Challenges & Solutions Associated with High DER

DPV contingency & low demand operation

2 March 2021

About AEMO

AEMO is the independent system and market operator for the **National Electricity Market** (NEM) and the WA **Wholesale Electricity Market** (WEM).

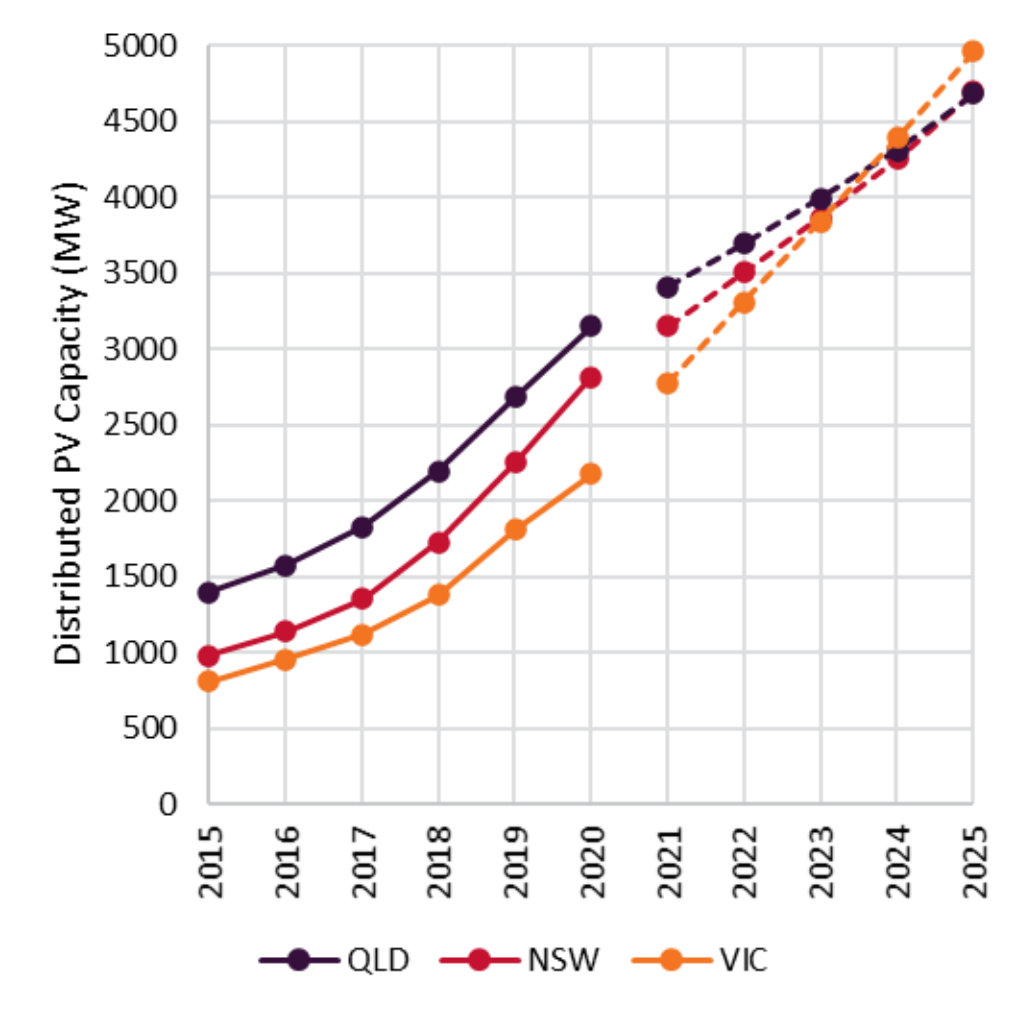
We also operate **retail and wholesale gas** markets across south-eastern Australia and Victoria's gas pipeline grid.

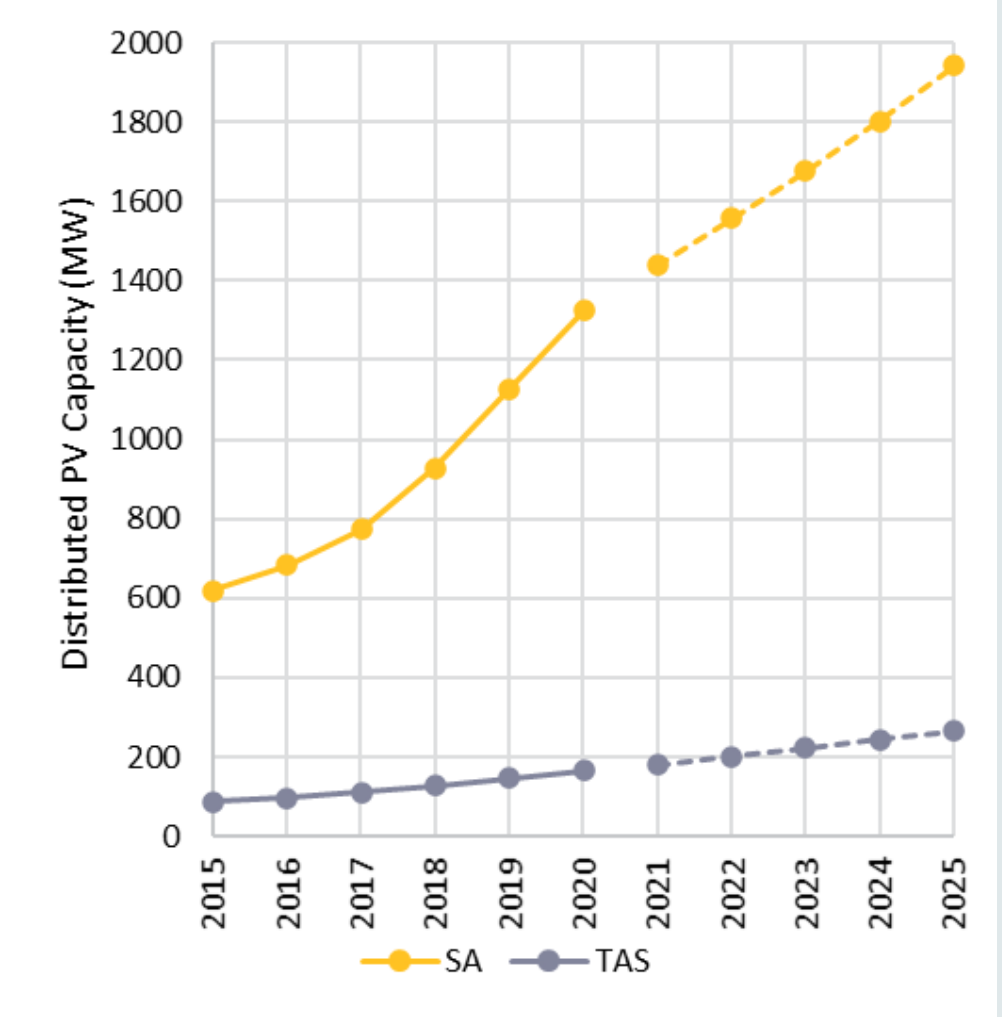
Ownership

40% Market participants

60% Governments of Australia

Distributed PV Capacity

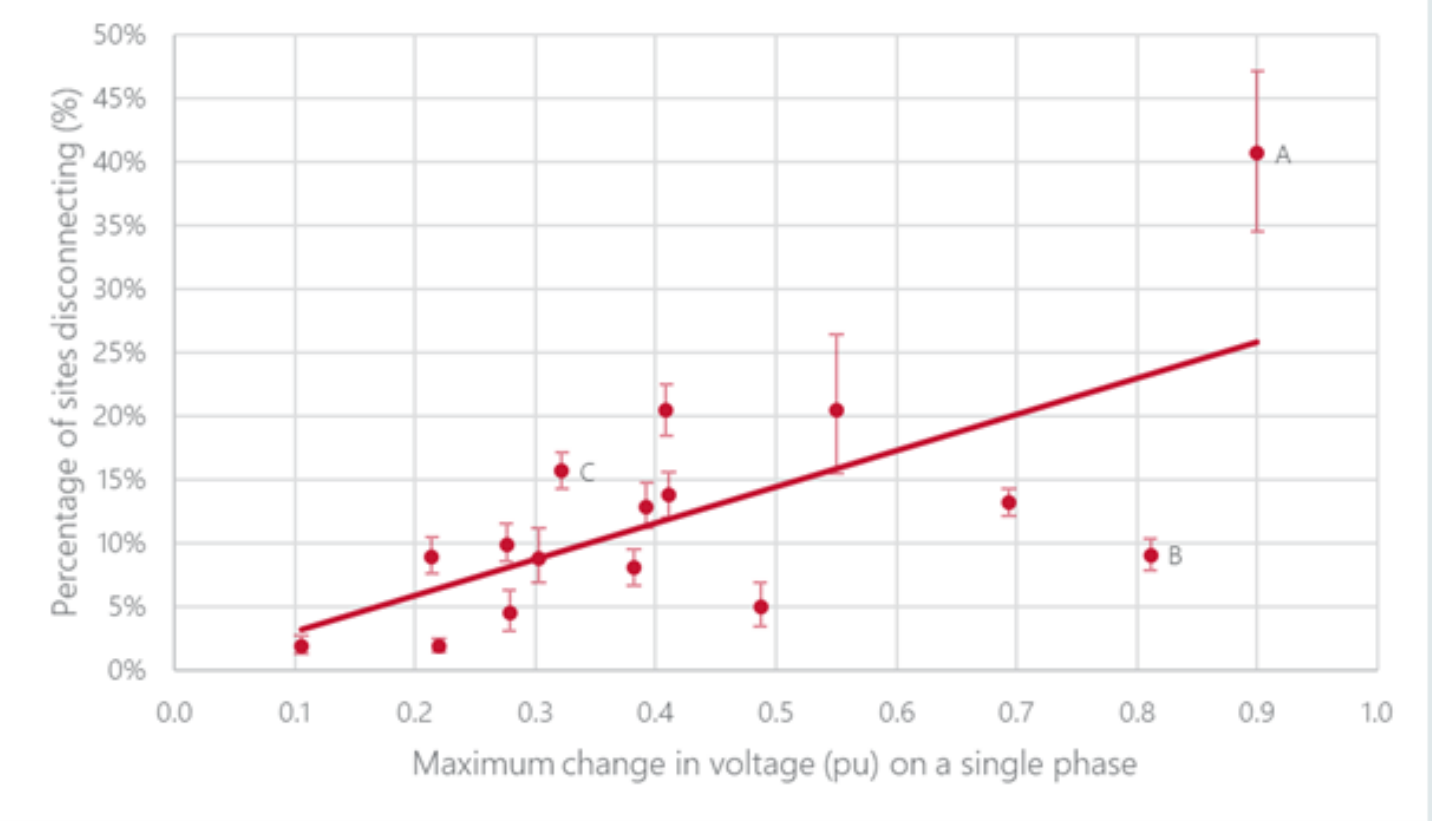




Forecasts: Central Downside, High DER scenario, 2020 ESOO

DPV Contingency

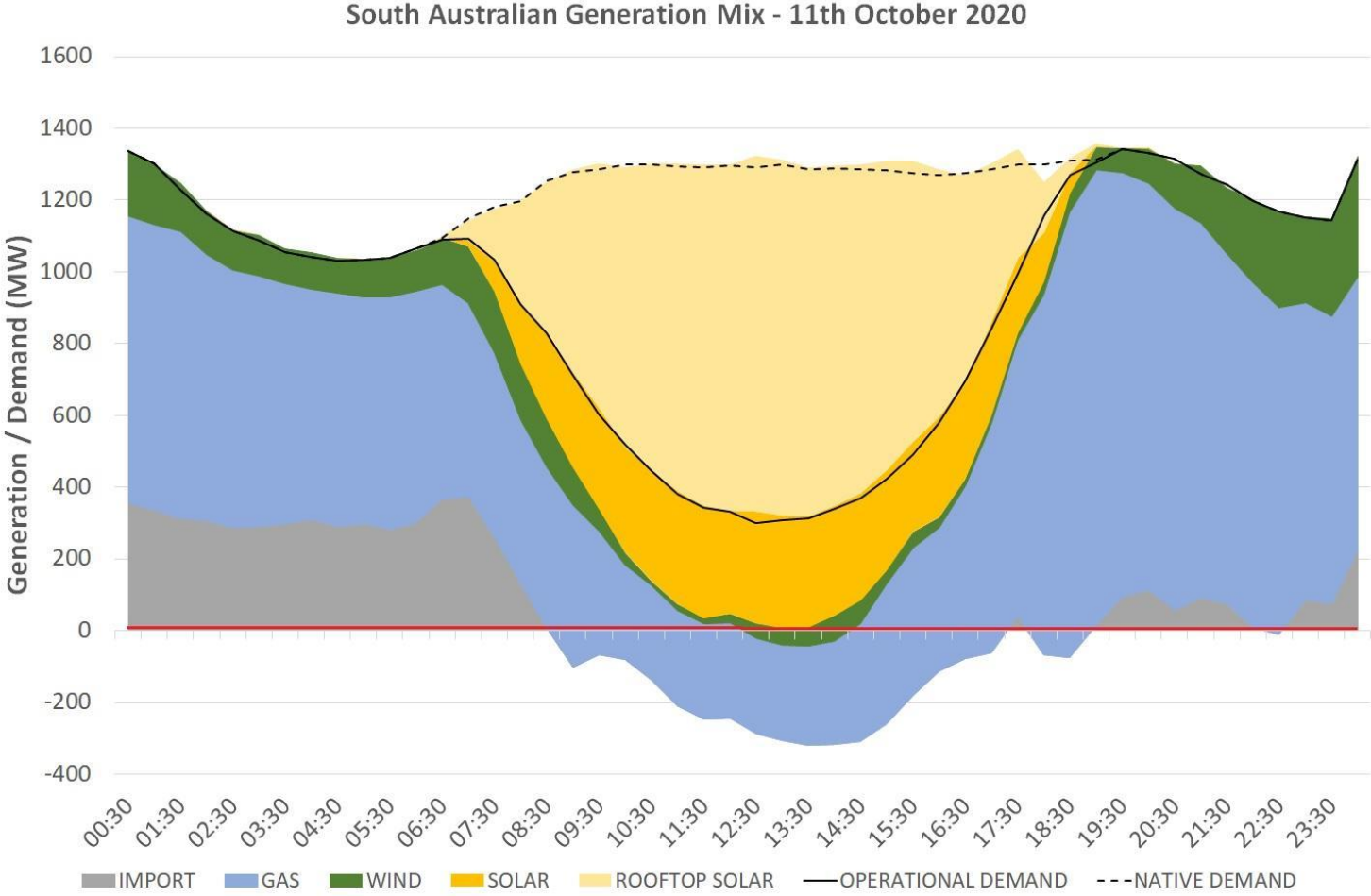
- Many distributed PV systems unintentionally disconnect during voltage disturbances
- Voltage disturbances also cause a load reduction which partially offsets DPV disconnection
- Volume of DPV disconnection can exceed amount of load reduction, leading to a net reduction in supply (the "DPV contingency")
- DPV contingency may coincide with the loss of a large generating unit
- Largest credible contingency is growing in some regions



DPV Contingency

Region	Influential Fault Locations	Disconnection of regional DPV	Disconnection of regional load
SA	Adelaide metropolitan 275kV network (eg. Pelican Point, Torrens Island)	39-43 %	14-25 %
QLD	Brisbane metropolitan 275 kV network, or Tarong, Tarong North, Swanbank E	32-36 %	9-16 %
QLD	Wivenhoe	30-33 %	9-15 %
VIC	Loy Yang A or B	40-45 %	12-22 %
VIC	Loy Yang A or B with de-energisation of Hazelwood – South Morang Line 1	35-38 %	12-22 %
VIC	Melbourne metropolitan 500 kV network (Sydenham – South Morang)	43-47 %	12-21 %
NSW	Sydney metropolitan 330 kV network, or Liddell, Vales Point	19-24 %	8-17%

DPV Contingency



- DPV generation equal to 78% of underlying demand
- Possible DPV contingency ~200MW

Low Demand

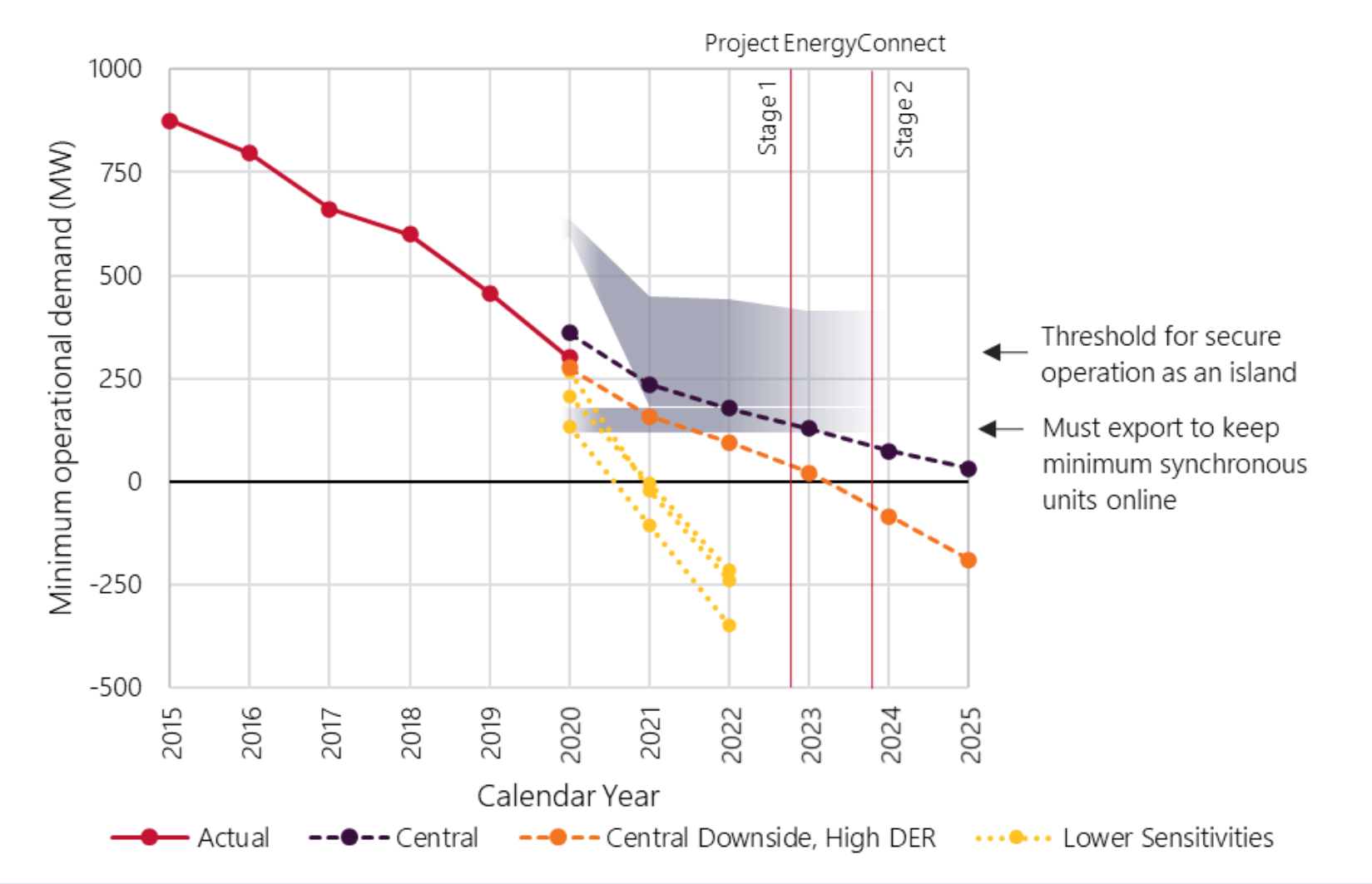

6000
5500
5000
4500
4000
3500
3000
2500
2000
Minimum Demand (MW)
2015
2016
2017
2018
2019
2020
NSW
QLD
VIC


1000
900
800
700
600
500
400
300
200
100
0
Minimum Demand (MW)
2015
2016
2017
2018
2019
2020
SA
TAS

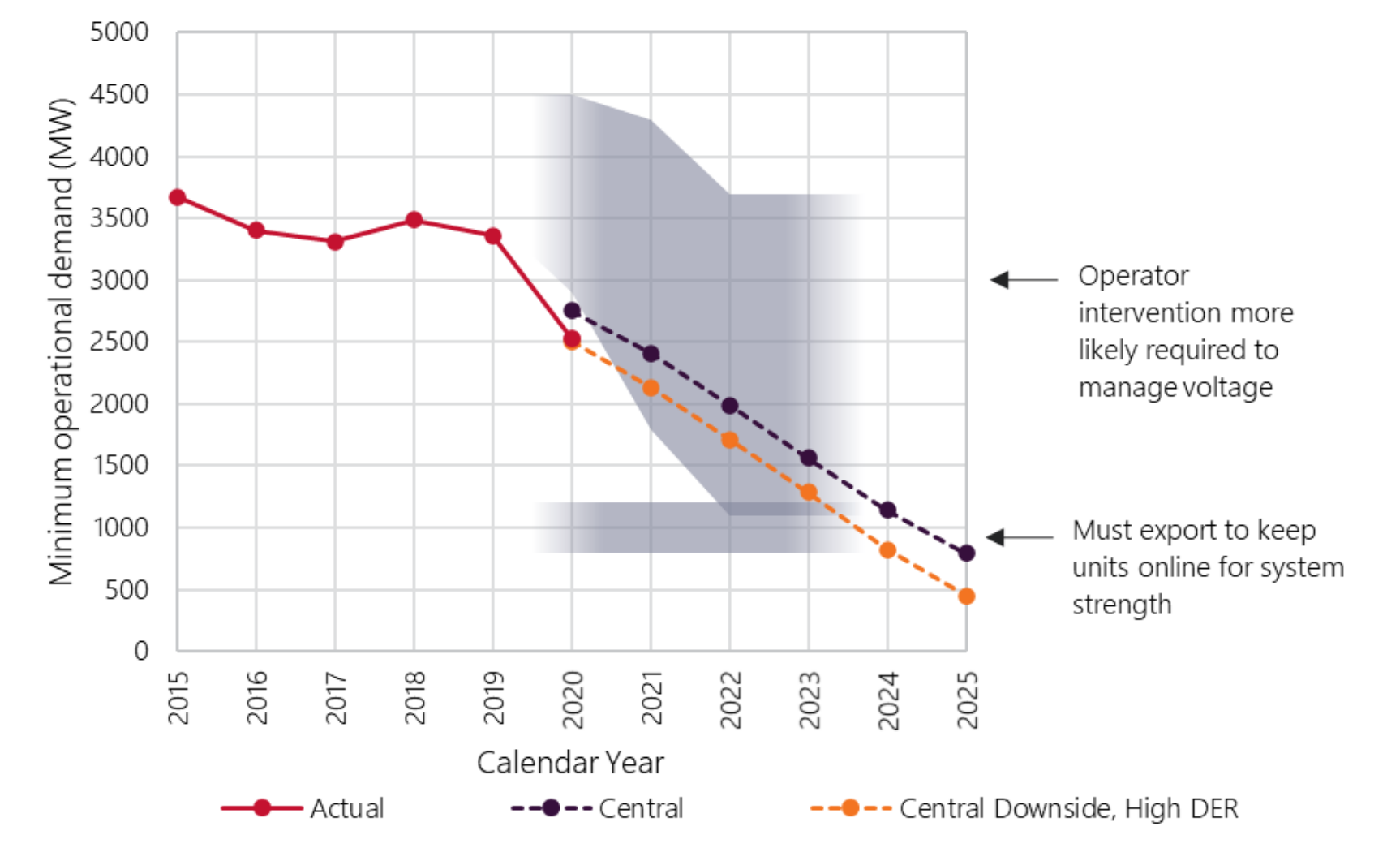
Low Demand Challenges

- Voltage management – low demand results in reduced flows on transmission lines
- System strength – generating units required for system strength have minimum generation levels
- Frequency control – generating units required for inertia and frequency control have minimum generation levels
- Emergency frequency control schemes – Underfrequency load shedding

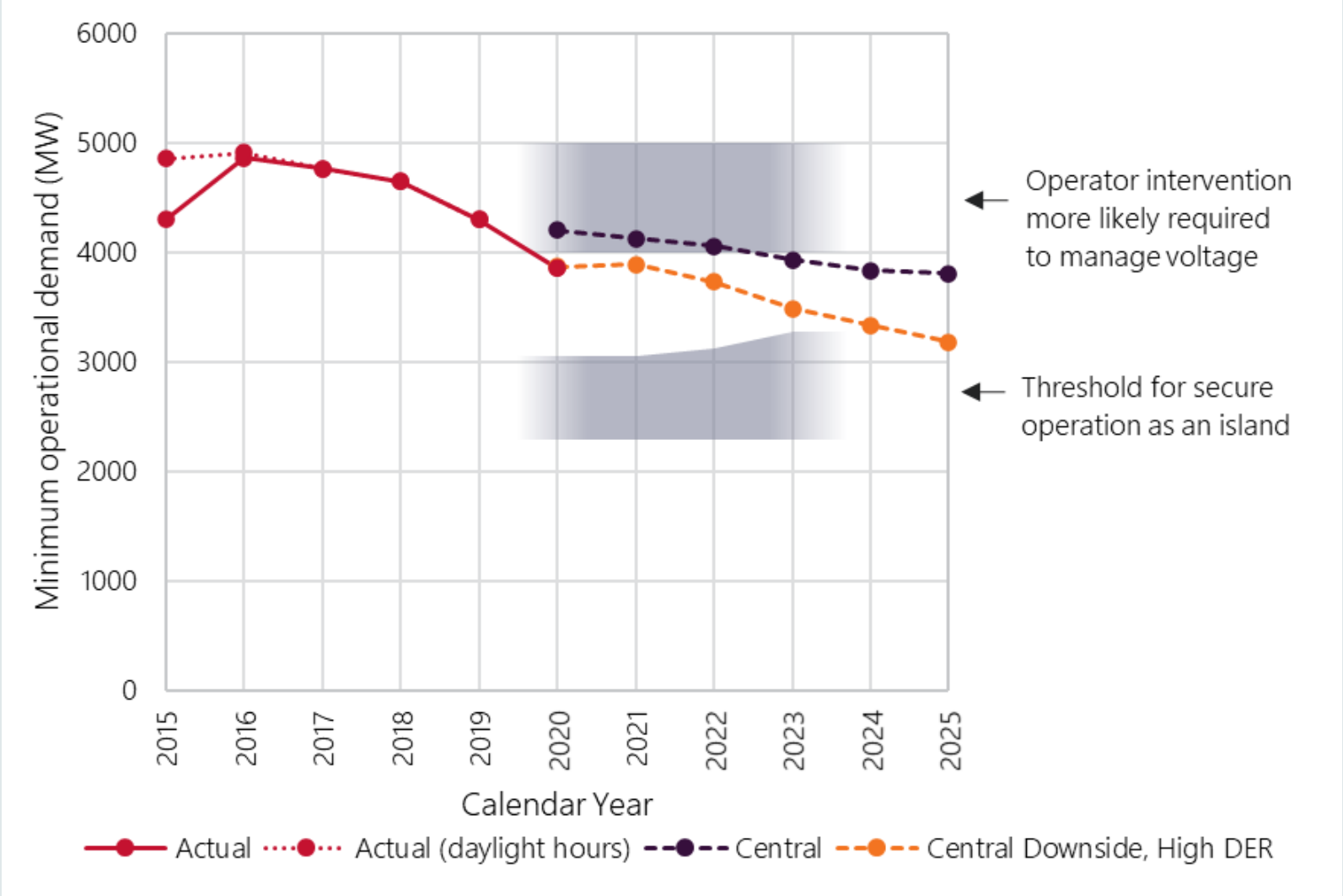
Low Demand Thresholds – SA



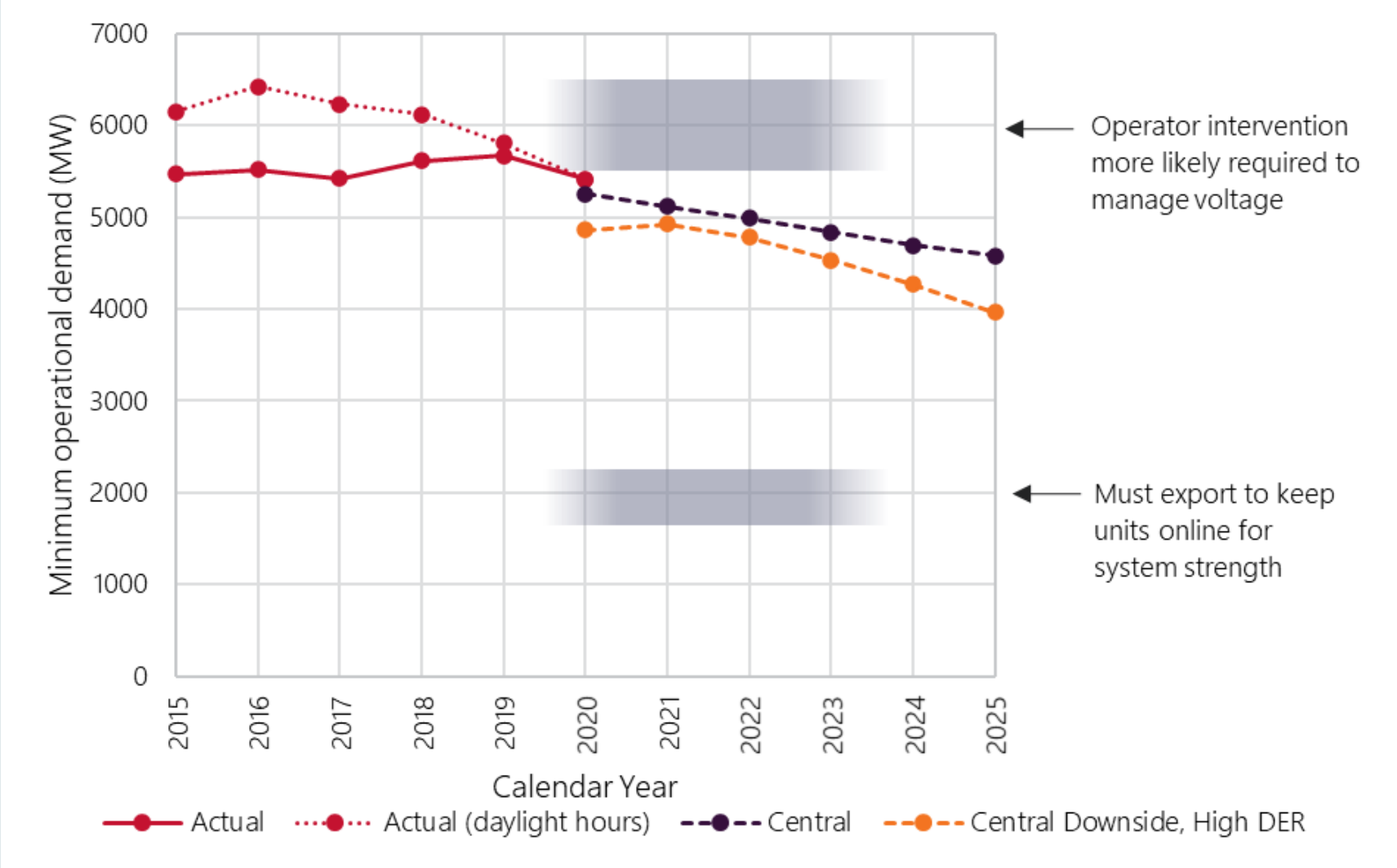
Low Demand Thresholds – VIC



Low Demand Thresholds – QLD



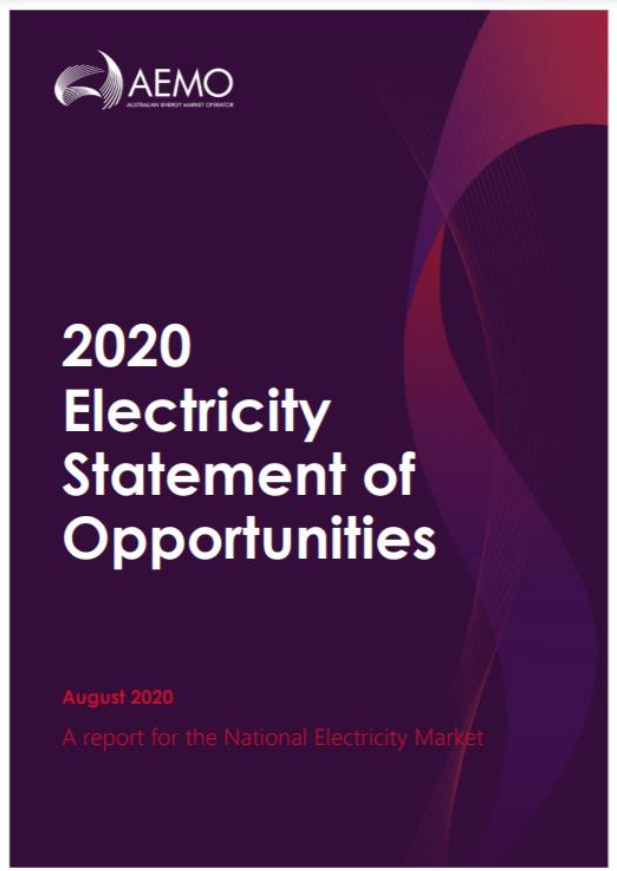
Low Demand Thresholds – NSW

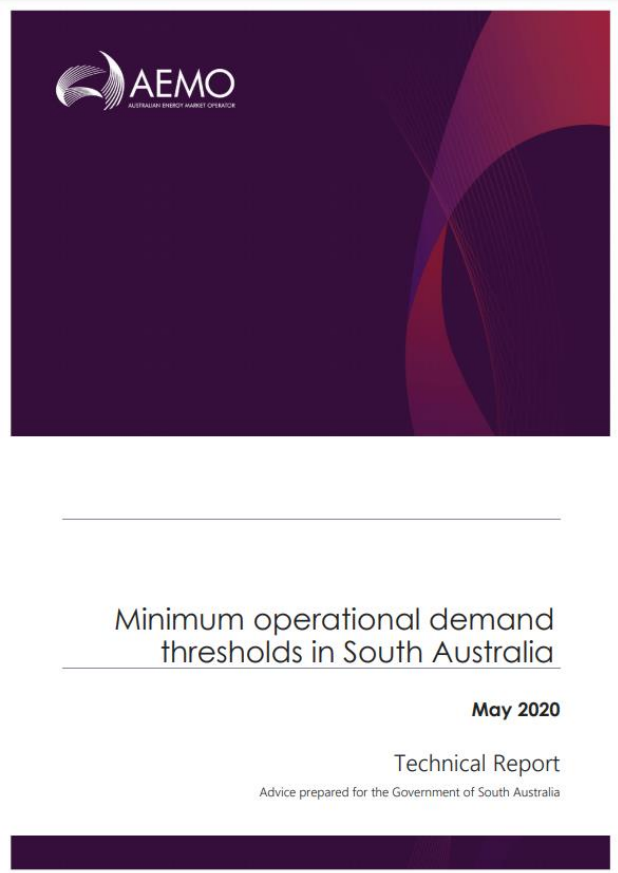


Solutions and Opportunities

- Disturbance ride-through capabilities – AS 4777.2:2020
- Emergency DPV shedding capabilities – to disconnect DPV during rare, severe operational conditions
- Frequency control – to manage growing DPV contingency sizes
- Load shifting – DBESS or flexible loads can ‘soak up’ excess DPV generation

Further information





- Chapter 7, 2020 ESOO
- Technical Report for Government of South Australia
- AEMO's DER Program

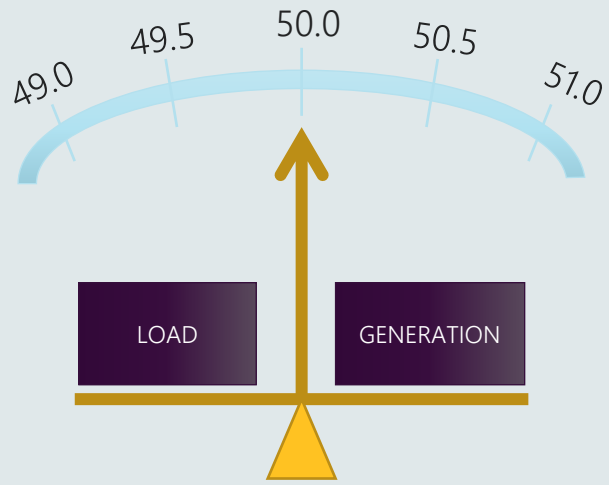
Challenges & solutions associated with high DER

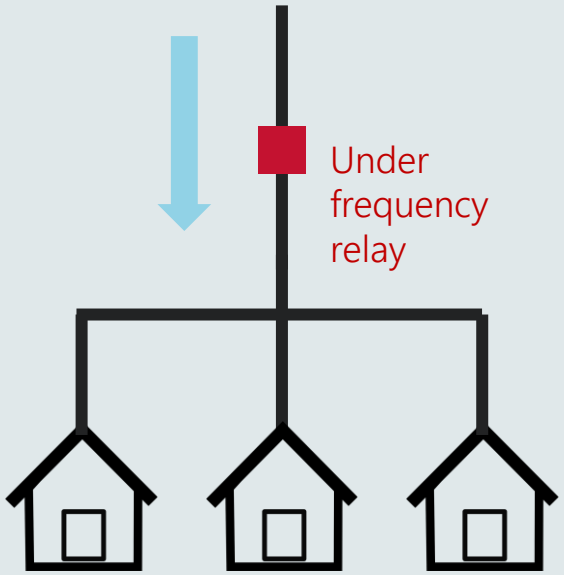
Under Frequency Load Shedding (UFLS) in South Australia

2 March 2021

What is UFLS?

Normal UFLS operation:





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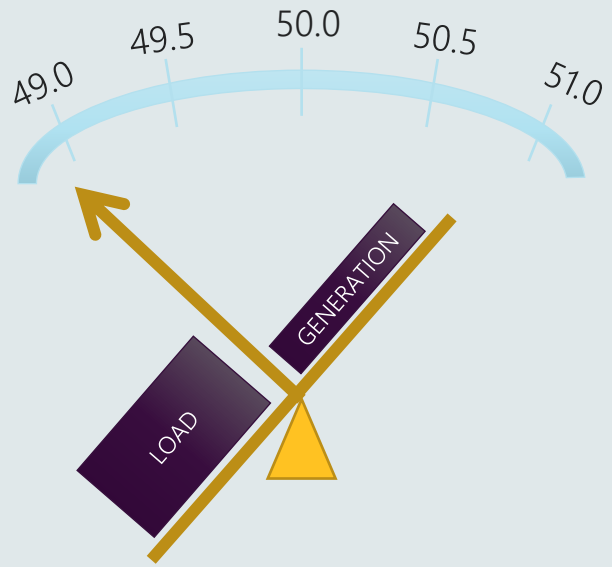

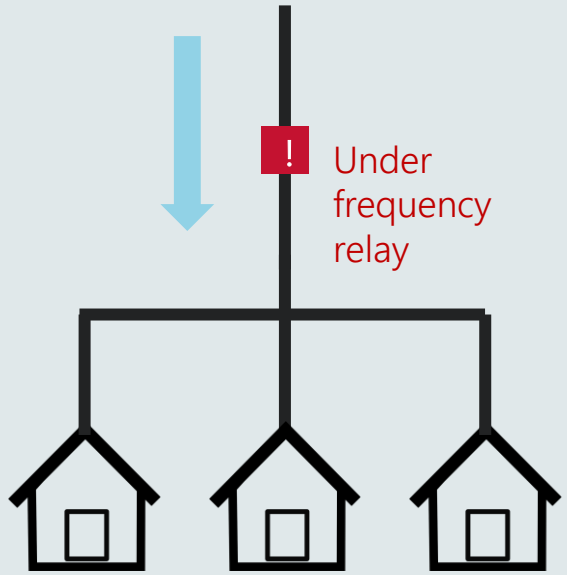

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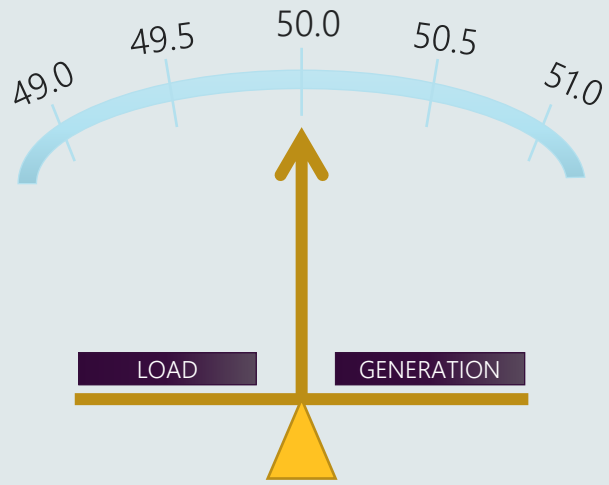
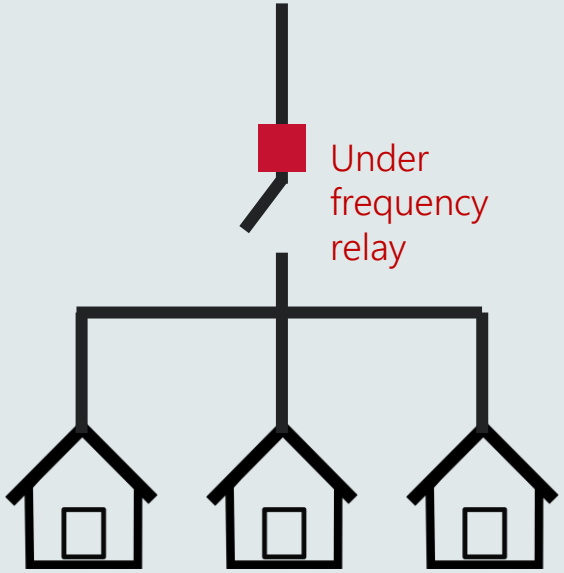
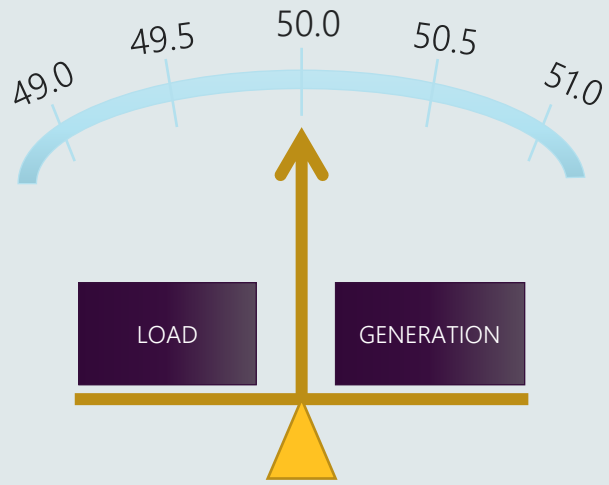
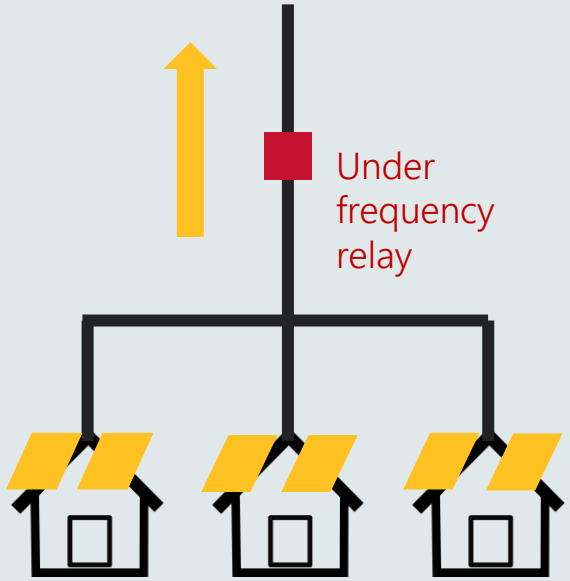




Reverse flows on UFLS feeders





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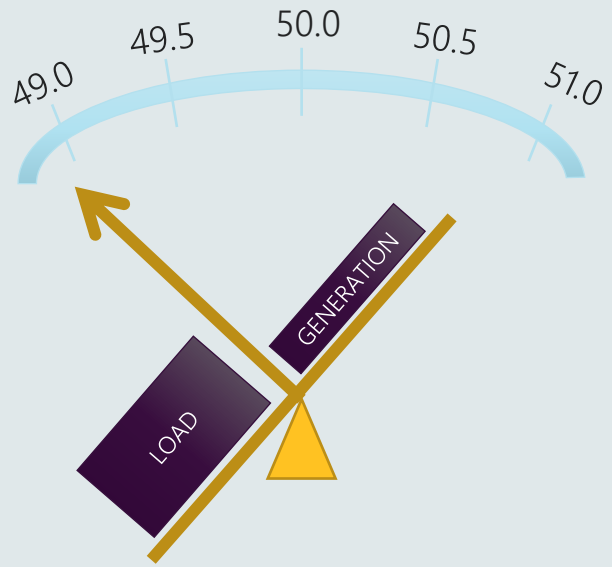

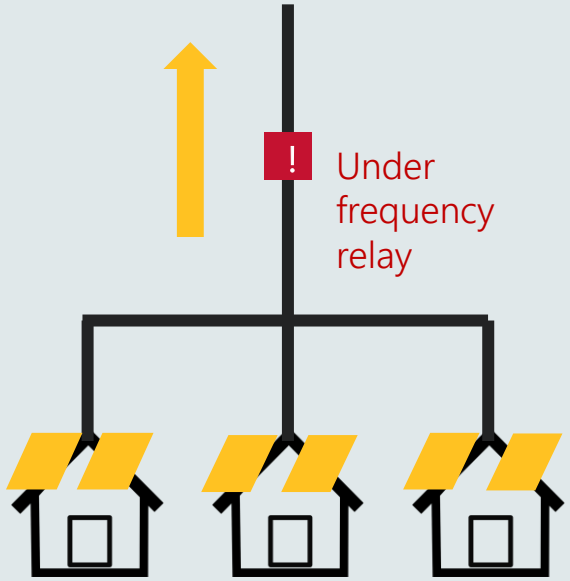

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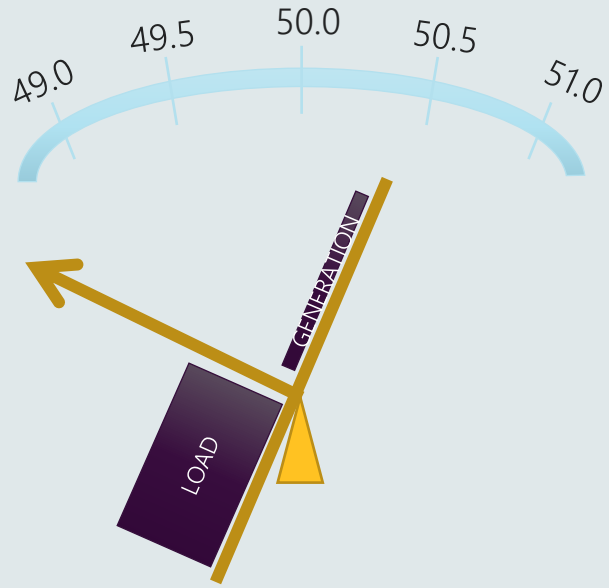
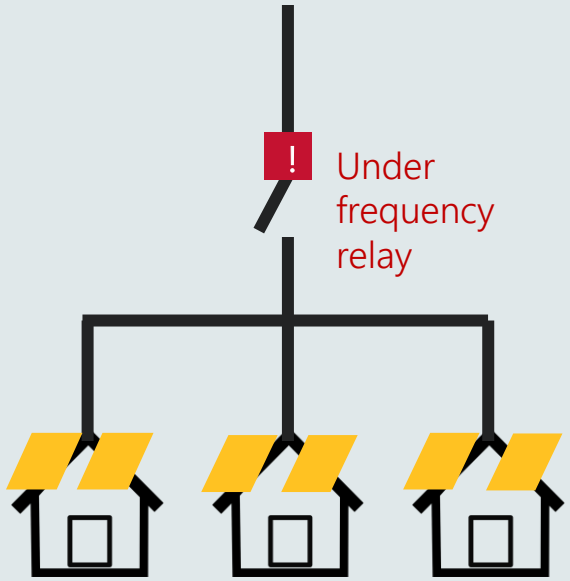
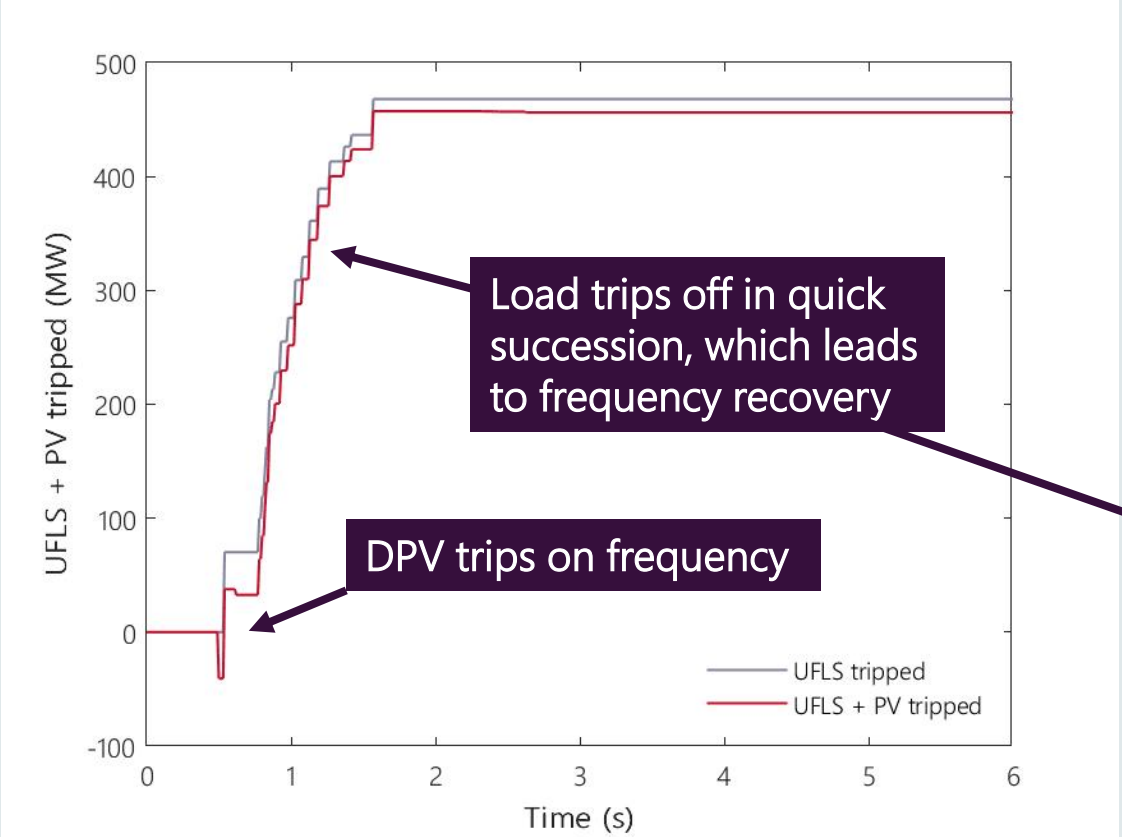
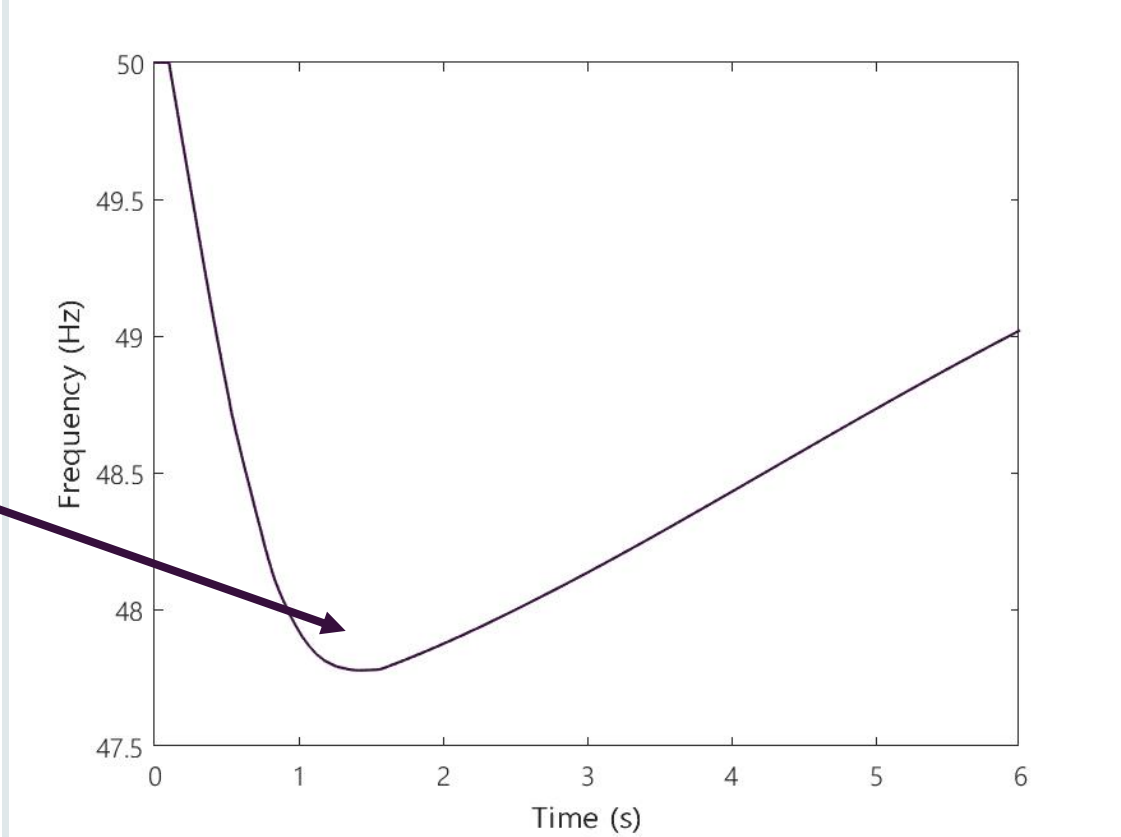




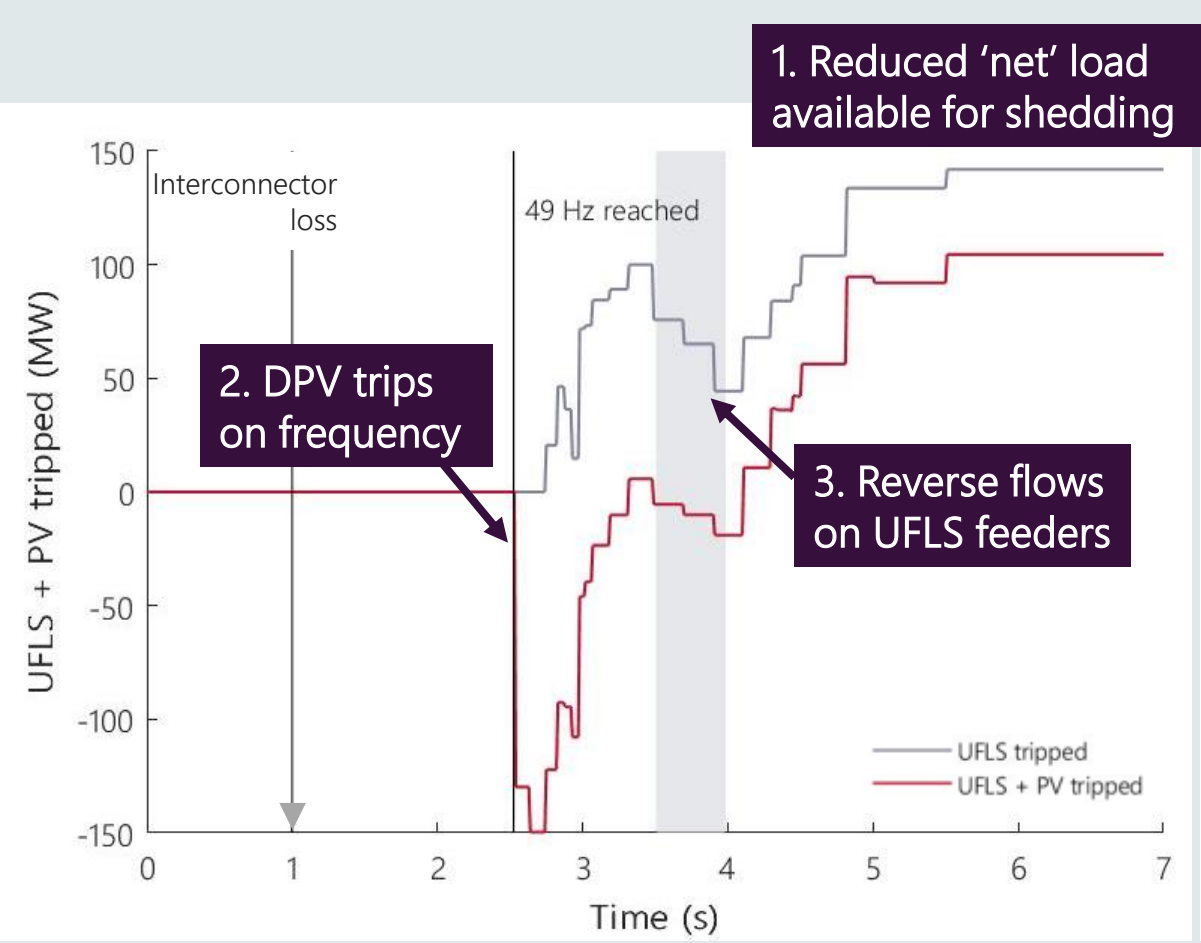
UFLS during an emergency event

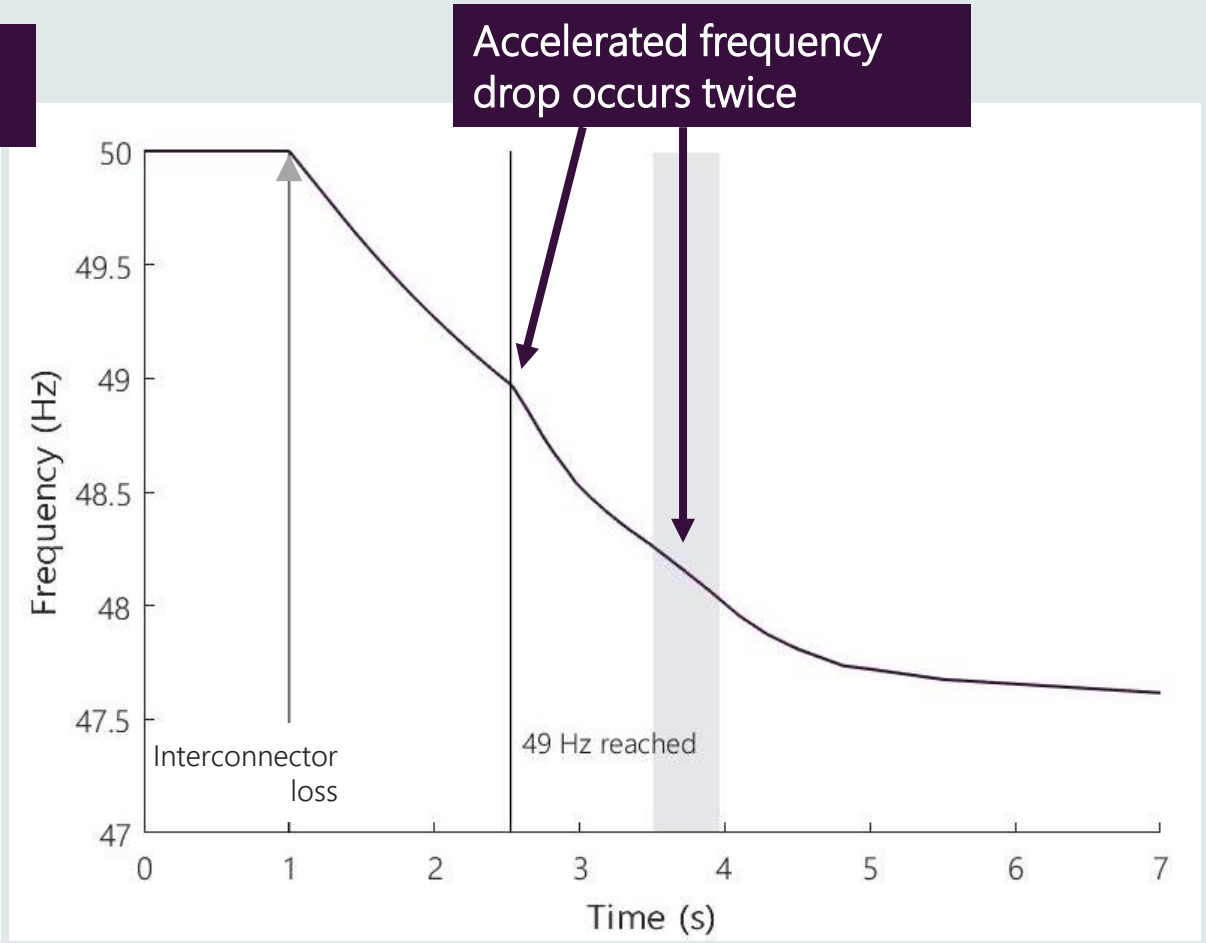




Generation loss = 620 MW, DPV generation = 400 MW, system inertia = 5,023 MWs, UFLS load = 620 MW

Case study: Impacts of DPV on UFLS

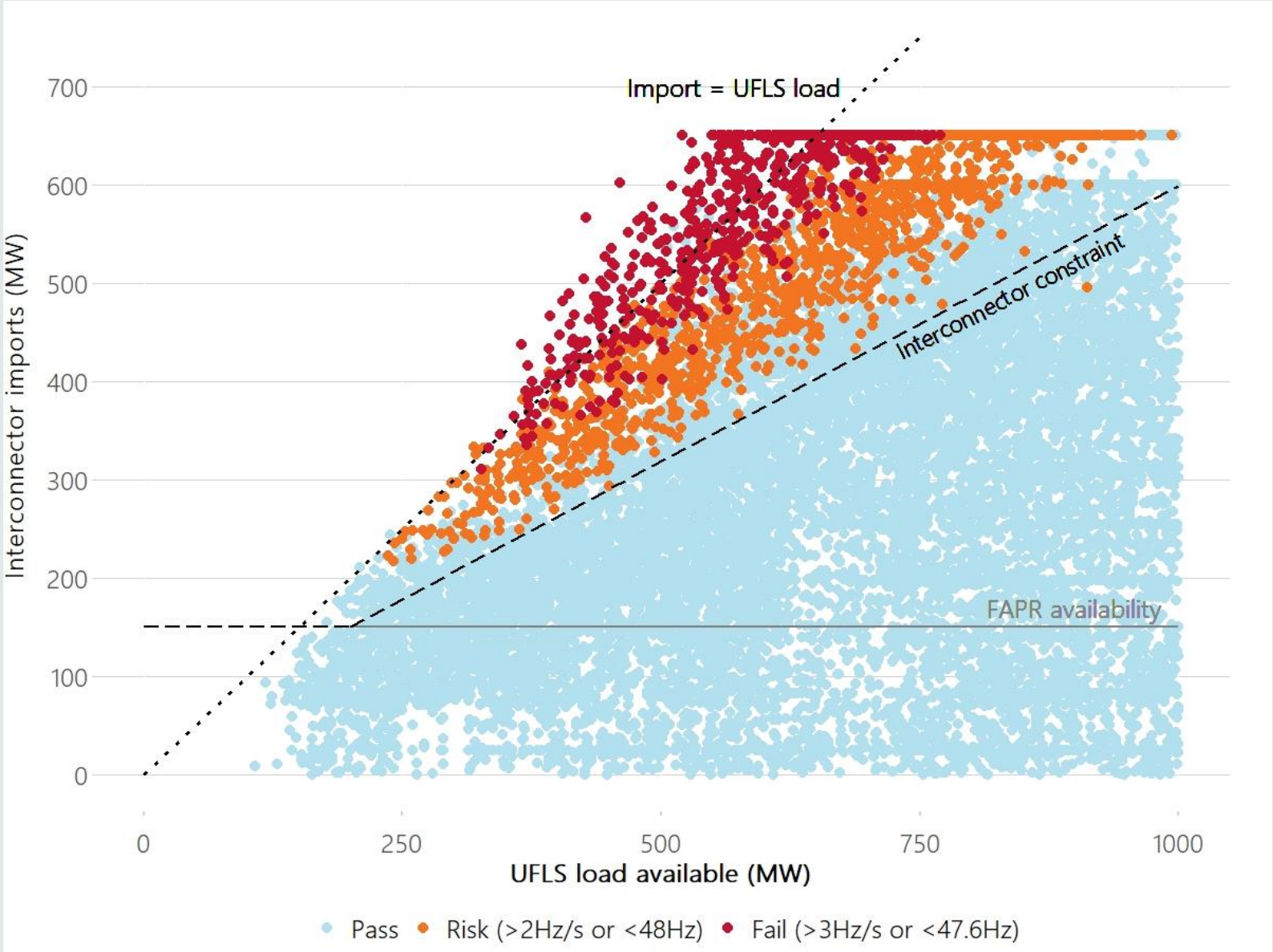




Generation loss = 200 MW, DPV generation = 1,600 MW, system inertia = 6,280 MWs, UFLS load = 345 MW

Risk mitigation - Loss of Interconnector

UFLS is the last line of defence for severe and unexpected power system events, such as interconnector loss



More information available in this fact sheet.

Risk mitigation – Other conditions

UFLS is increasingly important as more new and untested operation zones emerge in SA

- Upgrades to UFLS
  - Increasing load on UFLS
  - Dynamic arming of UFLS feeders in reverse flow
- Updating frameworks – possible EFCS rule change proposal
- Fast active power response and granular load shedding may also supplement and restore UFLS capabilities

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Modelling DER impacts on UFLS

Inputs

Model the loss of Heywood in a single mass model representation of the SA network, using:

- Net load on UFLS trip frequency bands from SAPN
- DPV modelling
  - Under frequency trip behaviour based on AEMO's 2016 survey of manufacturer settings
  - DPV installed capacity based on AEMO forecasts from the 2020 ISP and ESOO
- Various levels of fast active power response from SA's large batteries
- Dispatch scenarios based on strategic bidding from AEMO market models

Outputs

- % of year where we see risks
- Risk mitigation strategies – constraint on interconnector flows into SA

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Model of DER impacts on UFLS