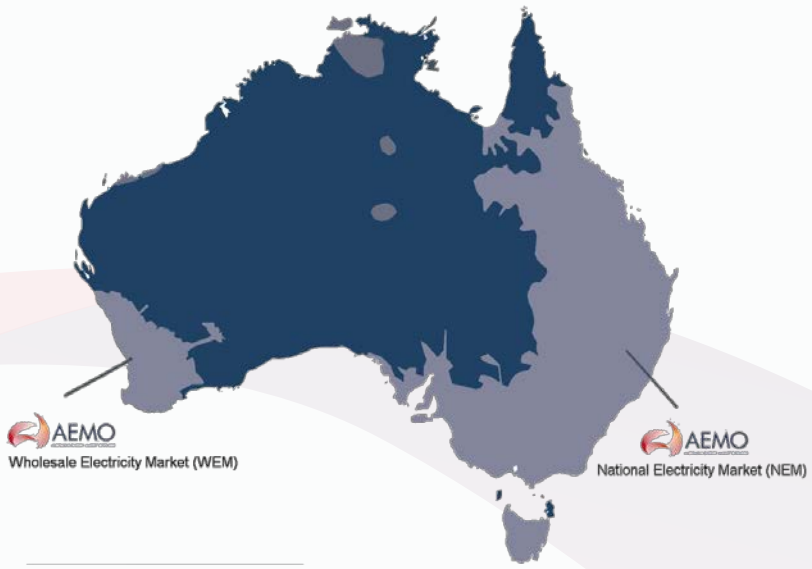
DER Integration

Emerging system security challenges in South Australia

About AEMO



AEMO operates Australia's National Electricity Market and power grid in Australia's eastern and south-eastern seaboard, and the Wholesale Electricity Market and power grid in south-west WA.

Both markets supply more than 220 terawatt hours of electricity each year.

We also operate retail and wholesale gas markets across south-eastern Australia and Victoria's gas pipeline grid.

Collectively NEM & WEM traded over A$20 billion in the last financial year.

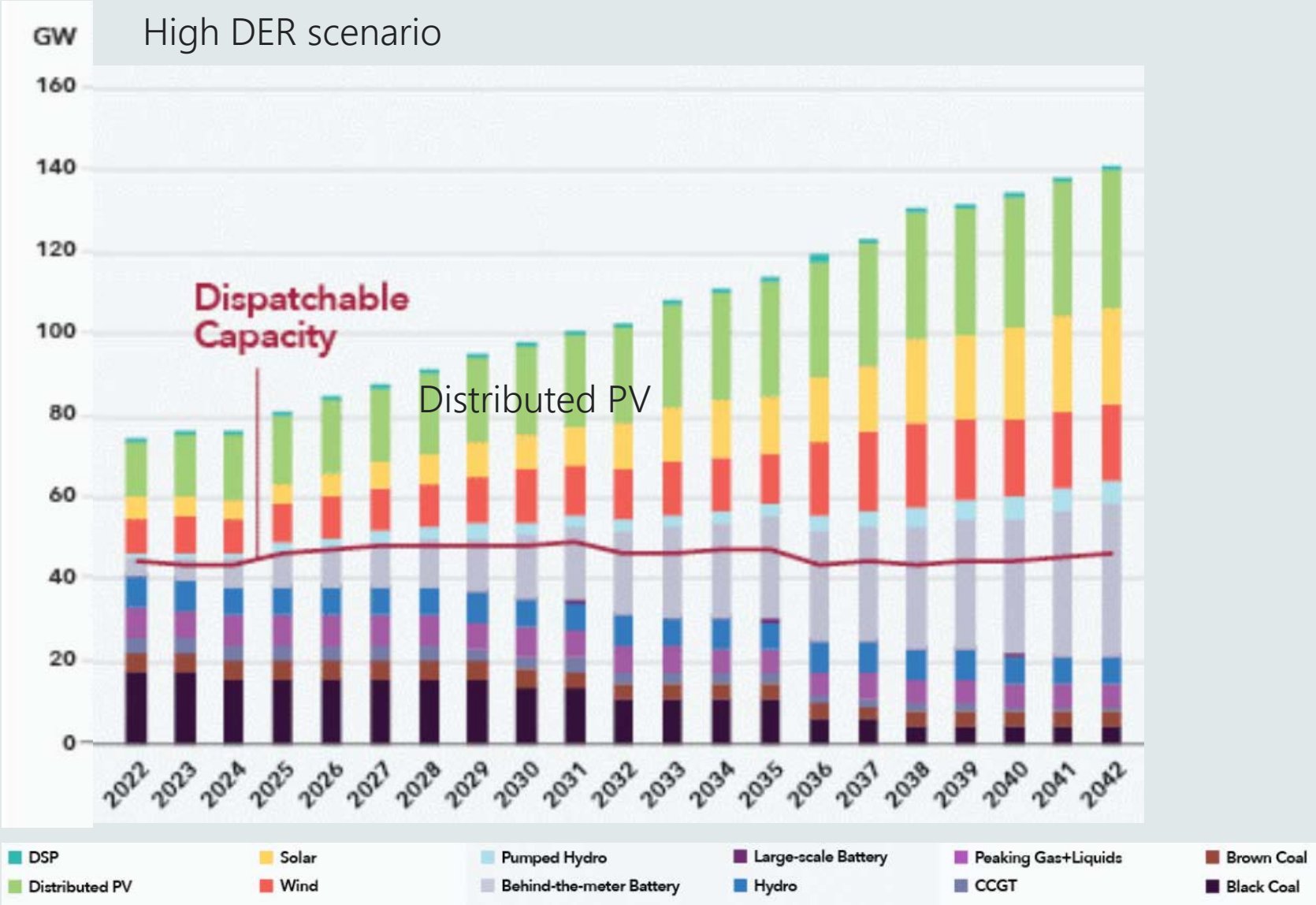
Ownership

40% Market participants

60% Governments of Australia

Resource development outlook

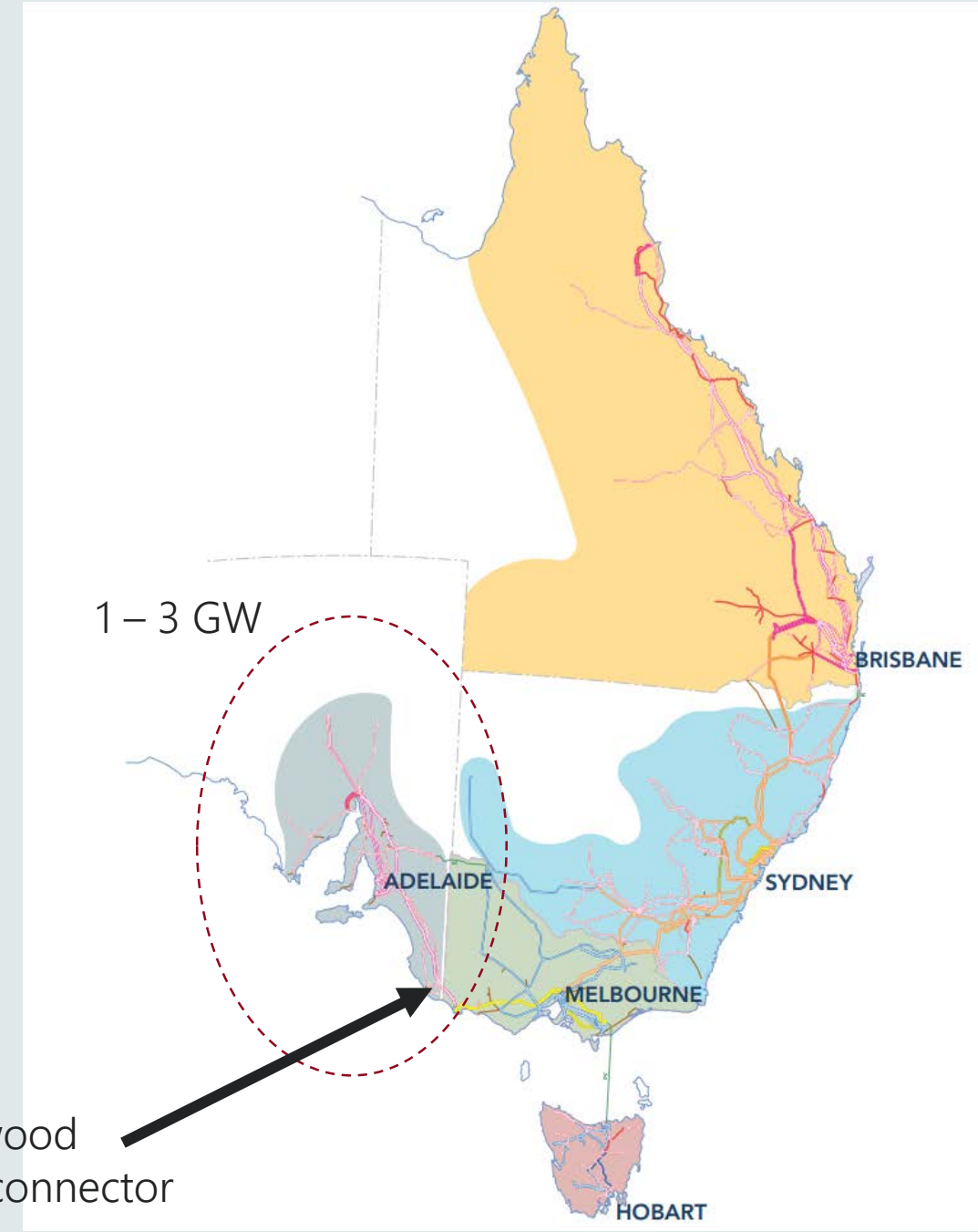
High DER scenario



AEMO (12 Dec 2019) Draft 2020 Integrated System Plan, at https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/isp/2019/draft-2020-integrated-system-plan.pdf?la=en

National Electricity Market (NEM)

~85% of electrical load in Australia



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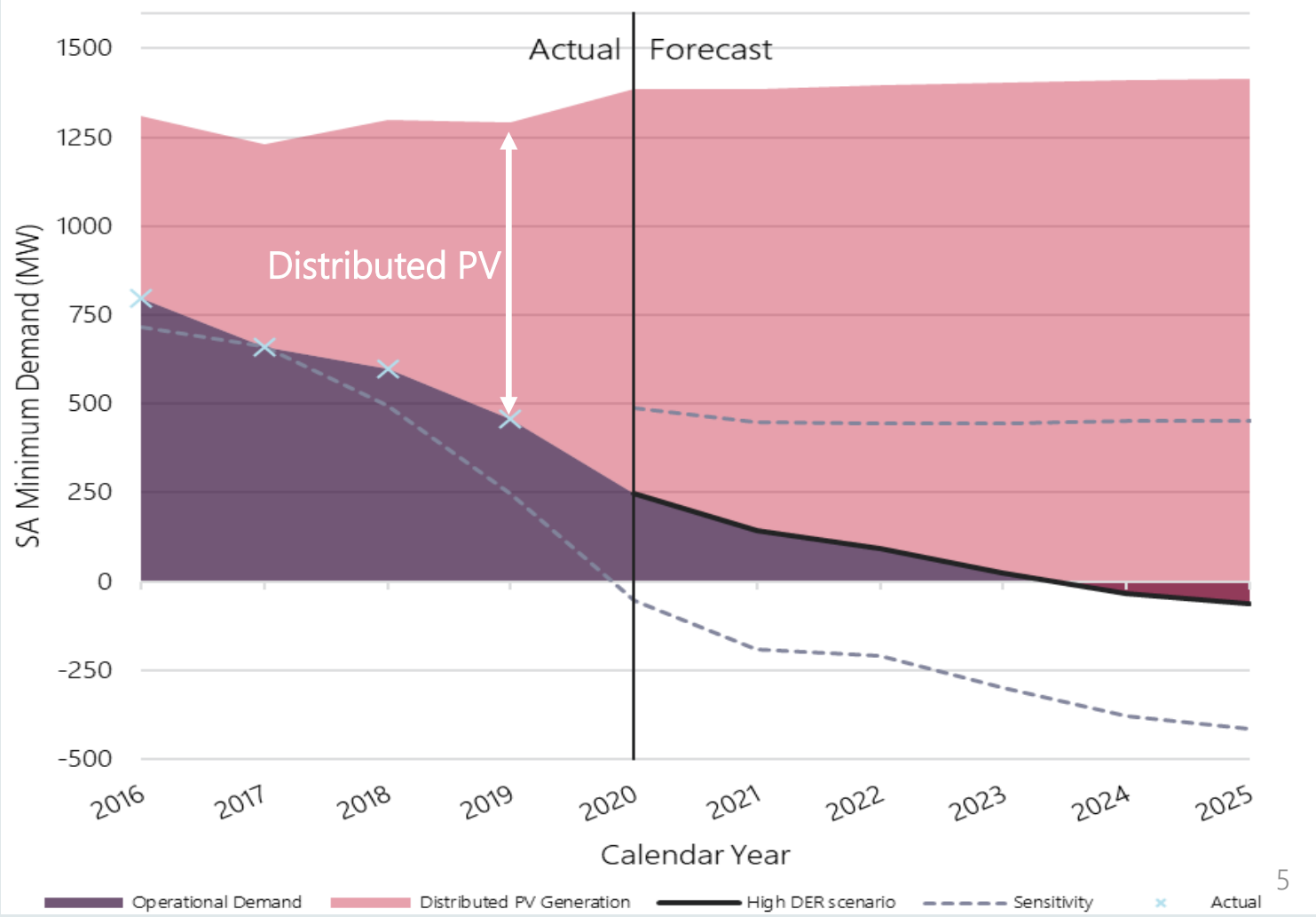
South Australia – DER integration

- Within 1-3 years, operational demand in South Australia could become negative.
- When and what operational challenges may arise?
- What actions do we need to take now, to ensure we can operate a secure system?
- Primary focus of DER Program Operations Stream

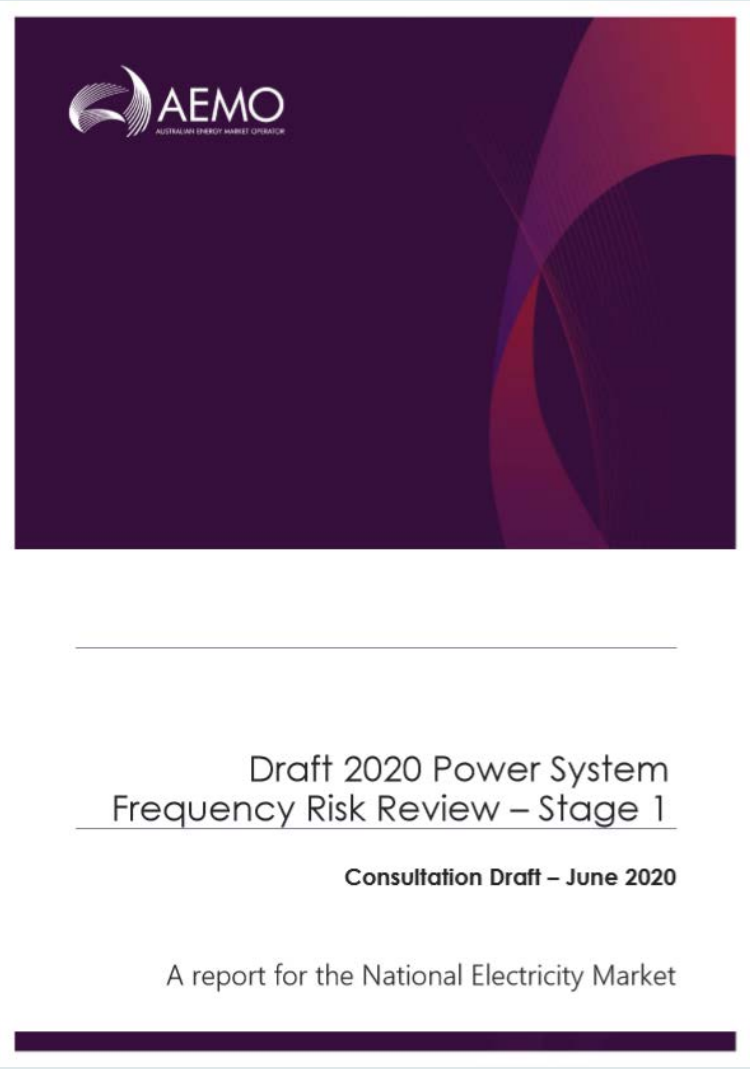
Minimum operational demand in SA



Agenda

- Preliminary findings and recommended actions

https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/sa_advisory/2020/minimum-operational-demand-thresholds-in-south-australia-review.pdf?la=en



Appendix A, at: https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2020/psfrr/psfrr-stage-1.pdf?la=en

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Preliminary findings

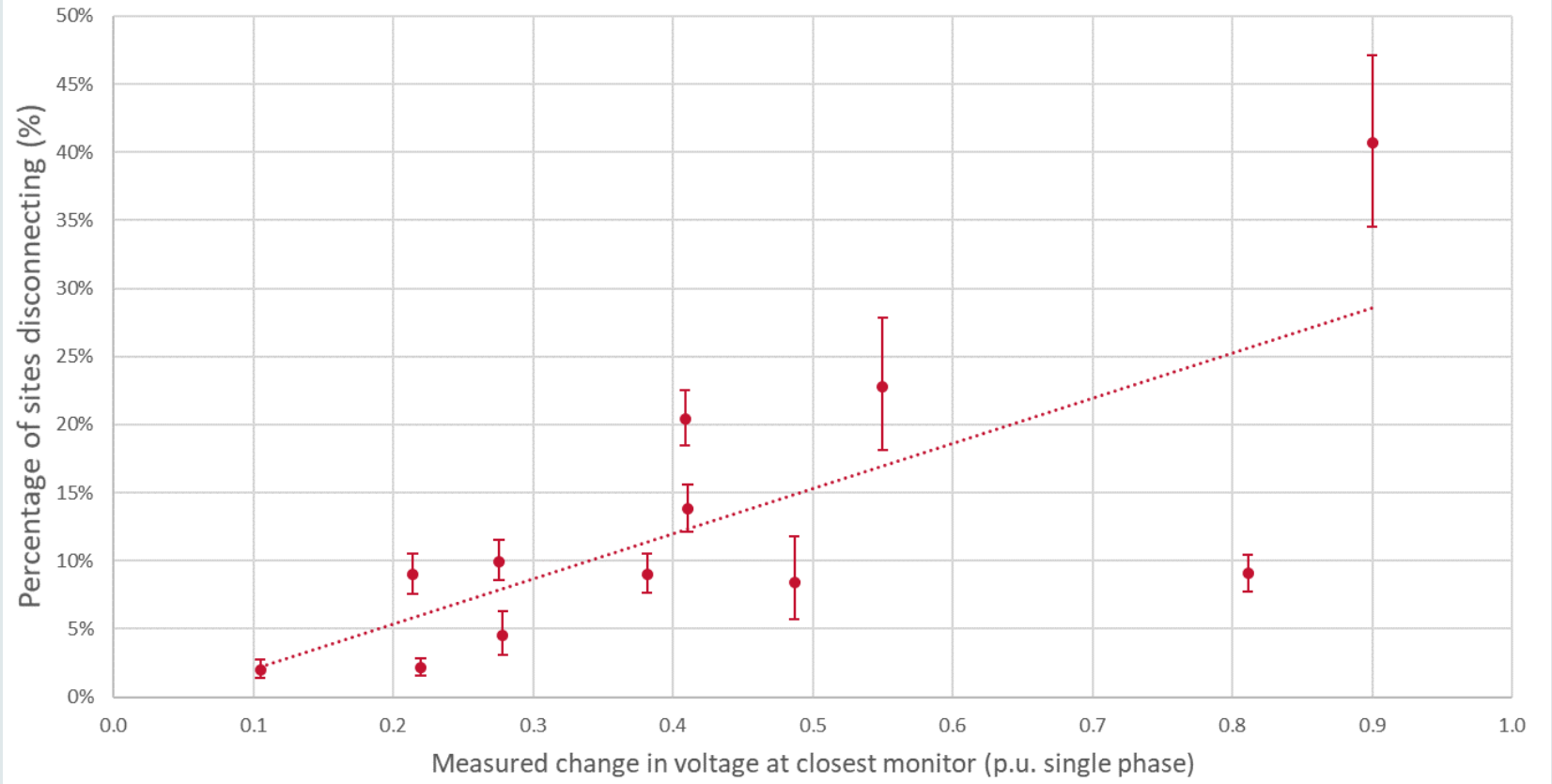
Challenges identified:

- Distributed PV disconnection
- Minimum load required to operate under islanded conditions
- Under Frequency Load Shedding

Distributed PV disconnection

- Analysis of PV disconnection based upon data from individual inverters
- Verified by bench testing (ARENA project with UNSW)
- Used to calibrate PSS®E model of DER behaviour
- PSS®E studies of a severe but credible fault in the Adelaide metropolitan area:
  - 19 - 20% of underlying load in SA disconnects
  - 38 - 44% of distributed PV generation in SA disconnects

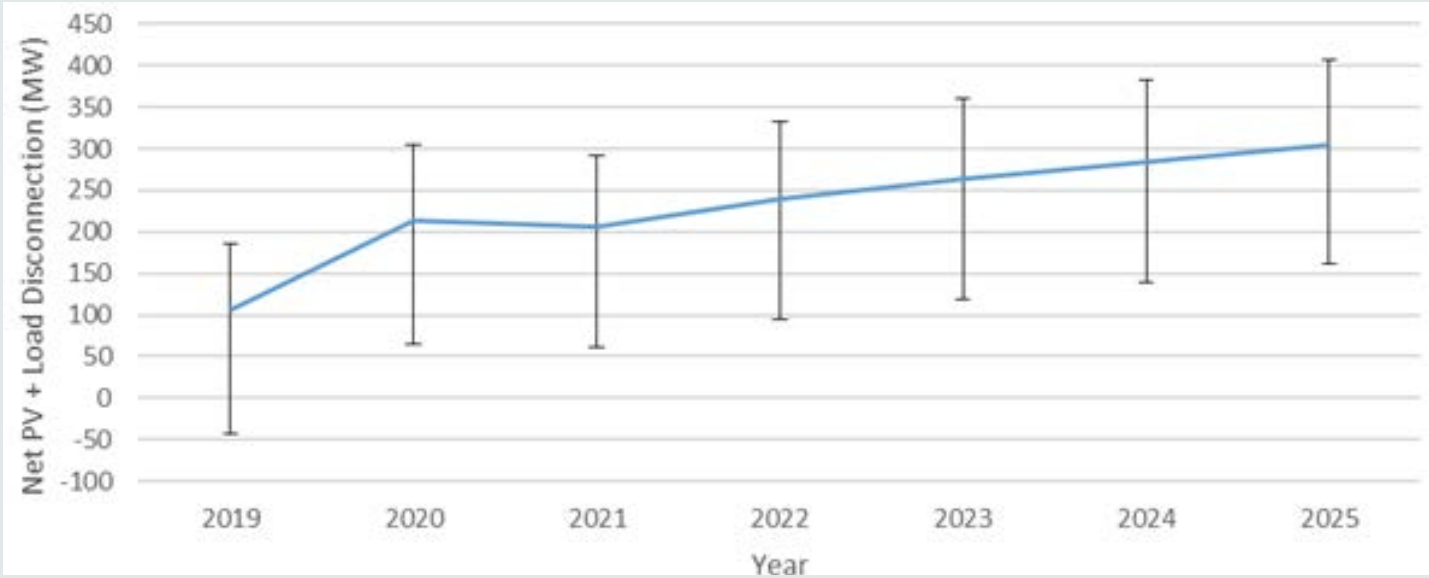
Distributed PV disconnection observed



Distributed PV disconnection

- Severe but credible fault near Adelaide metropolitan area could cause significant disconnection of distributed PV
- Increases largest credible contingency
  - Added to largest generating unit
- Constraint introduced to manage risks of separation/triggering SIPS
- When operating as an SA island:
  - Becomes almost impossible to maintain frequency >49Hz when DER-load loss exceeds ~150 MW (may be operating in this realm in some periods already)
  - AEMO may no longer have the ability to operate SA in a secure state, if islanding occurs at times of high distributed PV generation

Maximum net PV disconnection (SA)



Measures to manage PV disconnection

1. Improve DER standards (AS4777)
   - https://sapc.standards.org.au/sapc/public/listOpenCommentingPublication.action
2. Accelerated voltage ride through test in SA
   - https://aemo.com.au/en/consultations/current-and-closed-consultations/short-duration-undervoltage-disturbance-ride-through-test-procedure
3. Improve compliance with standards
4. Collaborate with DNSPs on connection requirements
5. EnergyConnect (new AC interconnector SA-NSW)
6. Network constraints

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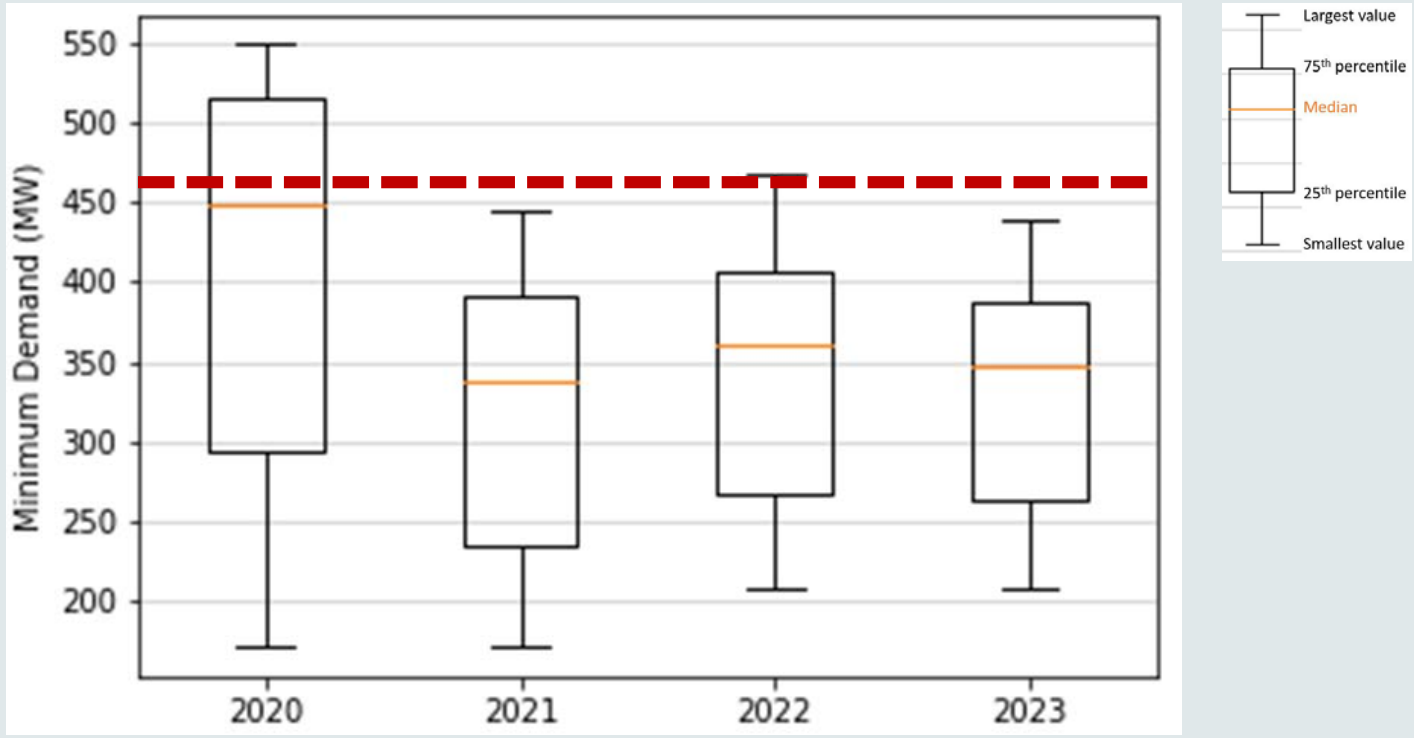
Minimum demand threshold

- **Islanded operation:** Need adequate load to operate necessary units for system strength, inertia, frequency control and voltage management
- Lowest operational demand experienced: 458 MW (10 Nov 2019)
- 2019 was a “moderate” year – minimum demand can become very low with:
  - Sunny
  - Mild temperatures, on
  - Spring/Summer public holidays

Minimum operational demand in SA

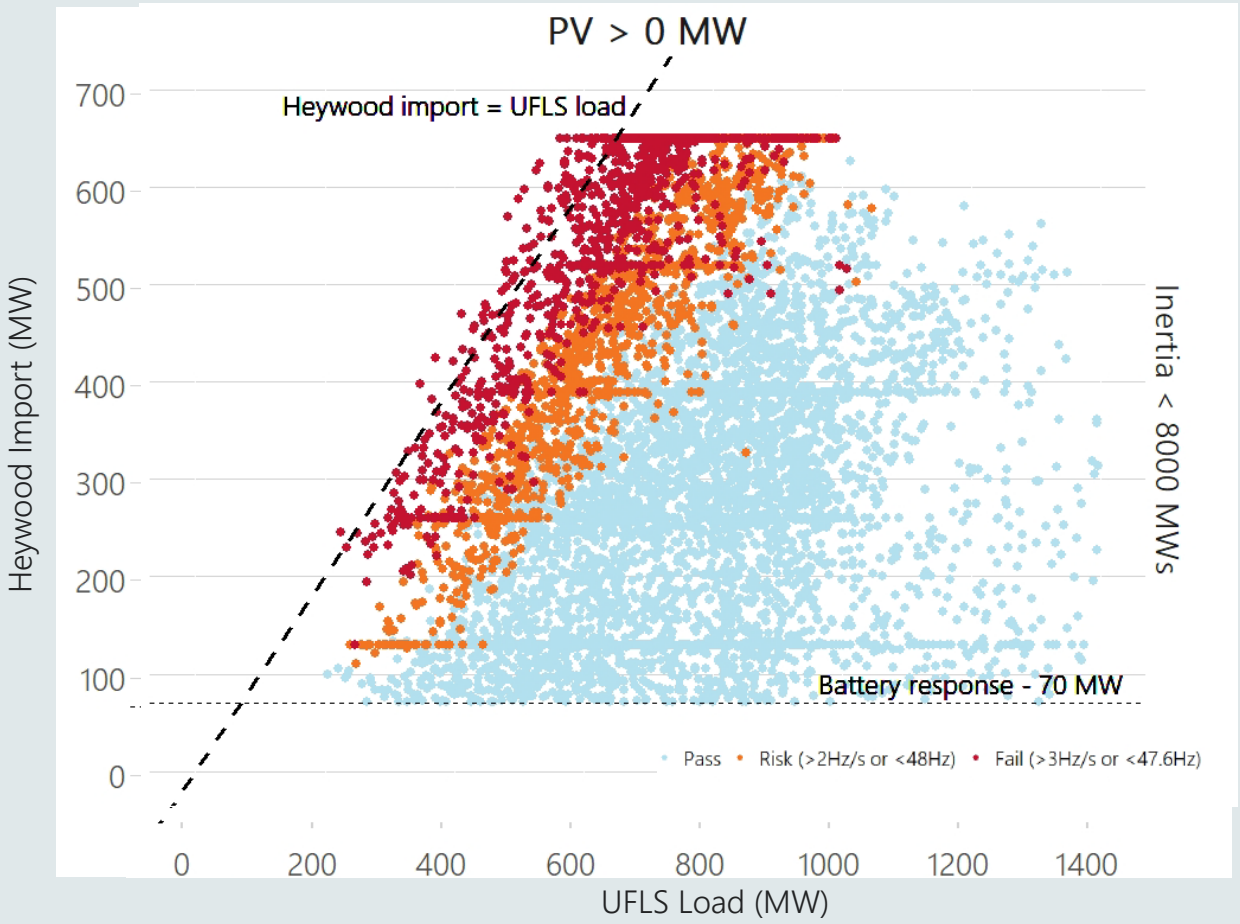


Measures for islanded operation with low load

1. SAPN: Flexible Exports – longer term, sophisticated, supports market integration and distribution management
2. PV shedding – immediate, simple, robust, supports system security
   - Analogous to load shedding
   - Anticipate use only during abnormal conditions, eg. islanding, line outages, etc.
   - Identified options that meet requirements:
     - Enhanced voltage management
     - Smart Meters

Under Frequency Load Shedding

- UFLS designed to arrest severe under-frequency events
  - Separation events
  - Multiple contingency events
- Security challenges identified:
  1. Reducing net load
  2. Reverse flows
  3. Distributed PV disconnection
- Incidence of risk forecast to increase in SA post syncon commissioning
- Actions:
  - Increase UFLS load
  - Dynamic arming of UFLS relays
  - Heywood constraint
  - Protected event submission
  - NER review
- Consultation:
  - https://aemo.com.au/consultations/current-and-closed-consultations/2020-psfrr-consultation



Next steps

- Collaboration with stakeholders on design and implementation of mitigation actions
- Analysis for other NEM regions underway
  1. PV disconnection and impact on contingency sizes
  2. Minimum load required for islanded operation (QLD)
  3. UFLS – data request for NSPs
- Continuing development of tools and data
  - Models in PSSE/PSCAD, rollout for stakeholders
  - Improving data on DER behavior (Solar Analytics, UNSW, ARENA)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