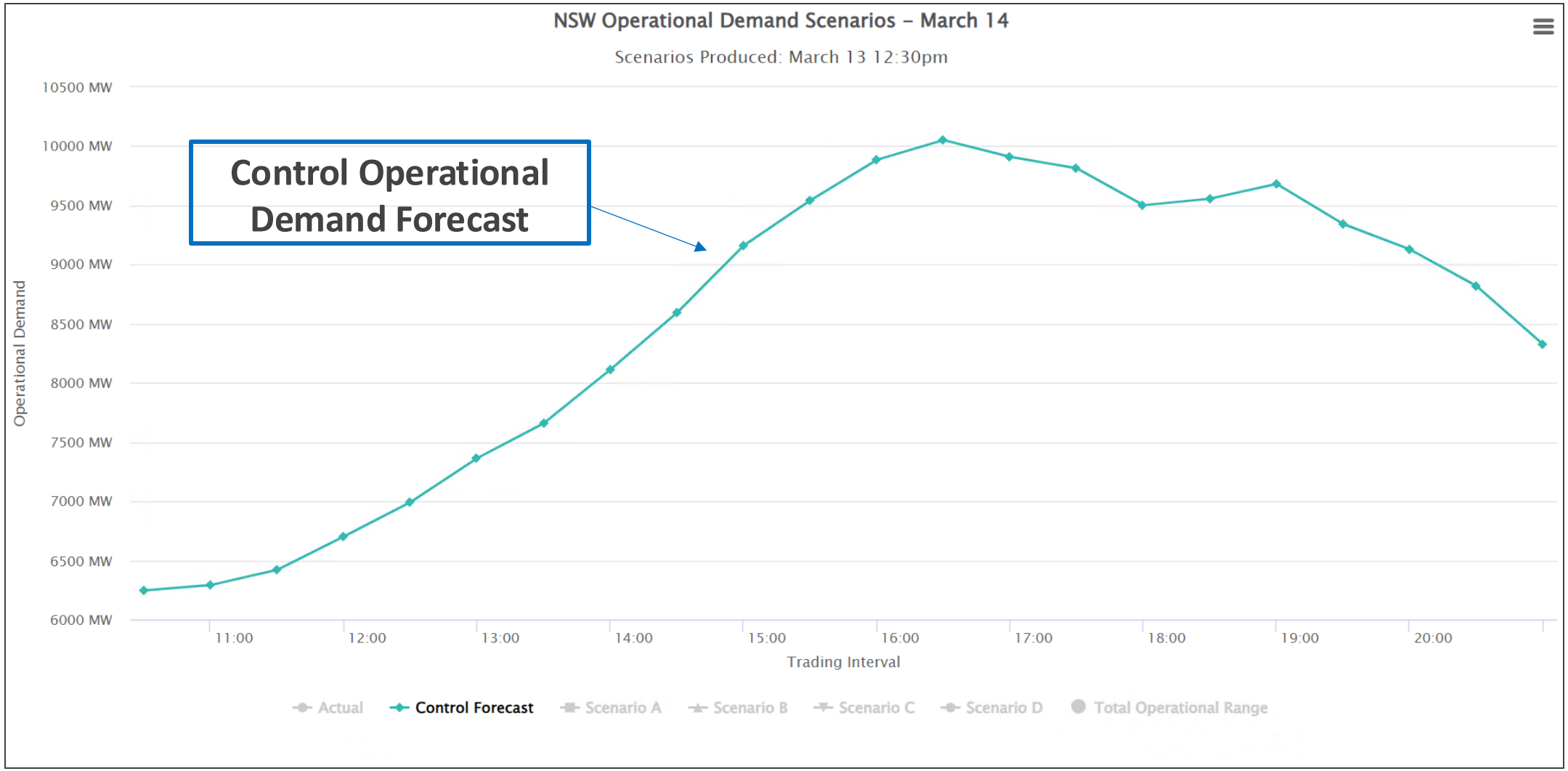

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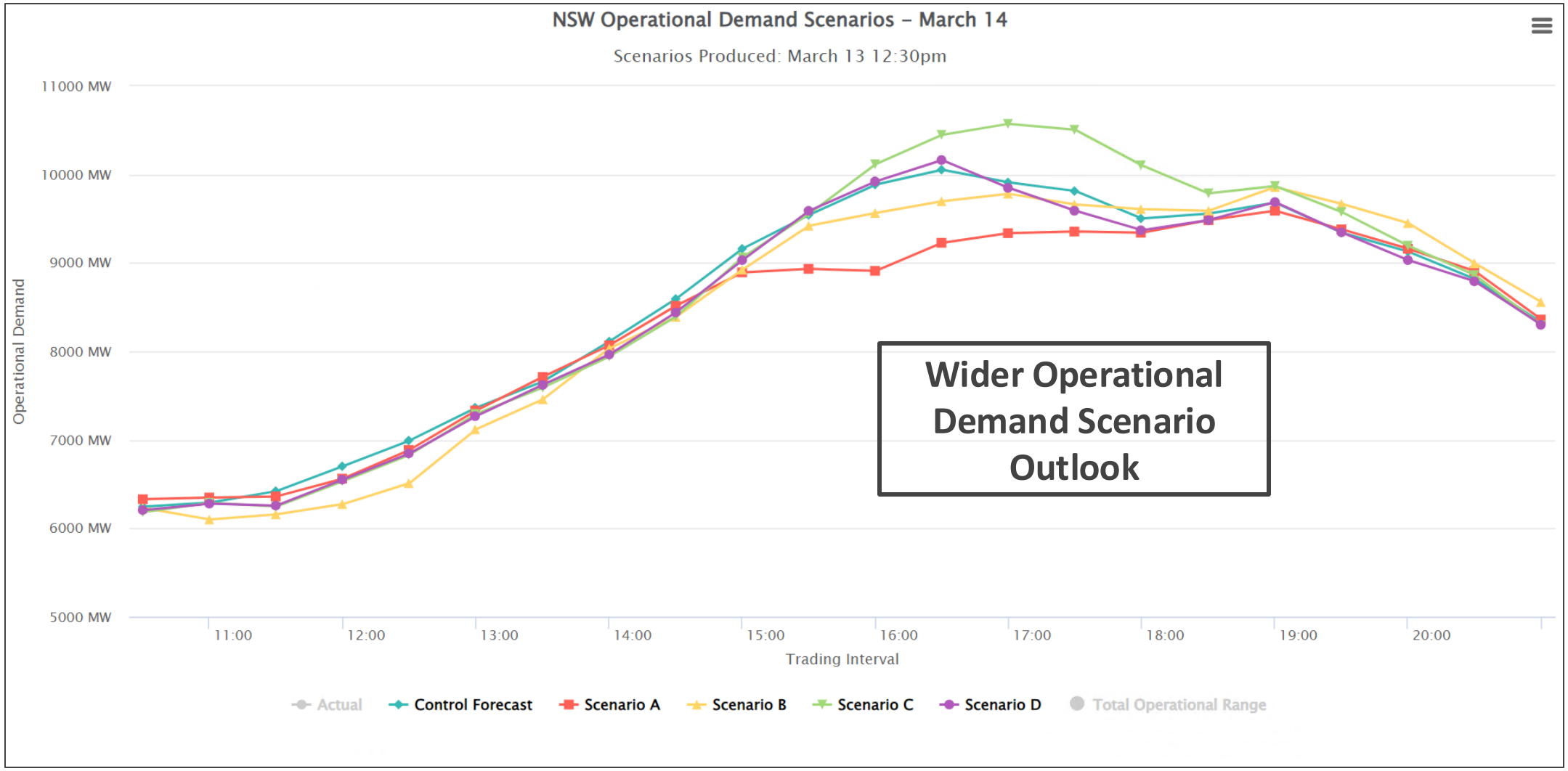

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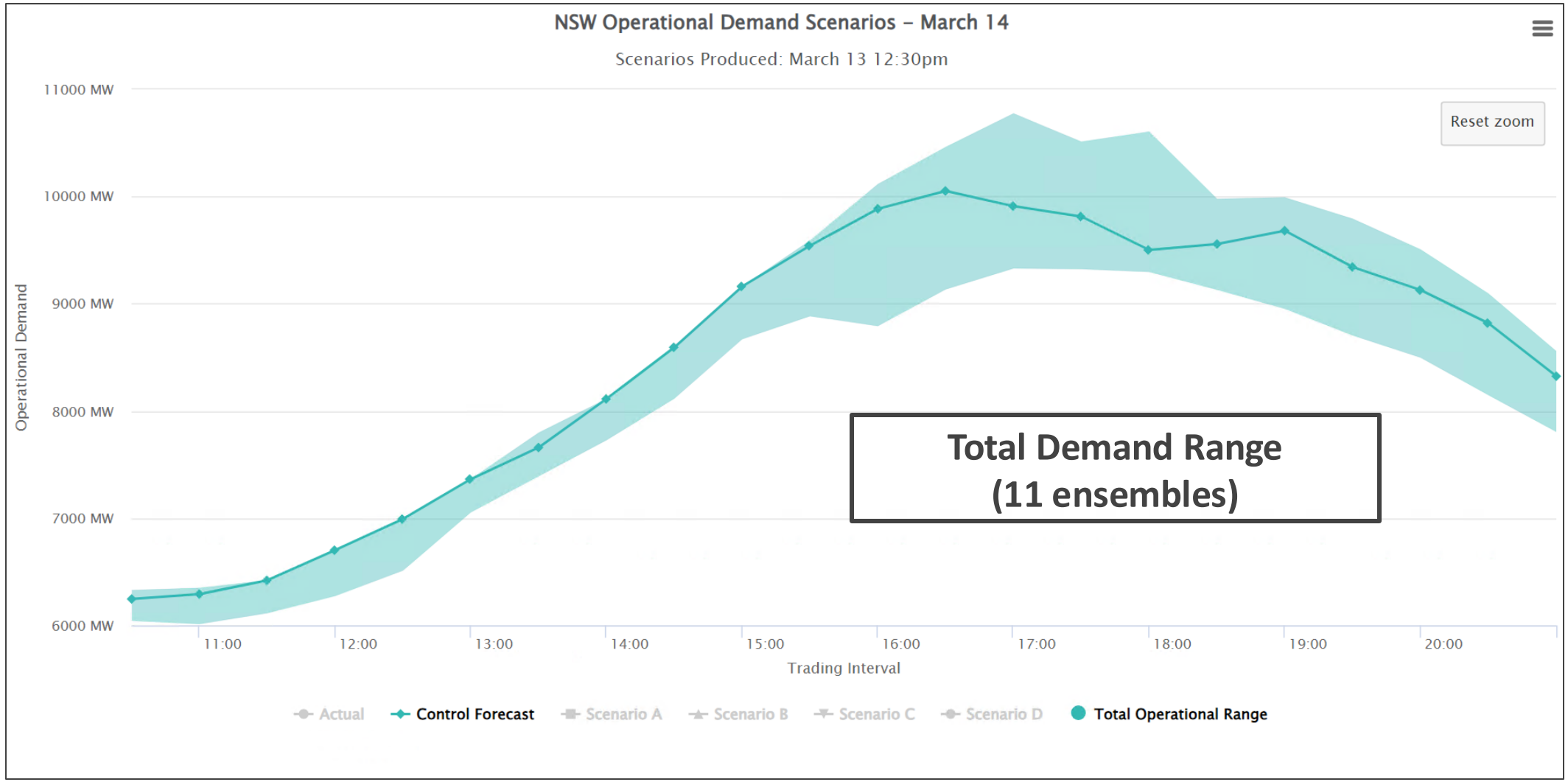

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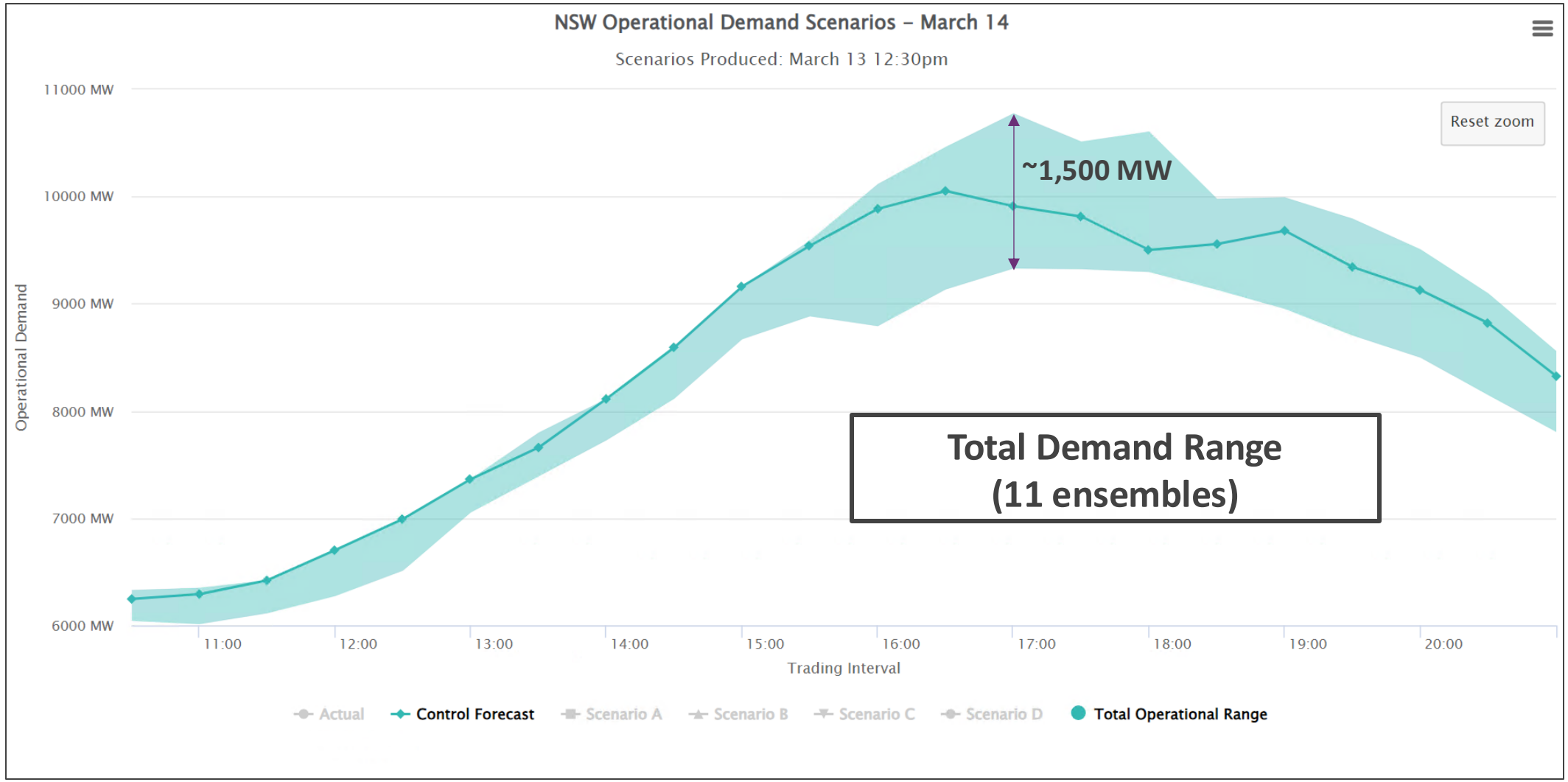

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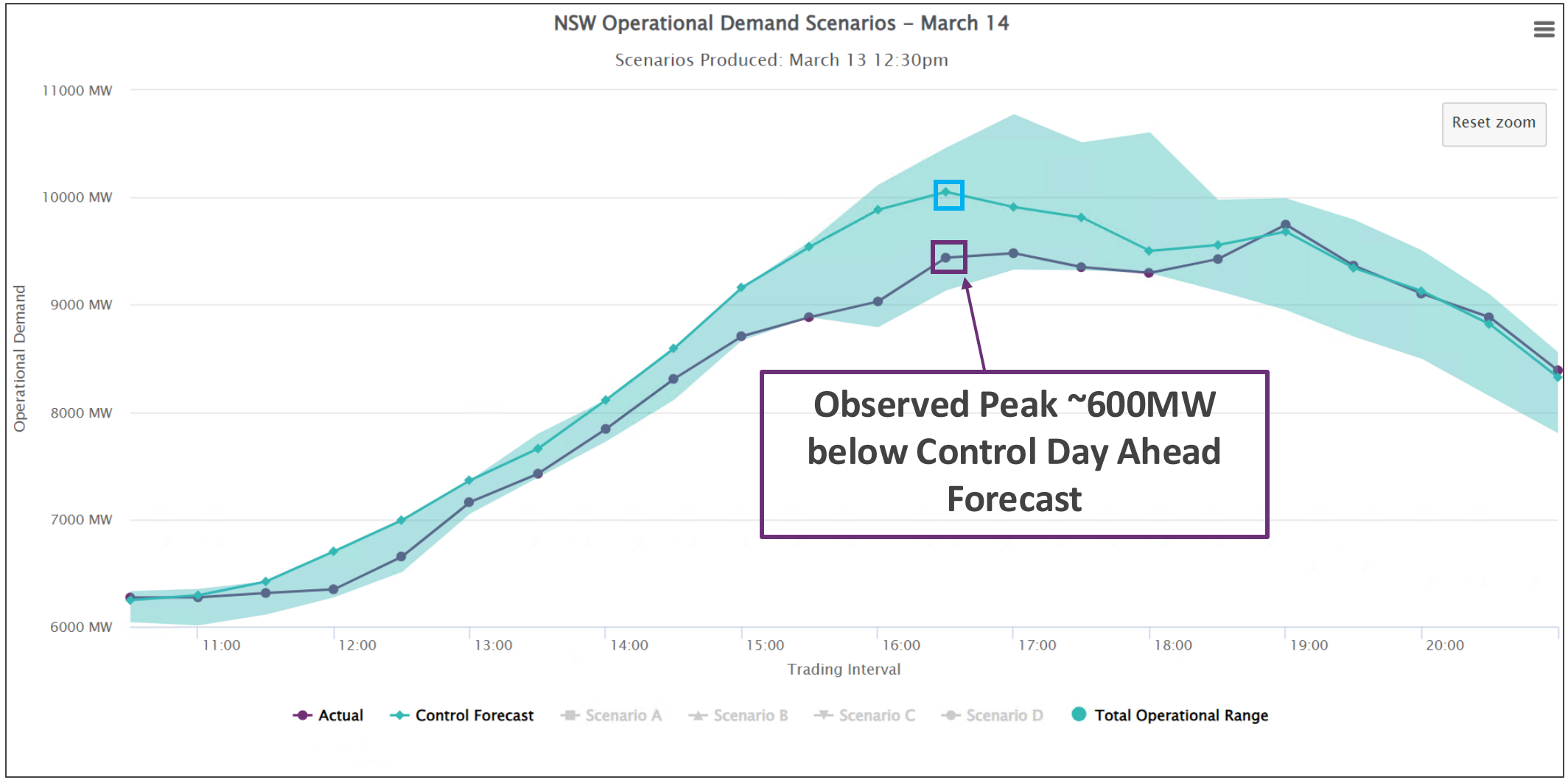

Weather Toolbox for the NEM

Hourly forecasts for demand forecasting
- 4 weather providers (2 for DFS)
- 94 weather stations (38 for DFS)
- 13 weather concepts
- POE 10 & 90 forecasts

Situational Awareness
- Gridded forecast data from 2 Global NWPs
- Ensemble forecast data from high resolution NWP
- Energy sector thunderstorm & severe weather forecasts
- High resolution synthetic radar and cloud forecasts
- Cloud ramping risk assessments

Operational
- 187 wind and solar farms providing real time weather data
- Minutely observations from 520 weather stations
- Real time Lightning and wind gust observations

Meteorologist support
- 5 embedded meteorologists
- Daily weather briefing packs from 3 providers
- Verbal event briefings

External Alerting & Frameworks
- NEM Local Temperature Alerts
- Abnormal Condition Reclassification Criteria

Ensembles are another tool in the toolbox …

Next Steps for Weather Scenario Ensembles

- Solar Irradiance for rooftop PV scenarios (solar swings > temperature)
- Improved visualizations and features
  - Using the range to communicate weather risk to control room
- Extended Horizons beyond 36 hours ahead (ECMWF: 7-10 days)
- More Ensembles (EC: 52 ensembles)
- Assigning relative likelihoods
- Bias correction of ensemble forecasts between ACCESS-C runs

For more information visit

aemo.com.au

Appendix

Key Challenges

- The need for true ensembles and probabilistic forecasts, based on physically representative weather models.
- Weather providers minimising average error in deterministic forecasts, therefore struggling to capture extremes and changes.
- Weather forecasts not updating quickly enough to pick up on changes, e.g. cool changes or irradiance changes due to cloud.
- Weather observation infrastructure centred around load and not developing generation such as VRE.
- Timing, severity and location of severe weather not forecast well ahead of time (e.g. high-end thunderstorms and convective weather).

What high impact weather do we need to predict and manage for?

- Destructive winds from super cell thunderstorms, convective downbursts, tornadoes, or tropical cyclones knocking down transmission towers.
- Bushfires and lightning strike threats to double-circuit transmission lines.
- Extreme temperatures or sustained high winds resulting in widespread wind turbine derating and/or cutting out events.
- Extreme multiday heat waves, coupled with elevated humidity, driving record levels of electricity demand.
- Strong and sudden cool changes dropping temperature and causing sharp drops in electricity demand.
- Cloud bands, storm fronts, or dust / smoke crossing metropolitan centres causing large swings in distributed rooftop PV generation.
- Extended periods of low wind and irradiance resulting in VRE droughts.