



Power System Frequency Risk Review (PSFRR)

Industry briefing

(edited version for publication)

14 December 2021

*We acknowledge the Traditional Owners
of country throughout Australia and
recognise their continuing connection to
land, waters and culture.*

*We pay our respects to their Elders past,
present and emerging.*

Online forum housekeeping

1. Mute your microphone if you aren't speaking.
2. Raise your hand or use the **Chat** function for questions or comments.
3. If you have dialled in via phone, please email PSFRR2022@aemo.com.au with your name and organisation for our records, and for any follow up.
4. Be respectful of all presenters, participants and the process.
5. This session will be recorded by AEMO • By continuing to attend you indicate your consent to recording.
6. Participants are not permitted to make separate recordings.
7. Slides will be shared after the meeting.

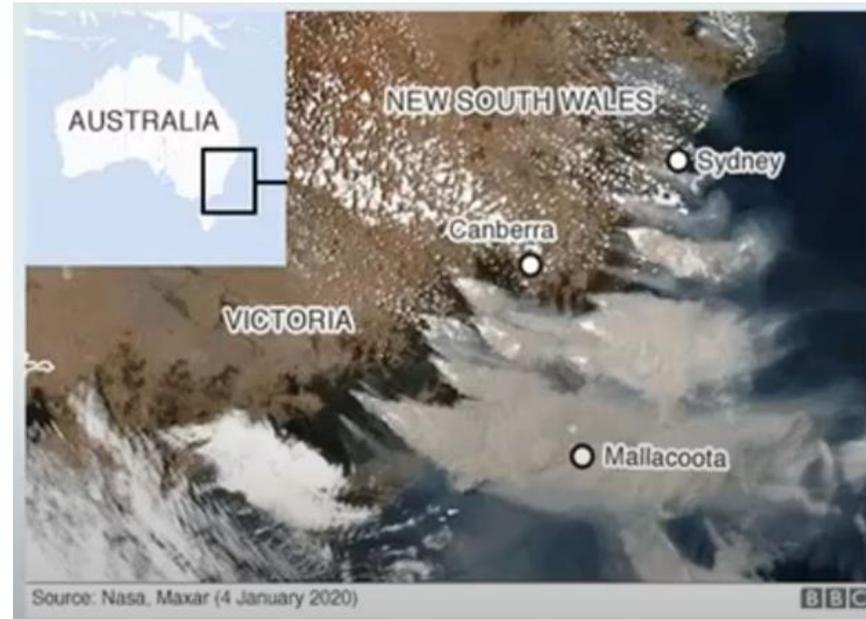
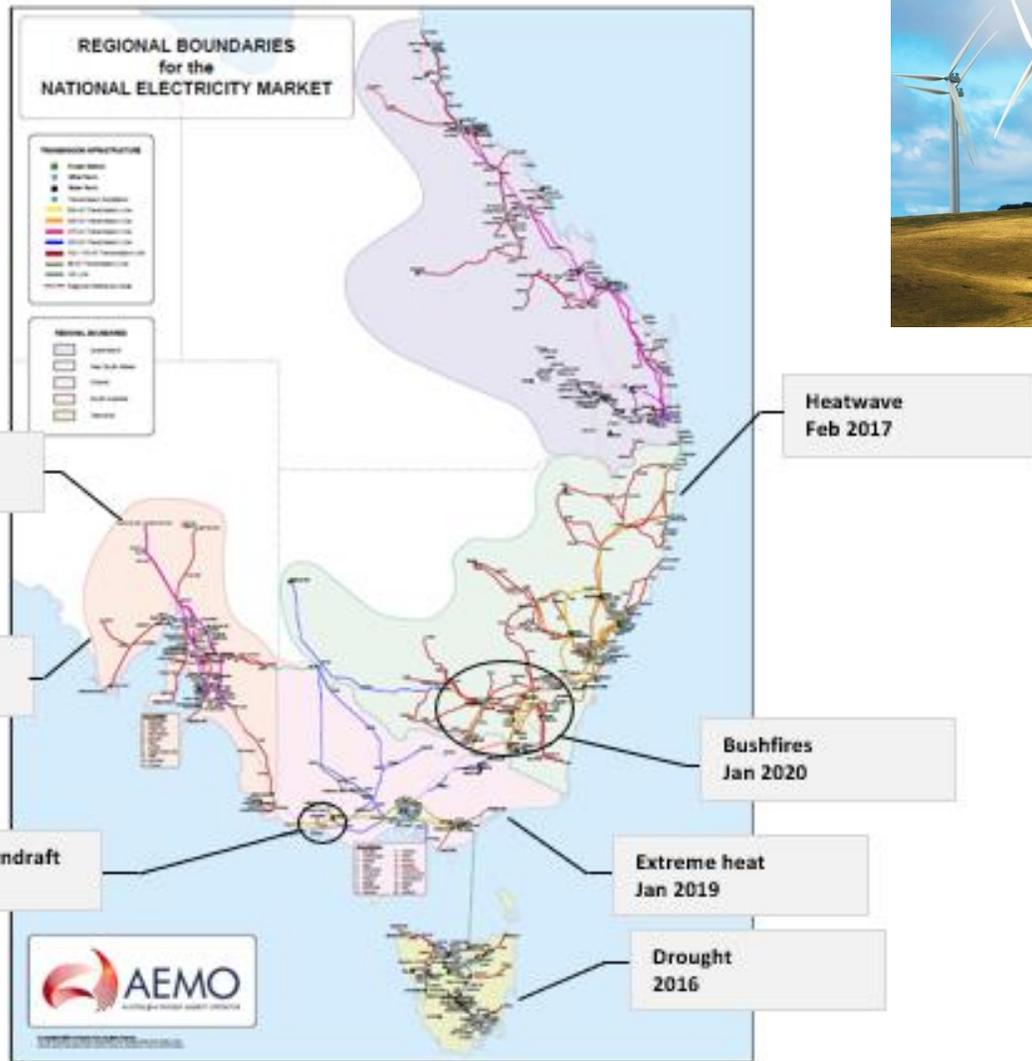
Today's briefing will cover

1. Background
2. Priority events
3. Modelling approach
4. Benchmarking results
5. Questions and discussion
6. Next steps



Background

Context



The PSFRR

Objective

- Review the potential for ‘non-credible’ power system contingency events to cause frequency changes large enough to initiate uncontrolled plant disconnections, that could in turn result in widespread transmission outages or a black system.
- This session is intended as an opportunity to brief stakeholders on our approach to the 2022 PSFRR, and for interested stakeholders to ask questions to help AEMO deliver a comprehensive review.

Approach

- In consultation with TNSPs, identify priority (non-credible) contingency events for assessment through the PSFRR.
- Assess current arrangements for management of those events.
- Identify options for management of risks (where required).

Key recommendations from the 2020 PSFRR

| Recommendation | Completion time proposed in 2020 PSFRR | Current Status | Planned completion date |
|--|--|--|--|
| Protected event recommended for SA during low ULFS availability and submission to reliability panel | Early 2021 | In progress | Actions progressing targeting submission Q3 2022 |
| Recommendation for CQ-SQ SPS review and upgrade considering increased QNI transfer limits following QNI upgrades, increased CQ-SQ flows | First stage mid-2021 | WAMPAC stage 1 scheme implemented WAMPAC stage 2 in progress | Stage 1 complete |
| Review of South Australian minimum inertia level to manage rate of change of frequency (RoCoF) - post syncon commissioning and new SA unit commitments | Early 2021 | Completed - Please see published inertia SA inertia requirements for more details | Completed |
| Management of over-frequency events in South Australia - assess adequacy of SA OFGS, consideration of SA separation from MLTS, addition of SA SFs into OFGS | No time line mentioned | In progress | Review 1/09/2022 Generator settings - 2023 |
| Recommendation for EAPT scheme review and upgrade; considering higher MLTS-HYTS region new generator connections, co-ordination of the scheme with IECS and UFLS | No time line mentioned | AEMO has recently completed several reviews of EAPT in response to a mal-operation event in 2018 and also as part of an impact assessment of recent network changes on the scheme. | Completed |
| Recommendation for IECS scheme review and upgrade; co-ordination of IECS, UFLS and EAPT; impact of new Victorian big battery on IECS | No time line mentioned | AEMO has recently reviewed the IECS and recommended that more load blocks be included into the selected load groups to be tripped by IECS. | Completed |
| Improved System Integrity Protection Scheme - WAPS - 2018 PSFRR recommendation | mid-2022 | In progress | Oct-22 |

Major reviewable incidents since the 2020 PSFRR

| Incident Date | Event | Likely Cause | System Impact |
|---------------|--|--|--|
| 24/01/2021 | NEM Wide SCADA failure | Software issue impacting SCADA refresh rate leading to SCADA failure | AEMO NEM wide SCADA failure, no load or generation loss and system remained secure |
| 12/03/2021 | Torrens island 275 kV CT failure | Single phase CT failure (internal failure) | Loss of 111 MW of generation and system constraints reducing other generation availability |
| 14/03/2021 | Instruction to maintain SA Operational Demand above 400 MW | Underforecasting of demand and Solar generation output | Around 71 MW of Distributed Photo-Voltaics (DPV) curtailed. |
| 25/05/2021 | QLD generation loss and load shedding | Fire at Callide C power station followed by un-cleared generator fault | Loss of 3045 MW of generation and operation of UFLS and 2300 MW of load in QLD |

Current status

- ✓ TNSP engagement on scope and risks completed
- ✓ Priority events identified for further analysis
- ✓ Model development undertaken
- ✓ Requested generators to update frequency control models & shared SPS models developed with NSPs
- ✓ Undertook benchmarking for 25 May 2021 event



Priority events

Priority events considered in 2022 PSFRR

- I. Separation of SA through loss of Heywood – South East 500 kV lines considering planned SA generation dispatch.
- II. Separation of SA through loss of Moorabool – Mortlake and Moorabool – Haunted Gully 500 kV lines considering planned SA generation dispatch.
- III. Separation of QLD through loss of QNI considering increased flows following QNI upgrades.
- IV. Loss of both 275 kV lines between Calvale and Halys with upgraded CQ-SQ SPS.
- V. Loss of the Victorian to New South Wales interconnection (VNI).
- VI. Fault of the Mt Lock 275 kV busbar.
- VII. Loss of both Dederang to South Morang 330 kV lines with updated IECS.
- VIII. Loss of Columboola – Western Downs 275 kV lines resulting in large loss of load.
- IX. Simultaneous loss of multiple Loy Yang A generating units.
- X. Loss of Ballarat – Waubra 220 kV line followed by Balranald - Darlington point 220 kV (x5) line or Darlington Point - Wagga 330 kV (63) line within 30 minutes.

Modelling approach

Study scenarios

Historical scenarios

System snapshot corresponding to past operating boundaries relevant to contingency in terms of:

- Operational load, interconnector flows, DPV generation.
- Availability of UFLS and OFGS (SA).

Future scenarios (2027)

- Min and max operational demand, inertia, IBR and DPV generation (ISP step change scenario).
- Scenarios without PEC, post-PEC stage 1, stage 2, QNI and VNI upgrades.
- Reduced network modelling approach to allow a range of scenarios (incl. synchronous machine dispatch combinations) to be assessed.
- Future connections modelled as a lumped generic model for wind and solar.

Modelling approach

Network model

- OPDMS network augmented with distribution embedded DPV and UFLS loads represented according to frequency trip bands.
- Future cases with simplified representation.

Dynamic models

- PFR Governor models: Proponent-provided model with site-specific settings incl. mandatory PFR settings or - if not available, AEMO-developed generic governor models with PFR settings for steam, gas and hydro units
- IBR models: If proponent model not available, generic IBR model.
- DPV model: Dynamic models with frequency/voltage based trips.

Modelling approach

Protection models

- UFLS models: Capable of tripping according to frequency/RoCoF settings along with underlying DPVs in UFLS feeders.
- OFGS models: Capable of tripping according to frequency settings.

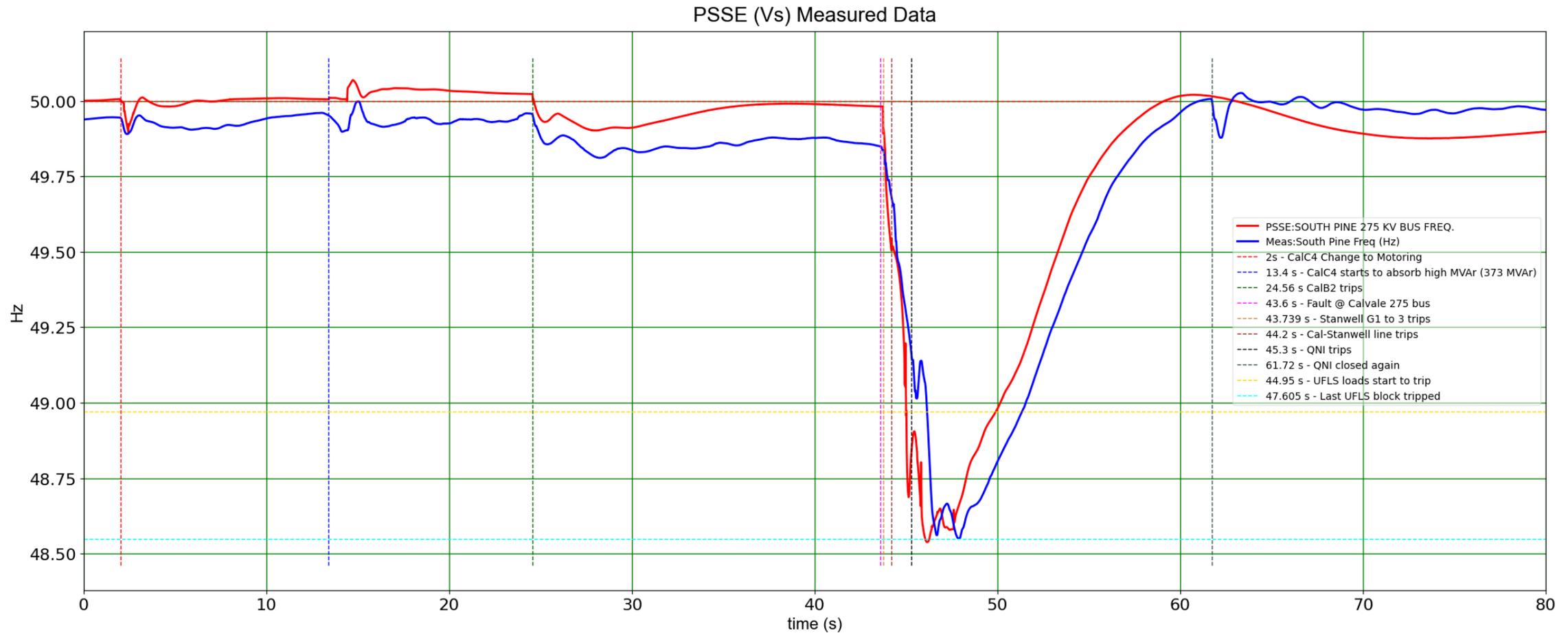
Special Protection Scheme models

- Victorian Emergency APD Tripping (EAPT).
- Victorian Interconnector Emergency Control Scheme (IECS).
- Heywood System Integrity Protection Scheme (SIPS).
- Central – Southern Queensland Wide Area Protection and Control (WAMPAC).

Benchmarking results

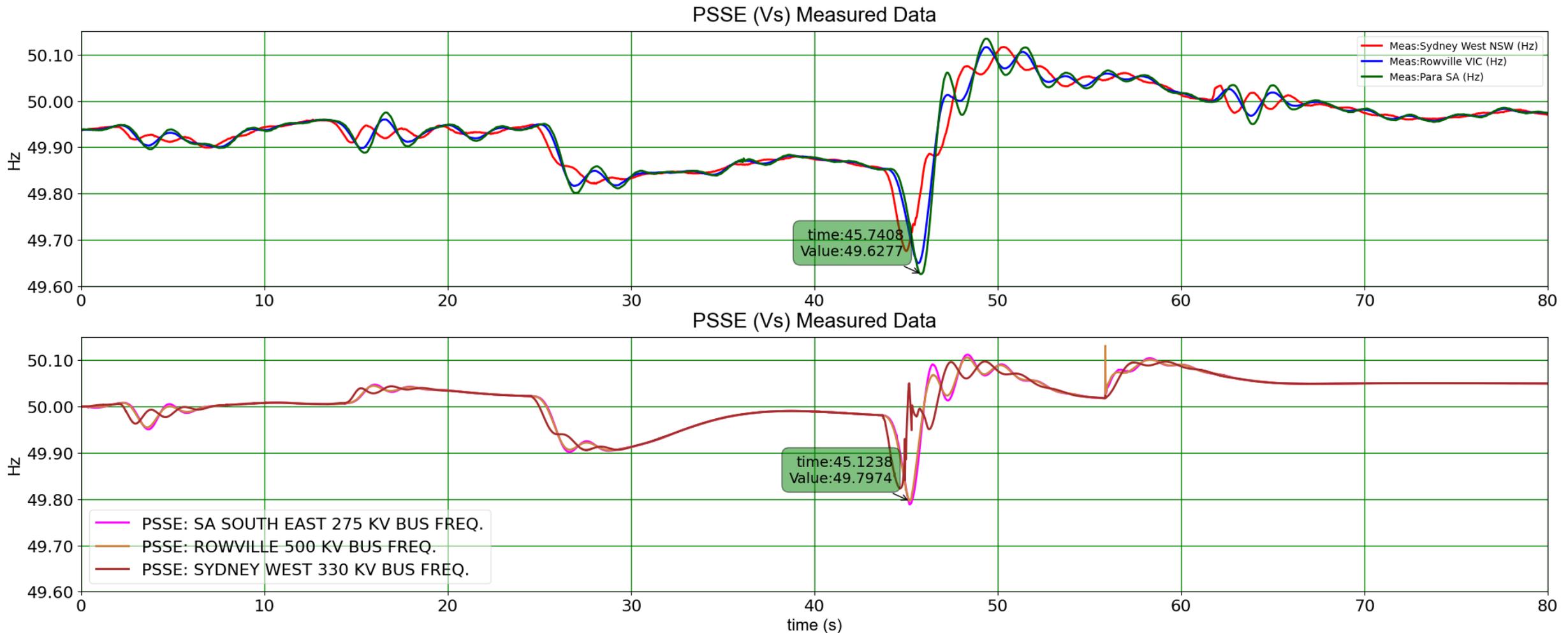
Model benchmarking results (25/05/2021) Callide event

Queensland Freq: Measured (vs) Simulated



Model benchmarking results (25/05/2021) Callide event

Remaining NEM Freq: Measured (vs) Simulated



Initial findings

Initial observations

Based on initial historical scenario studies:

- QNI loss (QLD exporting): Possibility of QLD frequency exceeding 52 Hz during night-time periods.
- Loss of both Calvale - Halys 275 kV lines: Further risk mitigation may be possible to improve the effectiveness of the WAMPAC scheme (work underway with Powerlink).
- SA separation from Moorabool: Improvements to EAPT operation (see also next slide).
- Management of VNI separation during bush fires.
- Potential opportunities for schemes to help manage:
 - Non-credible loss of Dederang – South Morang 330 kV lines.
 - Non-credible loss of Columboola – Western Downs 275 kV lines.

Protected Event for the separation of SA

- 2020 PSFRR: identified risks associated with low UFLS load in SA
 - Total UFLS load in SA has now reached as low as -110 MW in some periods
- Implemented updated constraints on Heywood imports to maintain RoCoF in line with limits advice for non-credible loss of Heywood.
- Protected event analysis is evolving:
 - Extensive model development and validation to more accurately model a broader range of aspects of SA separation events.
 - Preliminary findings:
 - Identified moderate risks for a range of possible points of separation (VIC 500kV network), particularly associated with risks of synchronous generator tripping in response to short duration extreme RoCoF.
 - Identified risks for frequency recovery following separation.
 - A suite of potential measures identified to incrementally reduce risks:
 - Updates to control schemes (EAPT), network constraints, adjustments to UFLS and OFGS settings, arrangements with fast start units to assist frequency recovery, adjusted settings for IBR to assist frequency recovery.
 - Working with NSPs to implement actions which can be pursued under existing framework.
 - Then consider remaining risk mitigation measures for a protected event submission
- Working with NSPs on UFLS remediation in parallel



Questions and discussion

Questions and discussion

- Feedback on proposed priority events to be assessed?
- Discussion regarding the methodology and assumptions?
- Any other questions/comments?

Next steps and 2023 GPSRR

2022 PSFRR indicative timing

- Consultation period on draft report for 3-4 weeks in April/May 2022 (min. 10 business days consultation period).
- Publish 2022 PSFRR report in June/July 2022.

2023 GPSRR indicative timing

- The GPSRR will include a broader range of events and conditions that could lead to cascading failures or supply disruptions.
- Commence scoping for 2023 GPSRR from mid-2022.
- Publish approach paper around December 2022 (min. 20 business days consultation period).
- Publish final 2023 GPSRR report in mid 2023.



Thanks for your time

Feel free to contact us directly or via 2022PSFRR@aemo.com.au with questions or feedback