ST PASA Replacement Project

PoC Showcase (External Stakeholders Update 28 May 2021)

Agenda

1. The ST PASA Replacement Project
    1. Objective & Progress to date
2. Key themes of HLD
    1. Proposed design
    2. Determination of Reliability
3. Proof of Concept
    1. High level Objective
    2. Scenario details
    3. Input data used
    4. Results
    5. Conclusion
4. Proposed Rule Changes
5. Next Steps

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ST PASA Replacement Project

Objective: To do a holistic review of the PD/ST PASA methodology and develop a system that would serve the NEM now, and into the future.

Details and updates can be found on ST PASA Webpage

Progress to date

- Phase 1 completed
  - ✓ Industry consultation
    - Business requirements
    - High level design (HLD)
  - ✓ Proof of Concept
- Full project funding has been approved including detailed design and implementation
- Rule Change proposal is being drafted
- Commenced work on Request for Proposal (RFP). Scope of the RFP currently being prepared

Key themes of HLD (Refresh)

- Reliability is a physical system issue hence the model should reflect the physical reality instead of the market
  - Full network model
  - Forecast at nodal level (load on bus)
- Determine uncertainties in demand forecast, VRE forecasts and scheduled unit forced outages
  - They become an input into the model (known as ‘Uncertainty Margins’)

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Proposed PD/ST PASA System

Inputs

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Forecasting & Probability Calculations
- Nodal Load Forecast
- VRE Forecast
- Forced Outage Rates (TBC)
- Uncertainty Margins

Standing Network Data
- Network topology
- List of credible contingencies

Other Network Data
- Stability and System strength constraints

Market Data
- RERT Contracts

NSPs
- Planned Network Outages
- Equipment Ratings

Market Participants
- Generator Bid & PASA Availabilities
- Energy limitations

Scenario Manager
- Base runs
- Scenarios e.g. extreme events, high impact outages etc

Optimiser
- Auto generate thermal constraints
- Carry out several runs

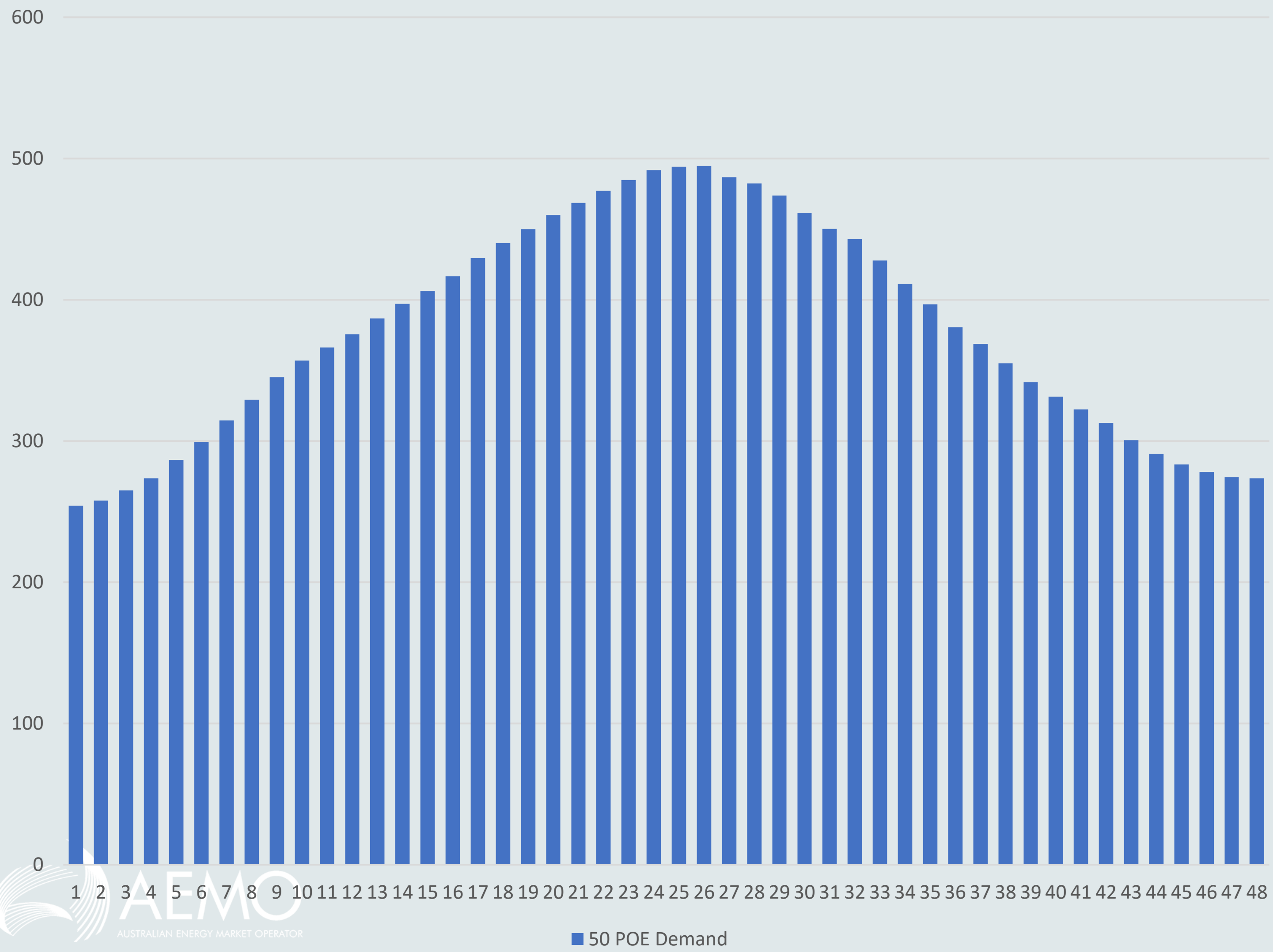
Outputs

- Generation Pattern
- Nodal Deficits
- RERT Schedule (if required)

Post-processing

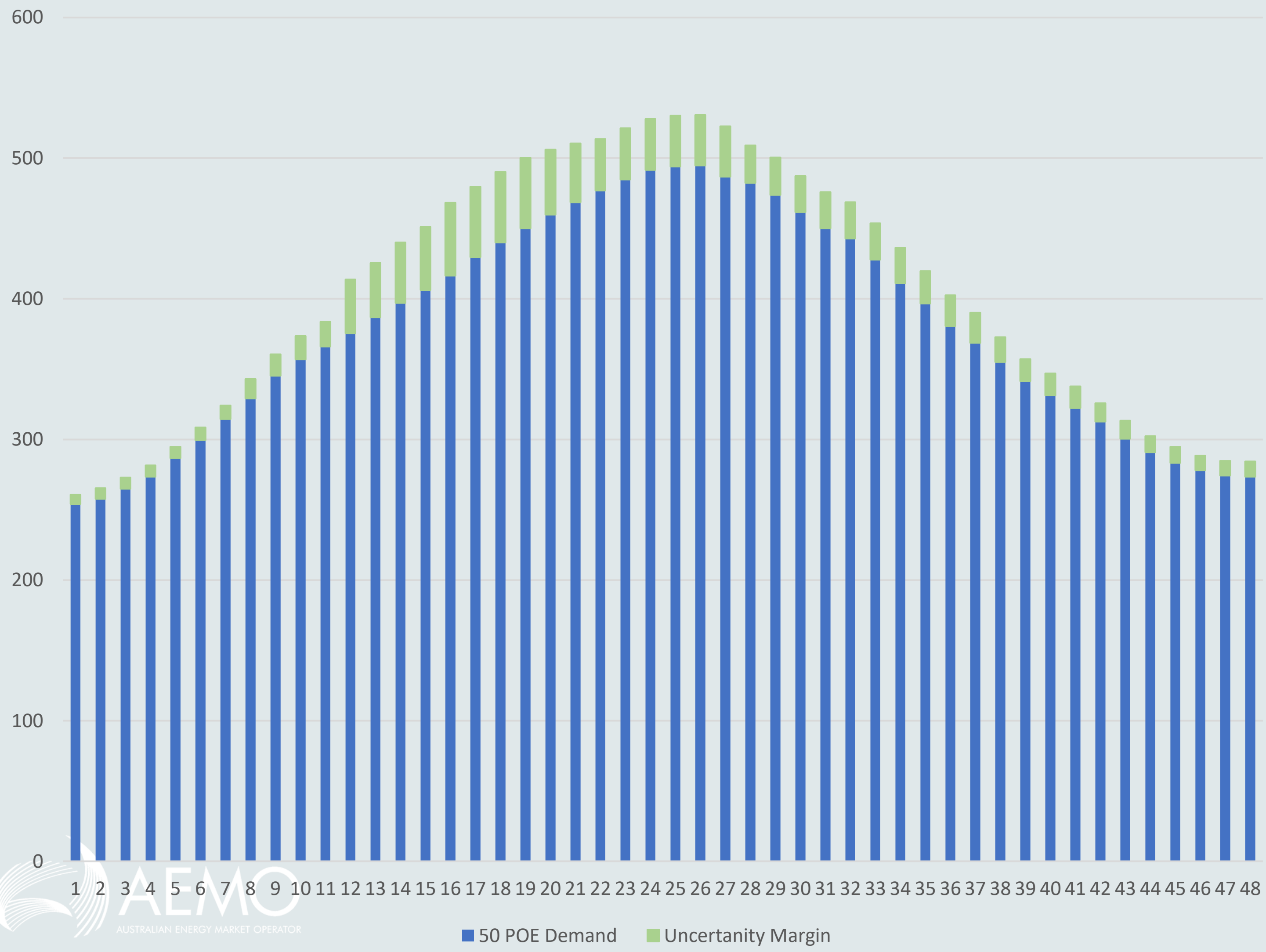
- Reliability Notices
- Identify Network Outages restricting the network
- Inertia & System Strength Issues
- Internal/External Displays e.g. Heat Maps

Determination of Reliability



	Proposed System
Objective	Create generation profile that meets the demand at the node
Subject to	n-1 security constraints (Transmission and generator contingencies)
Demand Used	50% POE demand + Uncertainty Margin
Reliability Measure	Deficit = Uncertainty Margin + 50% POE Demand - Gen
LOR Declared	Deficit > 0

Determination of Reliability



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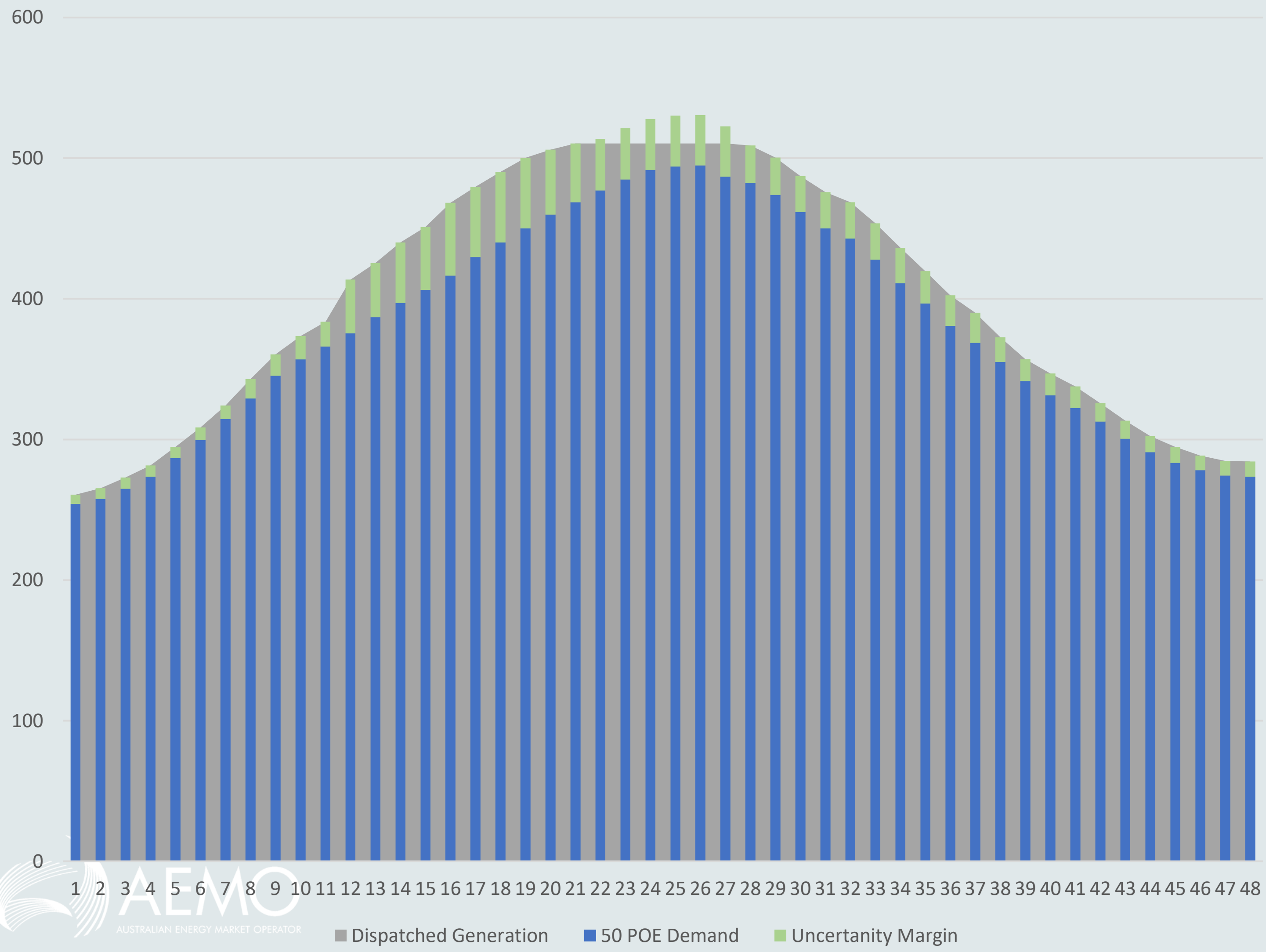

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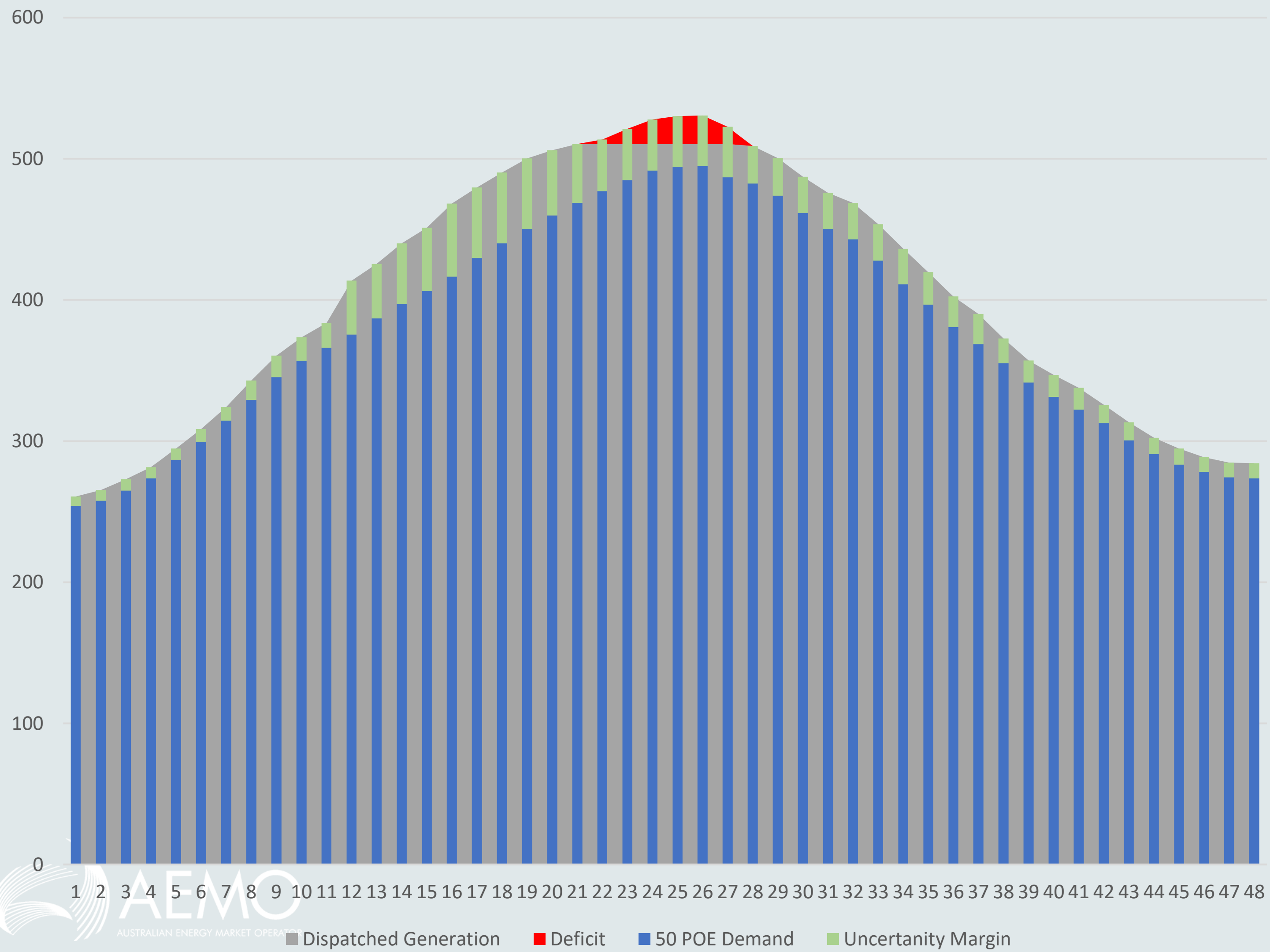

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Proof Of Concept - Objective

- A PoC was conducted to determine the feasibility and practicality of the proposed solution
- The PoC involved demonstrating that:
  - reasonable forecasts of demand and variable renewable energy (VRE) can be produced at a nodal level;
  - the proposed theory behind developing uncertainty margins at a nodal level can be applied practically; and
  - an off-the-shelf software can be utilised (with some configuration) to develop a full network model that determines the appropriate generation dispatch profile
- The PoC would show if
  - the reliability forecast produced appears reasonably realistic
  - the system is flexible enough to model unusual power system events

PoC – Scenario being showcased

- The PoC PASA was run from 0400hrs on 30 Dec 2019 for the next 6 days to an hourly resolution
- PoC based on 30 Dec 2019 event
    - Extreme day - hot temperatures, high demand, bushfires
    - Some non-credible contingencies reclassified as credible
    - No LOR1/2 conditions forecast for the day (at the time leading up to the event below)
    - At 1447hrs unplanned outage of 051 (Lower Tumut to Wagga 330 kV) line leading to:
        - Reduction of ~1000 MW of reserve in Victoria
        - Forecast LOR 2
        - Activation of RERT

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PoC – Expected outcome

- A deficit is forecast in the new PASA for that day i.e. it shows an equivalent of current LOR1 for the loss of a major intra-regional line
- The optimiser can develop thermal constraints based on the current (and forecast) network conditions i.e. does not rely on generic constraints to be developed beforehand (will still require generic constraints for stability limits)

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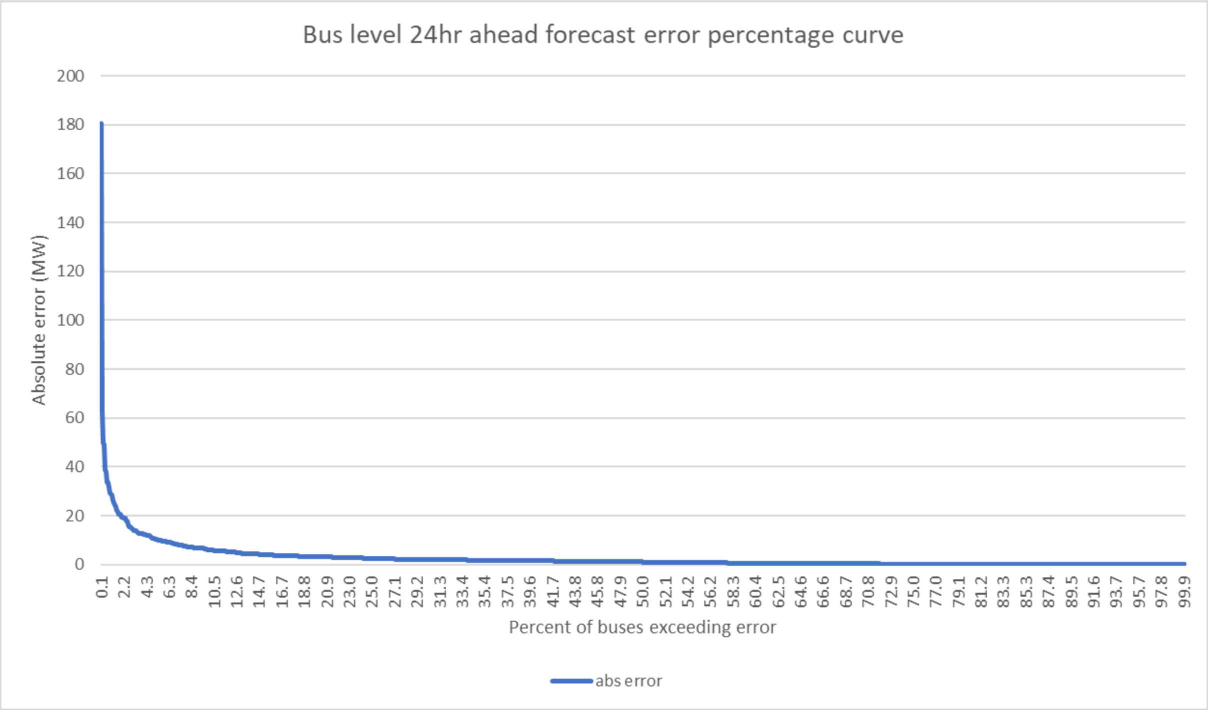
Forecasting and Probability Inputs

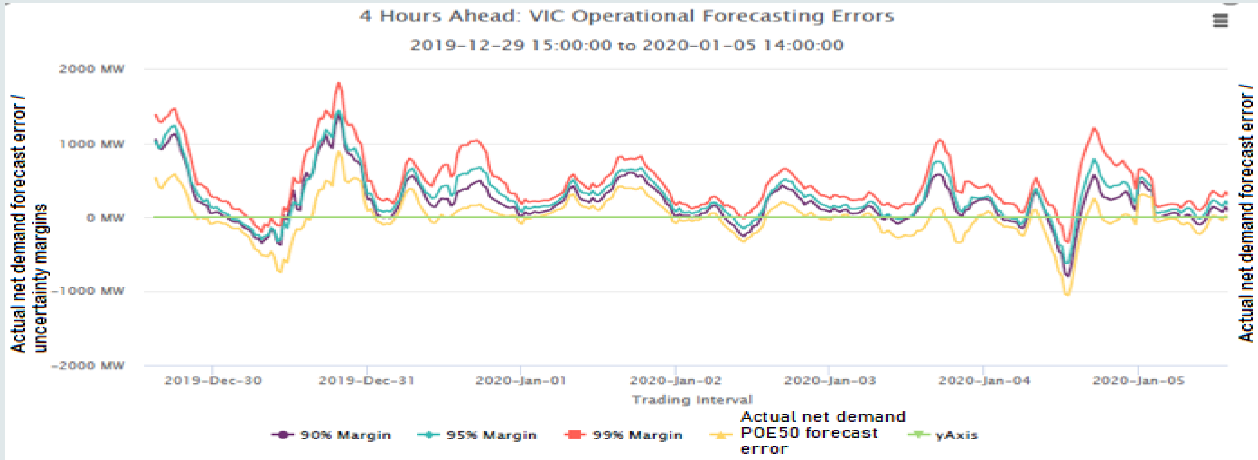
- Demand and VRE forecasts for the full horizon determined as at 1430 hrs on 29 Dec 2019 i.e. 24 hours before the event
- Used 50% POE nodal load forecast
- Uncertainty Margin
  - 95% Confidence level for all forecasts

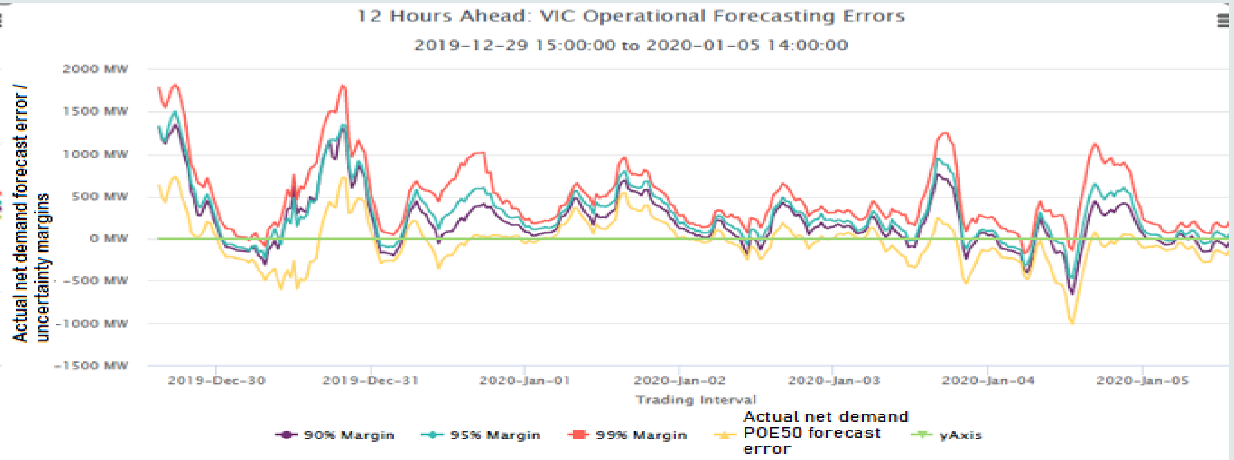
Forecasting inputs – lessons learned

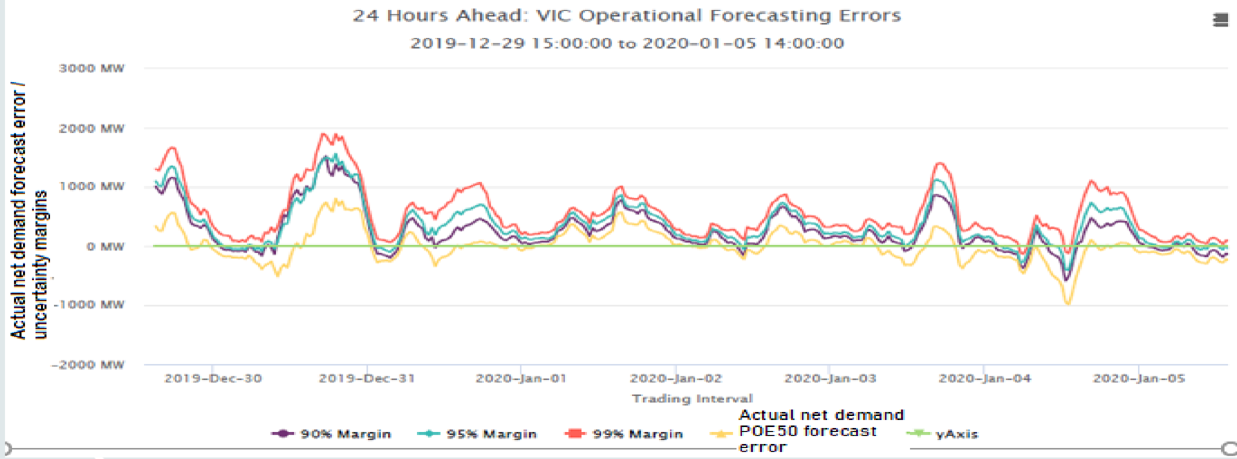
- **For load forecasts**:
  - The existing load forecasting methodology uses bespoke sub-region (area-level) top-down load forecast models from the DFS, and includes separating large industrial customers into separate models.
  - For the PoC these top-down forecasts are distributed to the nodes using calculated distribution factors.
  - Using this method proved suitable as over 98% of the buses had day-ahead load forecast errors less than 20MW, and the larger errors were due to industrial load buses changing output unpredictably.
  - Another project is underway that will enable more granular load forecasting capability which is expected to improve nodal load forecast accuracy

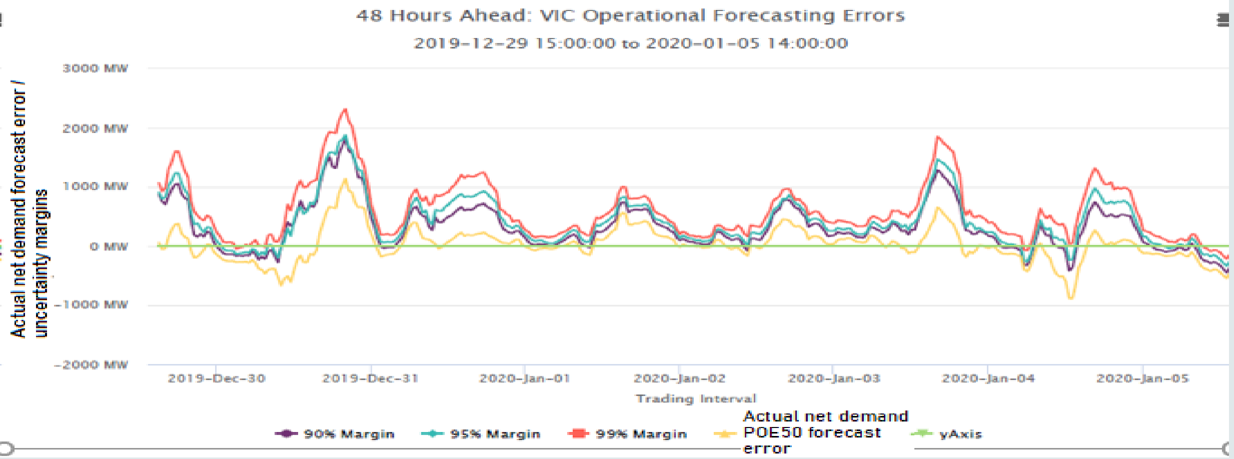


Uncertainty margins









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Uncertainty margins - application

- When the uncertainty margin is applied to certain types of nodes in the network model, it can lead to infeasible load serving requirements which results in erroneous deficits
  - E.g. applying a 95% confidence level uncertainty margin on top of an industrial load node may result in the total load to be served exceeding the thermal rating of the lines supplying that load, and exceeding the realisable maximum load that could be created by that industrial process.
  - Application of the uncertainty margin to each node must account for the characteristics of each node to ensure the resulting model is physically realisable
- Further work is needed in the next phase to perform a sensitivity analysis to determine how reported deficits change as the uncertainty margin confidence level is changed.
  - This will assist in determining appropriate initial confidence levels.
  - As operational experience with the new system is gained, the confidence levels should be tuned to ensure outcomes are consistent with the reliability standard.

Market Data

- Very simple market data sourced from the 29 Dec 2019 1300hr run of the 7 Day Pre-dispatch:
  - Max Availability with energy offers (load and gen for batteries)
  - Ramp rates
  - Energy available

Network Data

- Used the PSSE data as at 1430hrs on 30 Dec 2019
- Some credible contingencies taken into account including the ones reclassified for the day
  - 31 Bayswater – Regentville 330 kV line and 32 Bayswater – Sydney West 330 kV line
  - 76 Sydney South – Wallerawang 330 kV line and 77 Ingleburn – Wallerawang 330 kV line
- Thermal constraints were automatically created by the optimiser
- No generic constraints (for stability) were used for this run. The system is capable of using them, but we ran out of time

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PoC Modelling limitations

- An off-the-shelf optimiser was trialled
- The PoC model was limited compared to what could be possible long term:
  - Cut down solve window to match the 4am market boundary for energy limited data. Requires a software modification
  - Not all contingencies were modelled. There is a current hard limit in the software of 300 generator/load contingencies, so those < 25 MW were excluded
  - DC model only. Might be able to get an AC solution with more work. Generic constraints can help, possibly other technology such as flow gates.
  - Losses only modelled as a flat 3% increase in load across all nodes. AC modelling does 'proper' losses
- Use of AEMO's PSSE data meant that the full AEMO EMS network was not modelled (e.g.: switching devices not modelled, reactive devices combined)

Results

- As expected, most of the load deficits across the NEM occurred during the highest load periods.
- The bulk of the load deficits were reported in Victoria:
  - up to 530MW at SW Victoria and Keilor area
  - up to 200MW in Shepparton and Numurkah areas
  - Victorian imports were limited during these periods:
    - from NSW, due to a binding limit on Dederang-South Morang 330 kV line (828MW) for contingent loss of the other Dederang-South Morang 330 kV line
    - from South Australia, due to binding limits on South East-Heywood 275 kV line (584MW) and Tailem Bend-South East 275 kV line (597MW) for contingent loss of the other Tailem Bend-South East 275 kV line
    - from Tasmania, due to binding limit on Basslink (478MW) for large generator contingencies in NSW, John Butters generator contingency in Tasmania, or the contingent loss of the Musselroe-Derby 110kV line
  - There was also a binding limit on Rowville-Springvale 220kV line (698MW) for contingent loss of the other Rowville-Springvale 220kV line and Springvale 220kV transformer

Results (cont.)

Lesser load deficits were also reported in:

- South Australia:
  - up to 80MW in North West Bend and Berri areas
- Queensland:
  - up to 60MW in Brisbane metro area
  - up to 20MW at Townsville zinc smelter
  - up to 5MW in Proserpine area
- Subsequent analysis revealed that the load deficits reported in Queensland and Victorian Shepparton/Numurkah areas were reported incorrectly due to input data issues (which can be resolved in the final model)

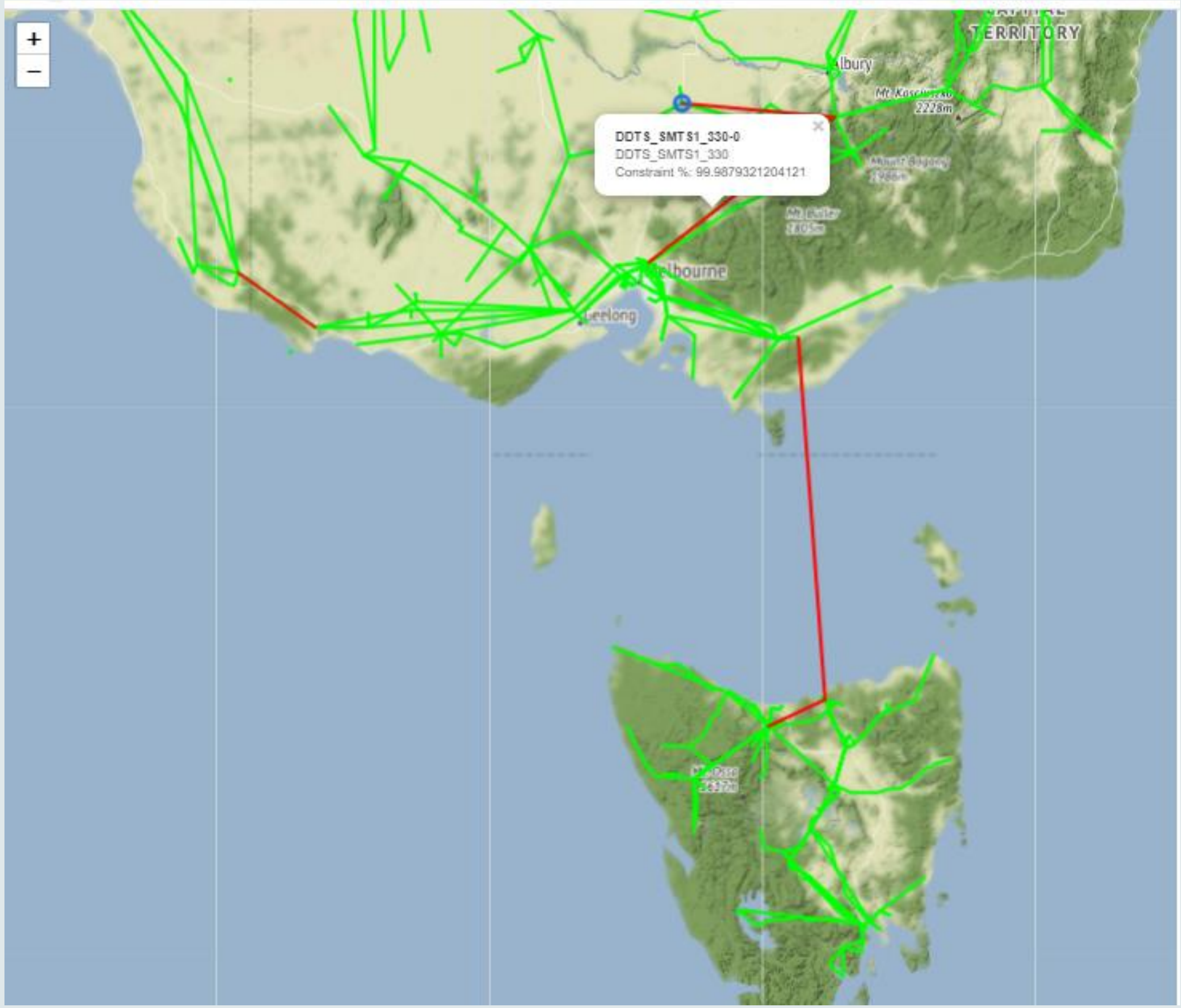
Proof Of Concept – Visuals (1)

1500 hrs on 30 Dec 2019

Victoria

Constrained lines (in red) resulting in restricted Victorian imports and load deficits (not shown in visual)

- From NSW: Dederang-South Morang 330 kV line
- From SA: South East-Heywood 275 kV line
- From Tasmania: Basslink



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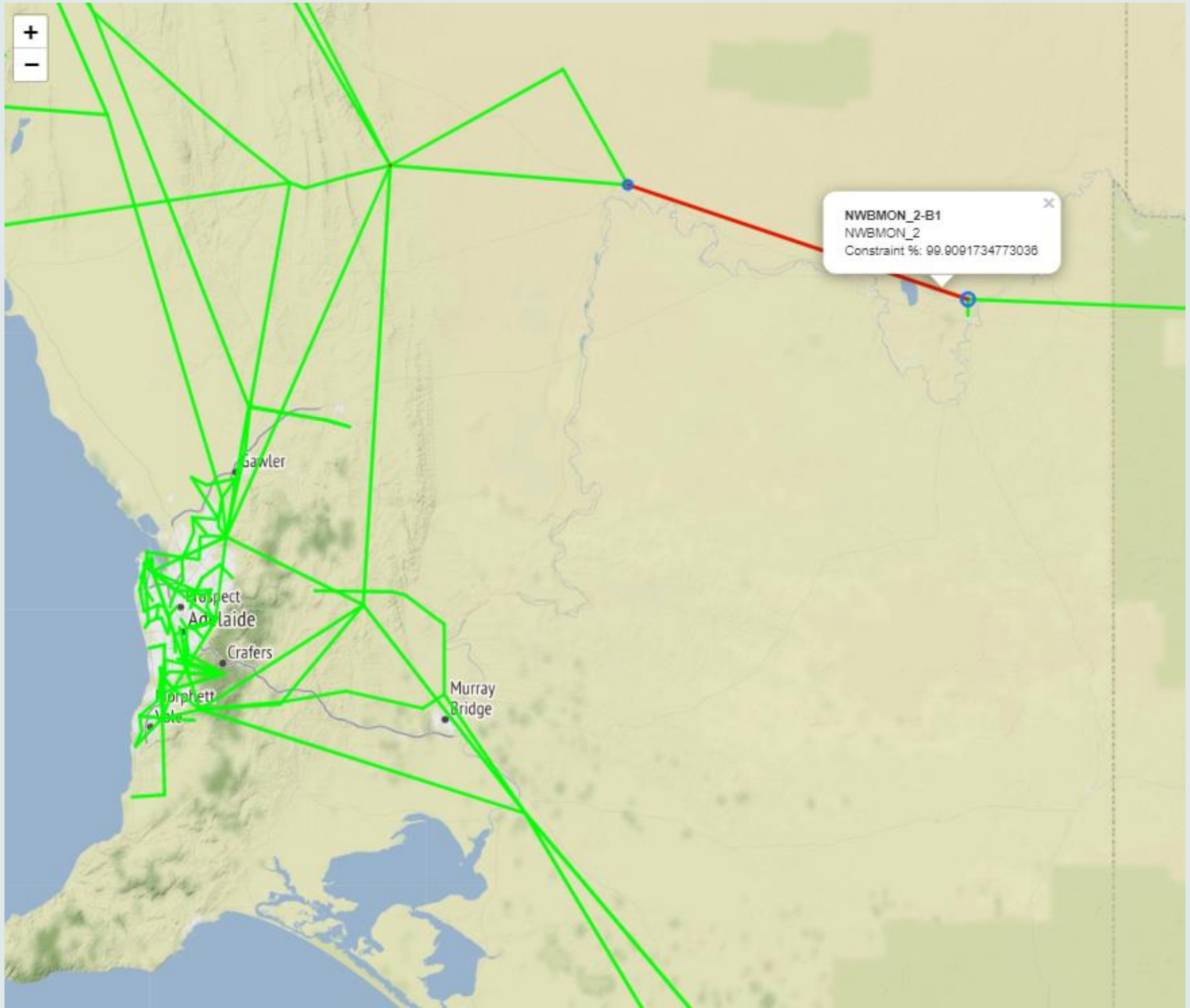
Proof Of Concept – Visuals (2)

1500 hrs on 30 Dec 2019

South Australia

Constrained lines (in red) resulting in load deficits (blue circles)

- North West Bend-Monash 132kV line



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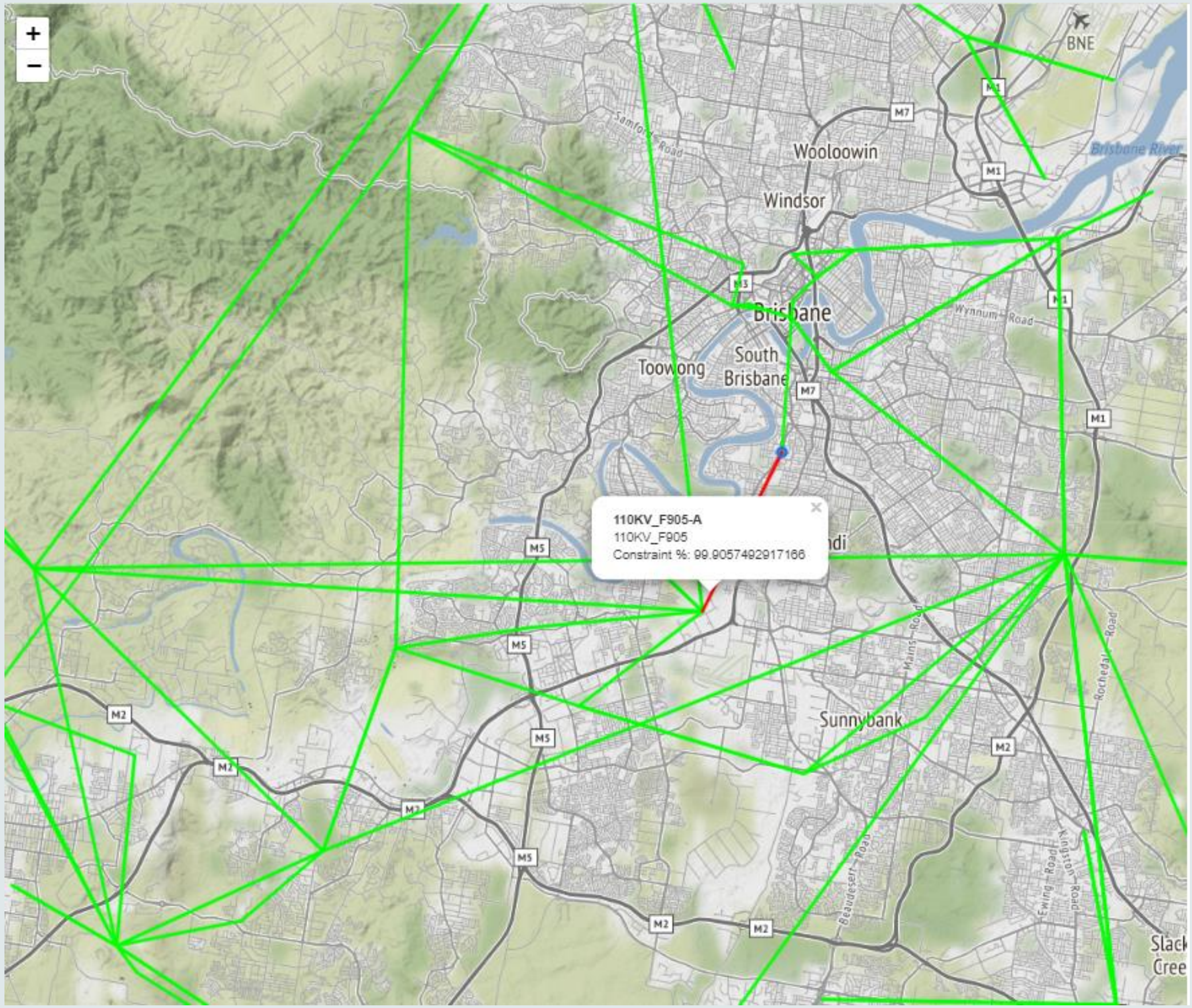
Proof Of Concept – Visuals (3)

1500 hrs on 30 Dec 2019

Queensland

Constrained lines (in red) resulting in load deficits (blue circles)

- F905 Rocklea-West End 110kV line
- Automatic scheme avoids overloads on this line, but this action was not modelled



PoC Conclusion

- The high-level design concept has shown to provide reasonable/realistic forecast of power system reliability
- The full network model will provide benefits like greater flexibility in modelling of unusual events
- Some work will need to be done to work out levels at which AEMO would intervene

Proposed Rule Changes – High Level Summary

- Move the details to procedures and keep high level principles only
- Change the STPASA coverage to include the pre-dispatch time frame (to reflect current and future practices)
- Combine ST PASA Process Description (*procedures*) and Reserve Level Declaration Guidelines (RLDG)
- Publish individual unit availability of all semi-scheduled generating unit and scheduled plants (including MNSPs) instead of regionally aggregated information
- Re-define PASA availability so that the recall period is flexible instead of being for fixed 24 hours.
  - MT PASA – to remain at 24 hours
  - ST PASA – any period up to 2-3 days ahead (TBD)

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Next steps

Deliverable/Milestone	Detail	Completion Date
Stakeholder Consultation	Continue Stakeholder consultation in development of ST PASA processes	Ongoing
Rule change proposal	Develop and submit Rule Change proposal	May 2021
Request for Proposal	RFP process to procure an optimiser	Sep 2021
Detailed Design	Develop solution architecture and detailed design	Nov 2021
Go Live	Complete implementation and Go Live	Q3 2022

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