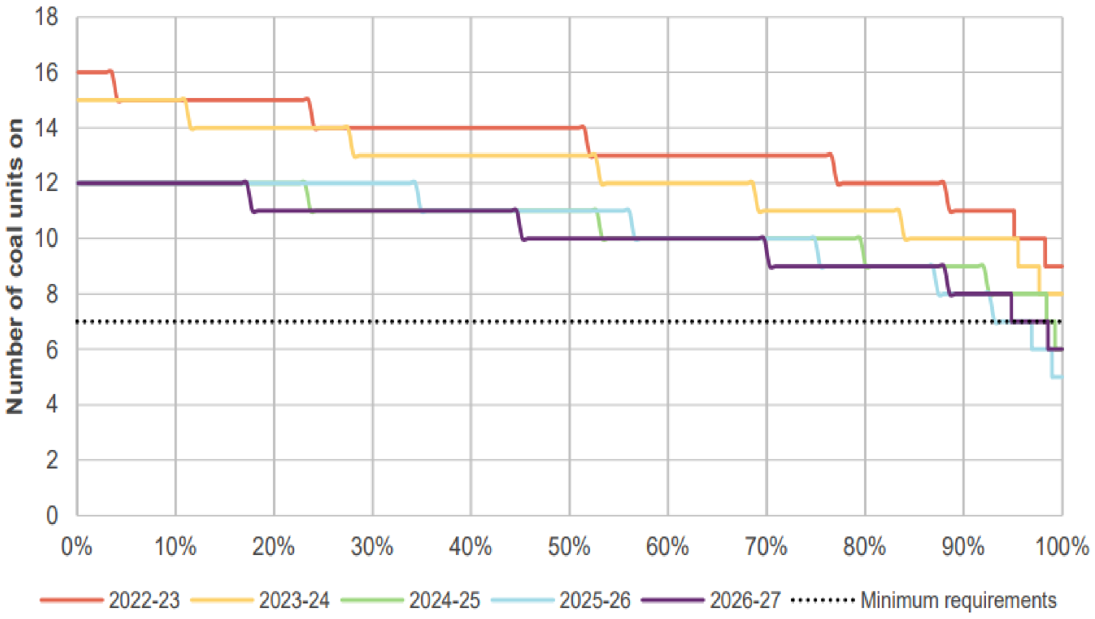
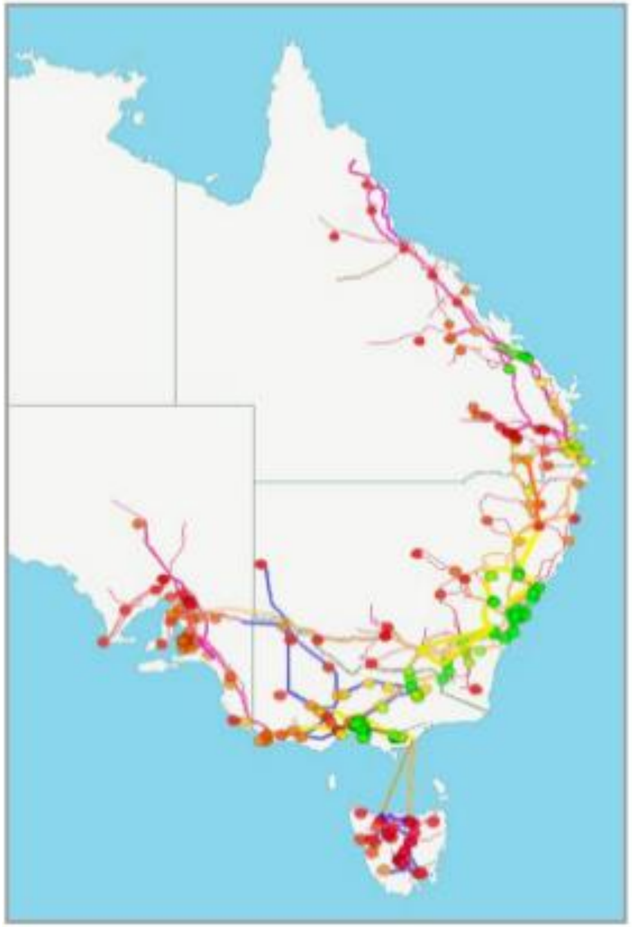
Efficient management of system strength during the power system transition

Inverter-based renewable energy uptake and declining synchronous generation commitment is driving urgent need for more system strength services in Australia



Number of coal units projected to be online under a 'progressive change' scenario in the New South Wales jurisdiction over the coming five years, shown against the minimum threshold. Since publication, a scenario with higher renewable uptake, 'step change', has been identified as more likely and a major coal-fired power station has announced early retirement. *AEMO, 2021 System Security Reports*



System strength outlook for the Eastern seaboard in 2031-32. Assumes 'backbone' system strength services are met and shows where additional support is needed to accommodate more inverter-based renewable energy generation. *AEMO, Draft 2022 Integrated System Plan*

Significant regulatory changes have been made to secure system strength services

Existing framework

- AEMO sets minimum fault level requirements for each region.
- Local transmission network secures ‘shortfall’ services against fault level projection.
- Newly-connecting generators self-remediate system strength impact.

Incoming framework

- AEMO sets system strength standard for each region, including fault level requirement and voltage waveform stability criteria.
- Local transmission network secures services to meet the full standard.
- Newly-connecting generators can pay to access the centralised service, or self-remediate.

AEMC, Efficient management of system strength on the power system

AEMO combines three modelling techniques to plan for system strength

Market modelling	Steady state loadflow	Electromagnetic transient analysis
• Long-term capacity outlook for generation resources and new generator planting. • Optimal development pathway for generation and network developments. • Time-sequential results projecting generator commitment and decommitment across the day and through the year.	• Holistic network planning to account for thermal limits, voltage management, and fault level projections. • Calculate long-term projections for fault level, to be compared against minimum values as a proxy for system strength.	• Assess power system stability for key power system snapshots, based on market modelling. • Study inverter interactions and generator performance pre- and post-contingency. • Derive a requirement for fault level (MVA) at key network nodes, to be used as a proxy for system strength needs. • Assess proposed system strength services from transmission networks.

A variety of system strength services have been implemented or are being explored

Synchronous condensers

Operation of hydro in synchronous condenser mode

Agreements with synchronous generators to remain online

Grid-forming inverters coupled with batteries

Tuning the inverters of existing variable renewable energy

Temporary constraints on number of inverters online for existing variable renewable energy

New network augmentations

Synchronous condensers can mitigate post-disturbance oscillations through injection of fault current

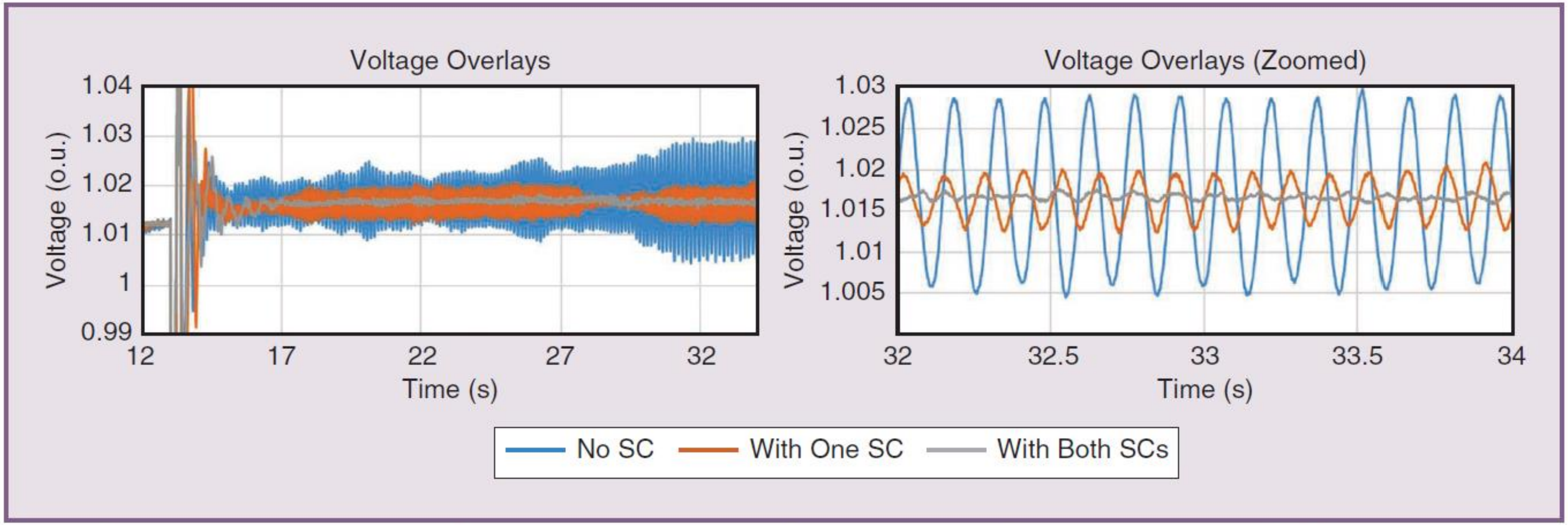


figure 6. The contribution of synchronous condensers on mitigating sustained postdisturbance oscillations.

[IEEE, Power system operation with a high share of inverter-based resources: The Australian experience]

Inverter tuning for variable renewable energy sources can prevent voltage waveform distortion

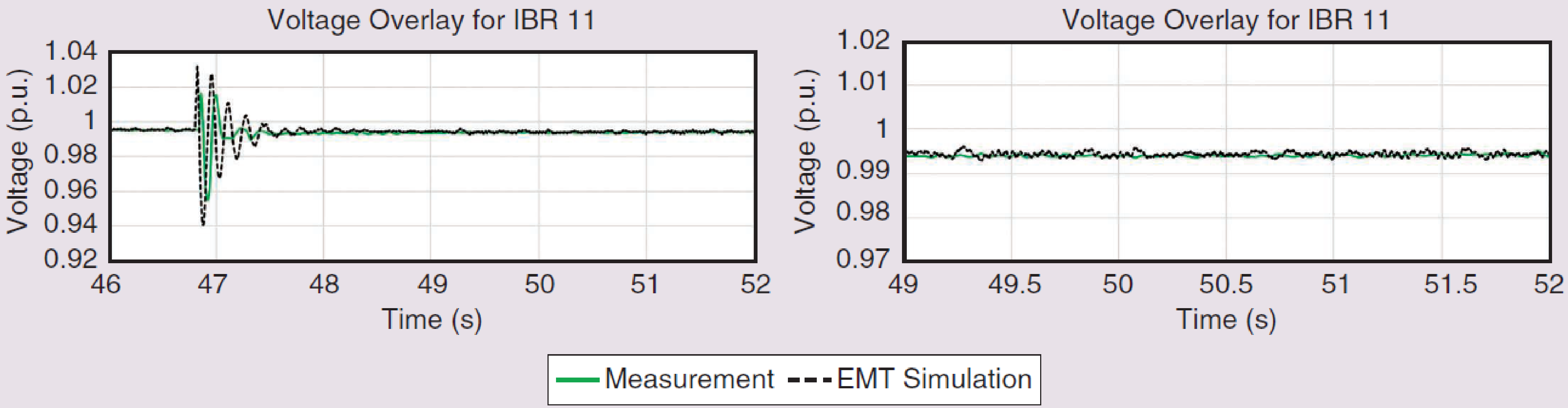
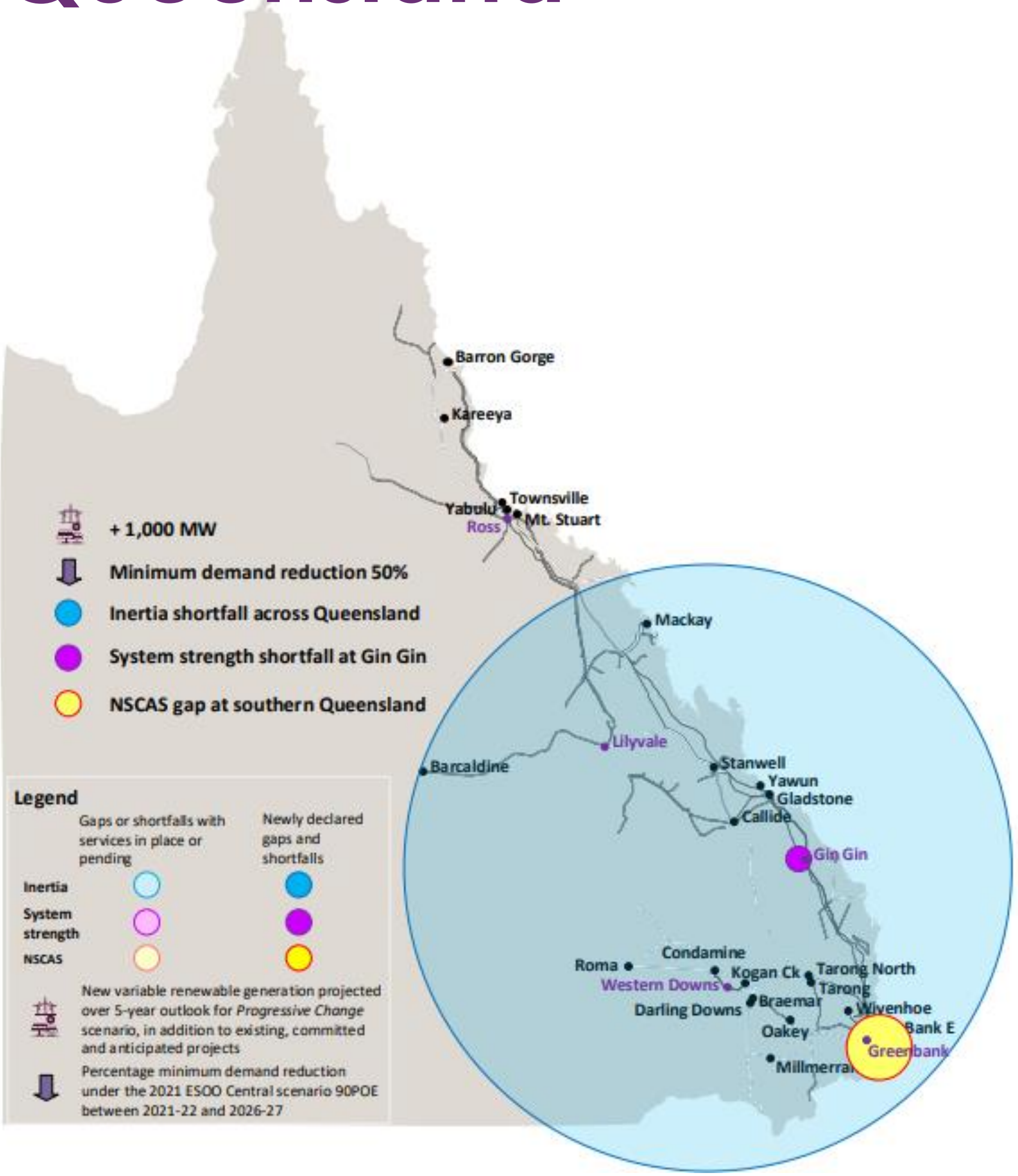


figure 7. Overlays of measured and simulated responses following IBR tuning.

IEEE, Power system operation with a high share of inverter-based resources: The Australian experience

Queensland



+1,000 MW

Minimum demand reduction 50%

Inertia shortfall across Queensland

System strength shortfall at Gin Gin

NSCAS gap at southern Queensland

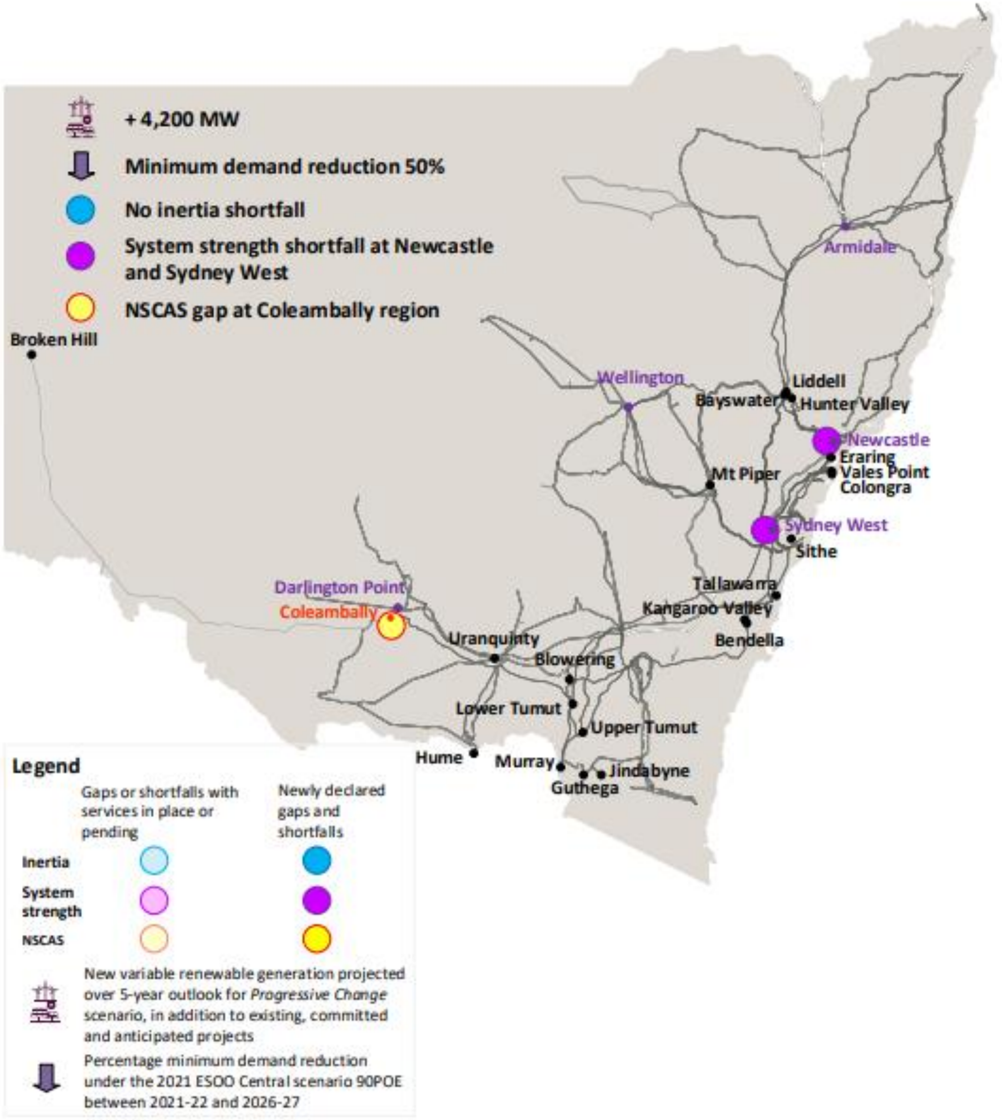
Legend

	Gaps or shortfalls with services in place or pending	Newly declared gaps and shortfalls
Inertia	○	●
System strength	○	●
NSCAS	○	●

New variable renewable generation projected over 5-year outlook for *Progressive Change* scenario, in addition to existing, committed and anticipated projects

Percentage minimum demand reduction under the 2021 ESOO Central scenario 90POE between 2021-22 and 2026-27

New South Wales



+4,200 MW

Minimum demand reduction 50%

No inertia shortfall

System strength shortfall at Newcastle and Sydney West

NSCAS gap at Coleambally region

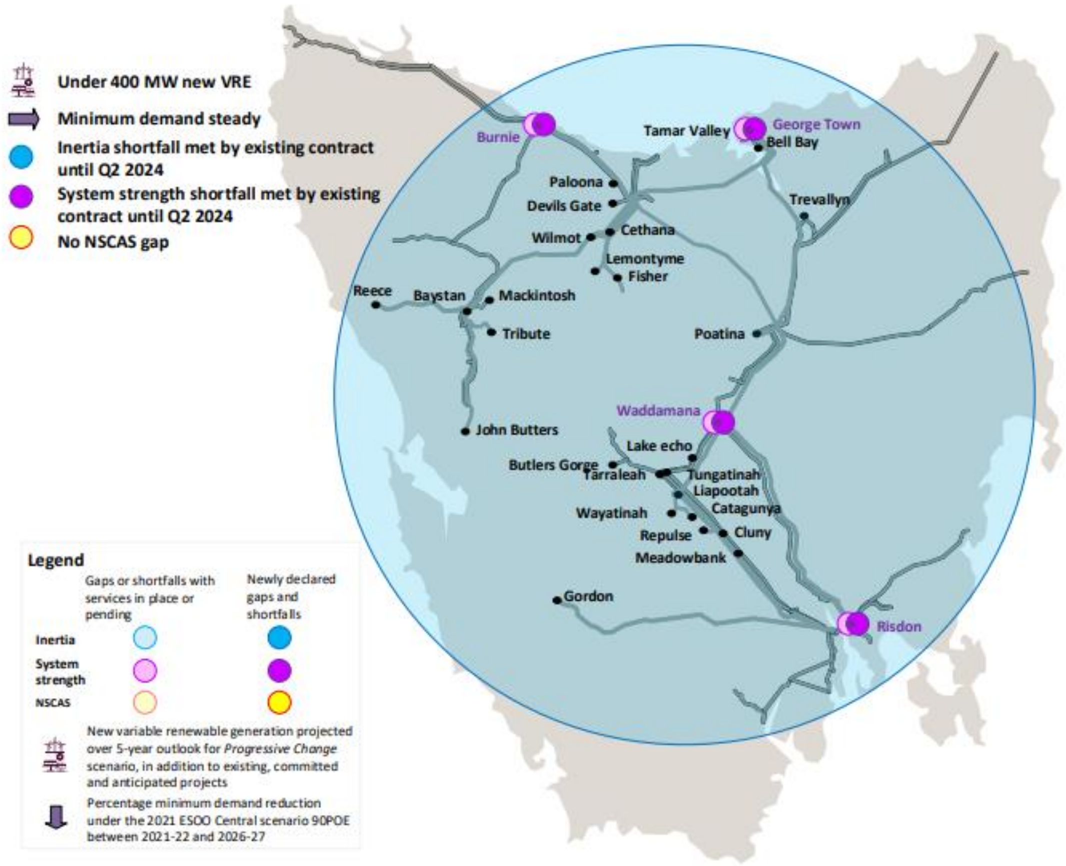
Legend

	Gaps or shortfalls with services in place or pending	Newly declared gaps and shortfalls
Inertia	○	●
System strength	○	●
NSCAS	○	●

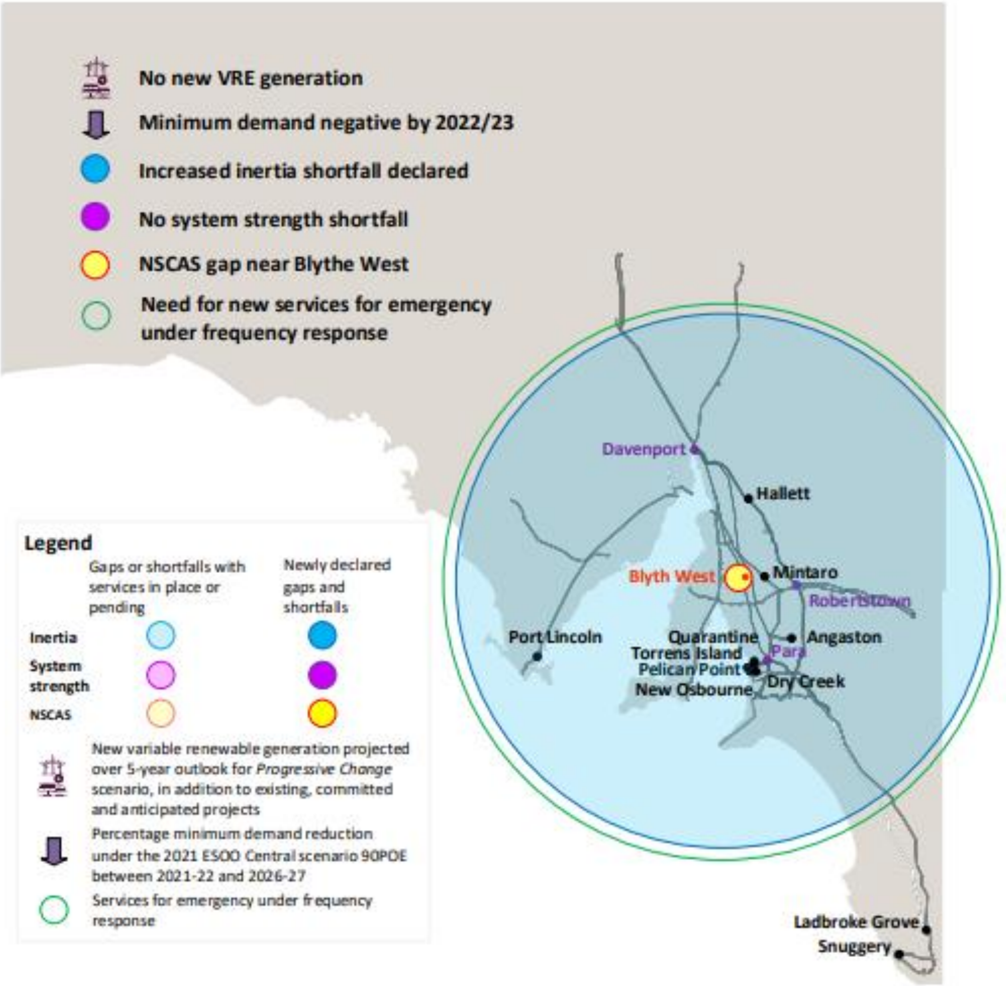
New variable renewable generation projected over 5-year outlook for *Progressive Change* scenario, in addition to existing, committed and anticipated projects

Percentage minimum demand reduction under the 2021 ESOO Central scenario 90POE between 2021-22 and 2026-27

Tasmania



South Australia



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