Updating AS/NZS4777.2 to manage grid disturbances

Rooftop PV Impacts on the Grid Operator

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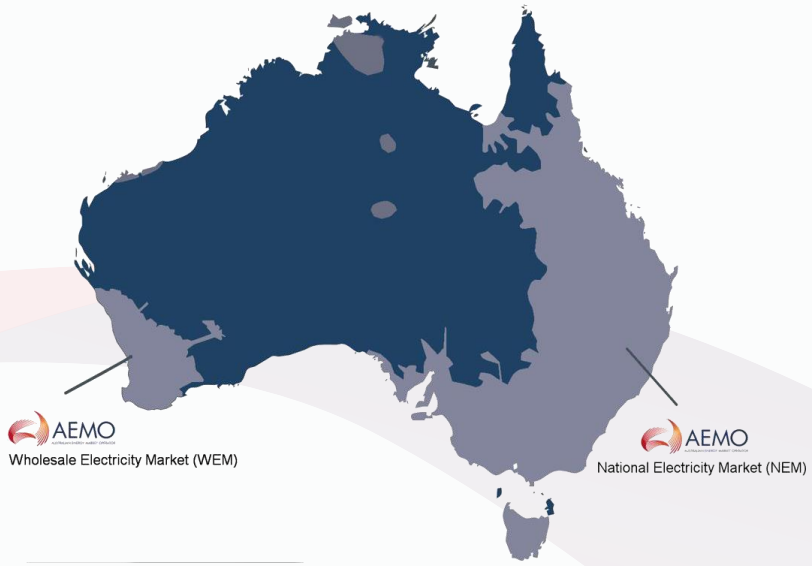
About AEMO

Shaping a better energy future for all Australians



We operate 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.

As the Independent System Operator we co-ordinate the supply and demand of electricity in real-time from generators to load.

The dispatch of generation is based on market participant (or generator) bids.

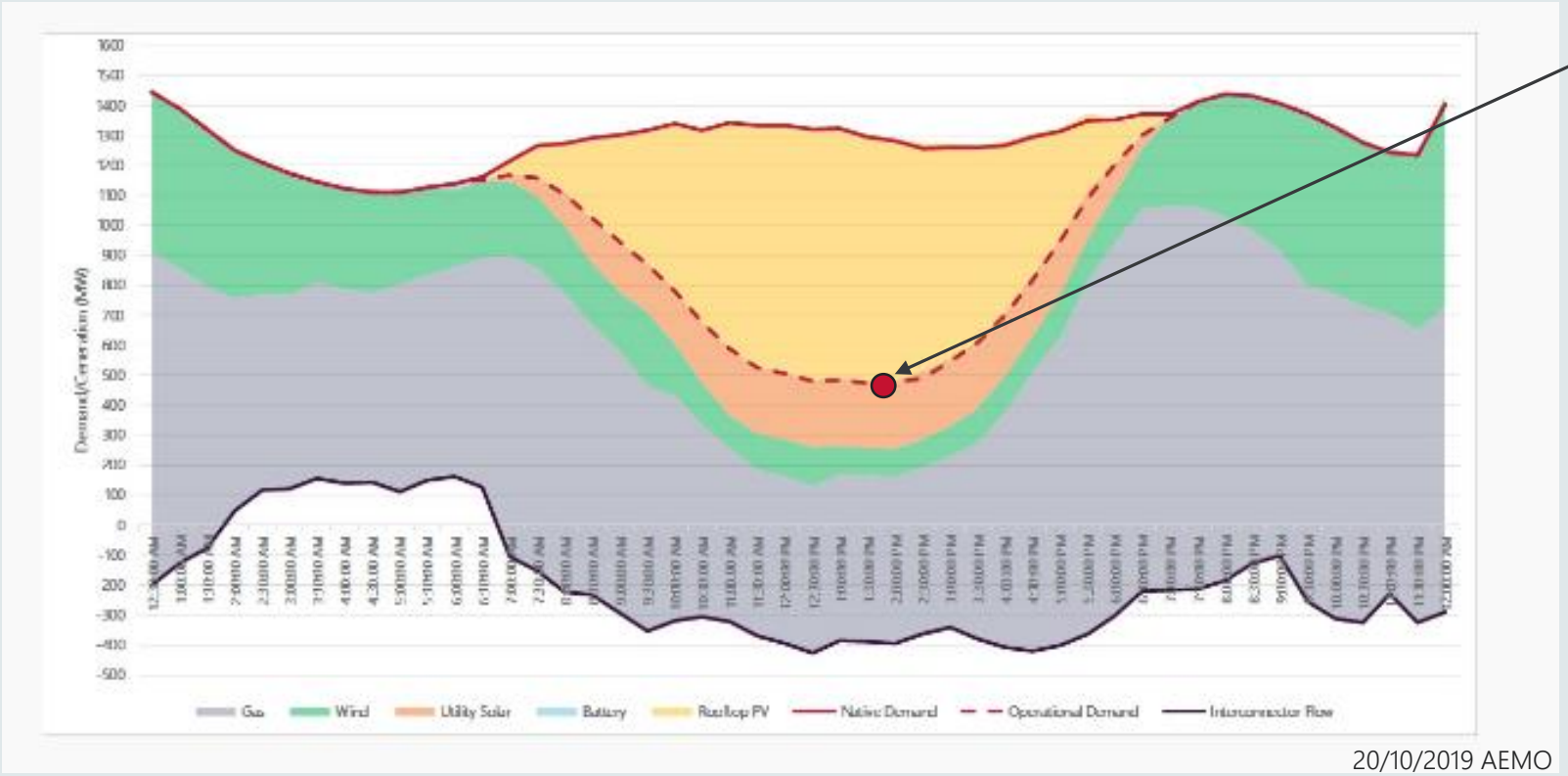
Both markets supply more than 220 terawatt hours of electricity each year.

Ownership

40% Market participants

60% Governments of Australia

Changing Load Profile



20/10/2019 AEMO

In the last month, SA repeatedly set new minimum demands:

- **29/09/2019 12:30:** 574 MW
- **12/10/2019 13:30:** 533 MW
- **20/10/2019 13:30:** 475 MW

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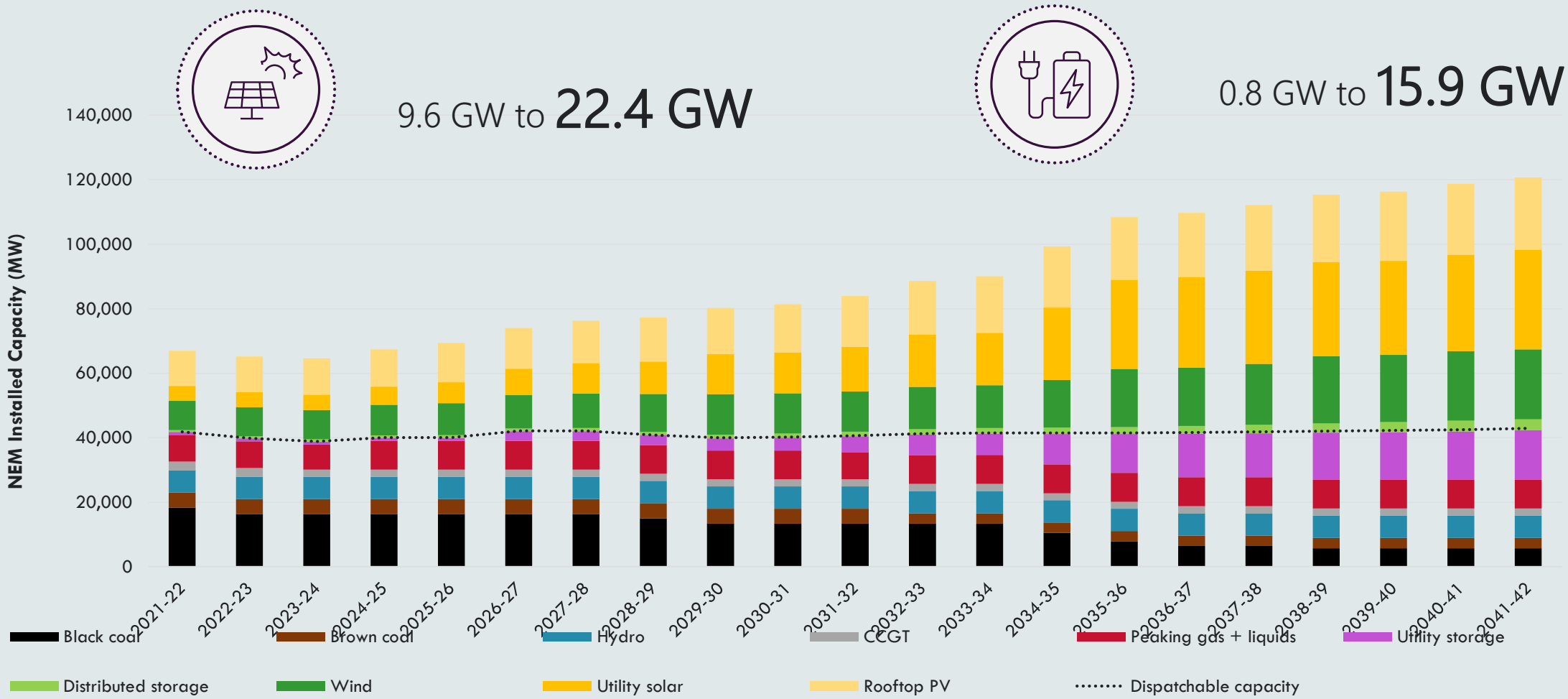
The growing level of consumer choice

Rooftop PV generation capacity

9.6 GW to **22.4 GW**

Embedded battery storage capacity

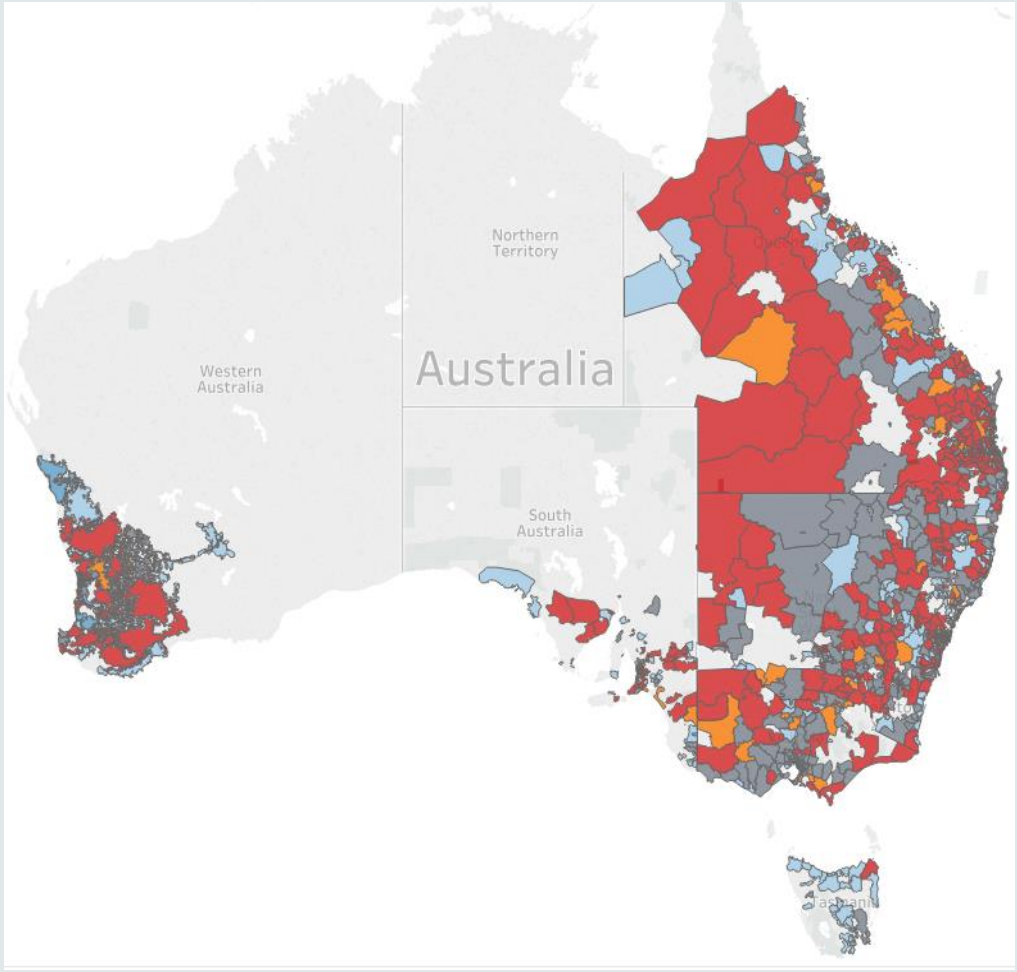
0.8 GW to **15.9 GW**



Source: AEMO 2019 ISP Insights, neutral scenario

Key Challenges of increasing rooftop PV

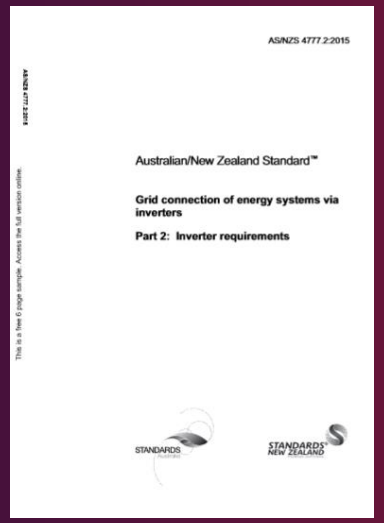
- Over-voltage at the distribution network
- 'Reverse electricity flows' across Australia's distribution networks
- Managing supply and demand will be more difficult
- Ramping needs in the evening are exacerbated
- Response of distributed energy resources (DER) to disturbances is uncertain.



Fast DER scenario

Source: CSIRO 2019

Addressing challenges through performance standards



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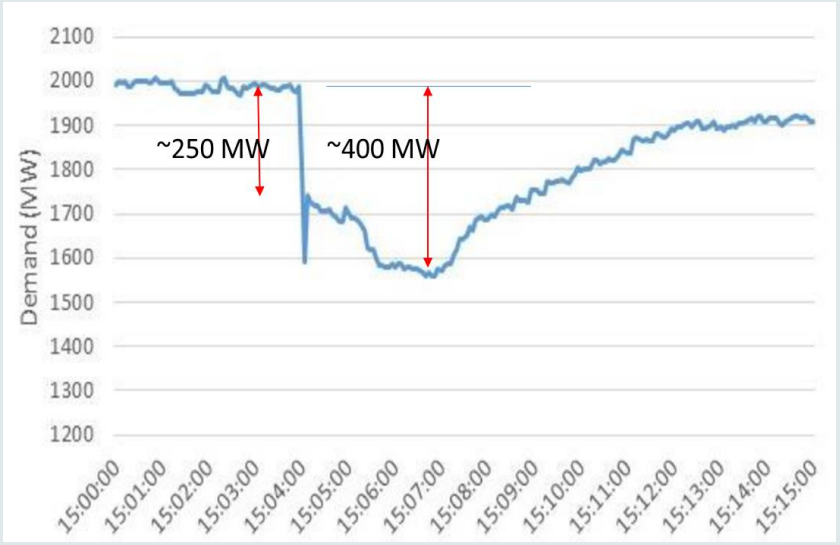
AS/NZS4777.**2** is the Australian Standard for Grid Connection of energy system via inverters: **Inverter Requirements**

- AEMO submitted a proposal to review the Standard in June 2019,
- CEC provided feedback that was incorporated into the submission,
- Currently the exact changes/values are being consulted on with inverter manufacturers, distribution network service providers, and installers (through the CEC).

Loss of 40% of distributed PV

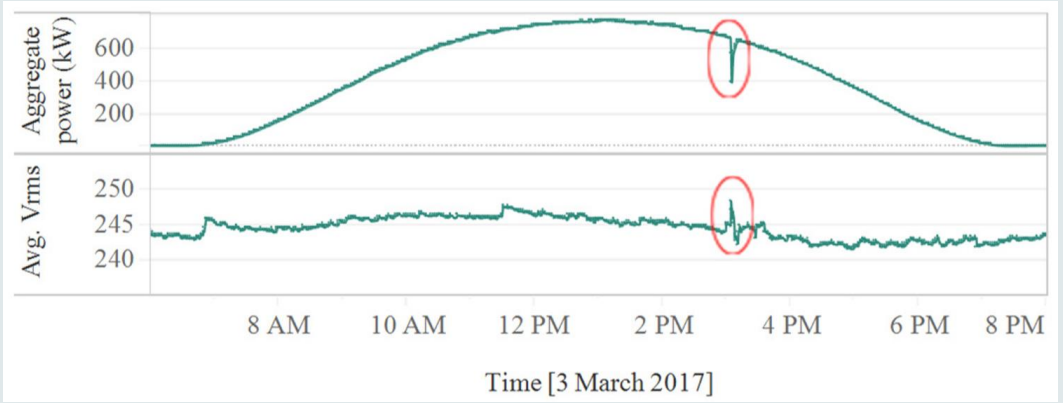
- 3 March 2017: Series of faults resulted in the loss of ~610 MW of generation in SA
- Flows on Heywood interconnector increased to ~918 MW.
- Estimated that demand reduced ~400 MW
- Estimated that distributed PV reduced by ~150 MW (40%)
- Projecting forwards, loss of 40% of DER will exceed credible contingency sizes, possibly requiring additional frequency control reserves.

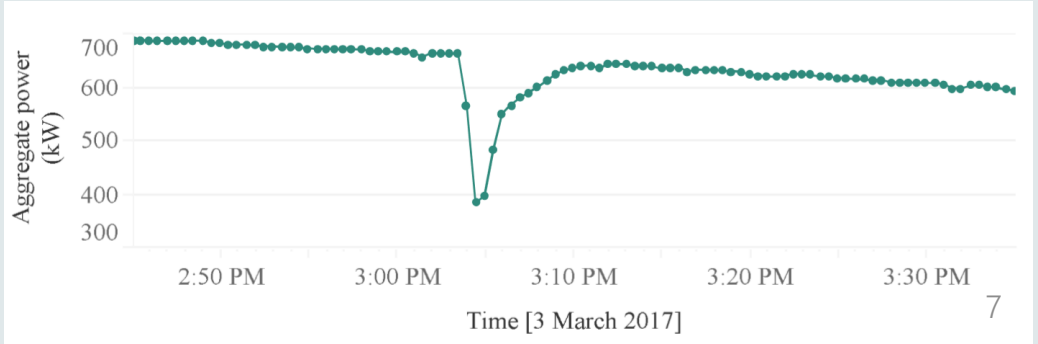
3 March 2017: Demand in South Australia:



Data from Solar Analytics (~200 distributed PV systems) confirms disconnection of some inverters:

Generation by distributed PV:





Analysis by Naomi Stringer, UNSW Sydney
Data from Solar Analytics

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Disturbance withstand capabilities

Proposed changes are intended to:

- Align their expected response to disturbances (as much as possible) to large-scale generators and International Standards,
- Ensure inverters have a minimum response during disturbances (provision of minimum requirements),
- Provide immunity to transmission events while maintaining adequate protection from islanding for distribution networks,
- Define clear zones of operation to provide clarity to manufacturers on the required behaviour and responses of inverters during system conditions.

TABLE 13

PASSIVE ANTI-ISLANDING SET-POINT VALUES

Protective function	Protective function limit	Trip delay time	Maximum disconnection time
Undervoltage (V<)	180 V	1 s	2 s
Overvoltage 1 (V>)	260 V	1 s	2 s
Overvoltage 2 (V>>)	265 V	—	0.2 s
Under-frequency (F<)	47 Hz (Australia) 45 Hz (New Zealand)	1 s	2 s
Over-frequency (F>)	52 Hz	—	0.2 s

Disturbance ride-through

- Extend as much as possible to suit both AEMO and DNSP needs

Multiple voltage disturbances

- Ride-through requirements for multiple voltage disturbances

Phase angle jump

- Specify withstand requirements for Phase Angle jumps.

RoCoF ride-through

- Specify withstand requirements for RoCoF

Momentary cessation

- Determine appropriate requirements, considering periods with most generation from DER

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Power Quality Modes

Volt-Var and Volt-Watt

- Default enablement
- Determine relative priorities of control schemes
- Consider smaller deadbands and settings aligned with international standards

Over-frequency response

- Specify required response times

Under-frequency response

- Require response from already curtailed inverters, of storage inverters
- Specify response times

Proposed changes are intended to:

- Align expected response to International Standards (where applicable),
- Provide an autonomous response to local voltage management issues and maintain the grid within technical limits,
- Increase hosting capacity of distribution network feeders,
- Ensure inverters do not exacerbate disturbances and help to manage their response,

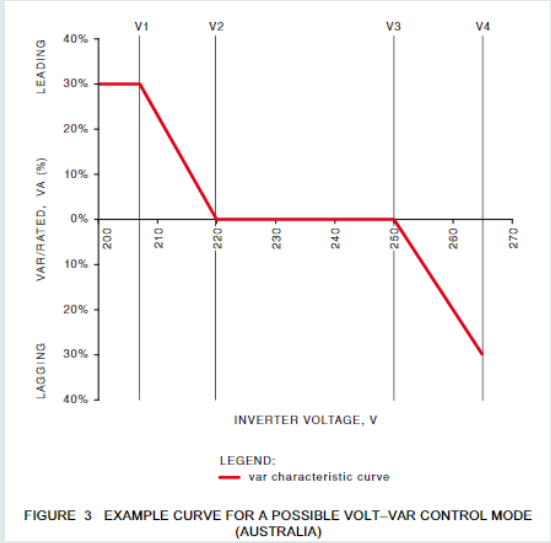


FIGURE 3 EXAMPLE CURVE FOR A POSSIBLE VOLT–VAR CONTROL MODE (AUSTRALIA)

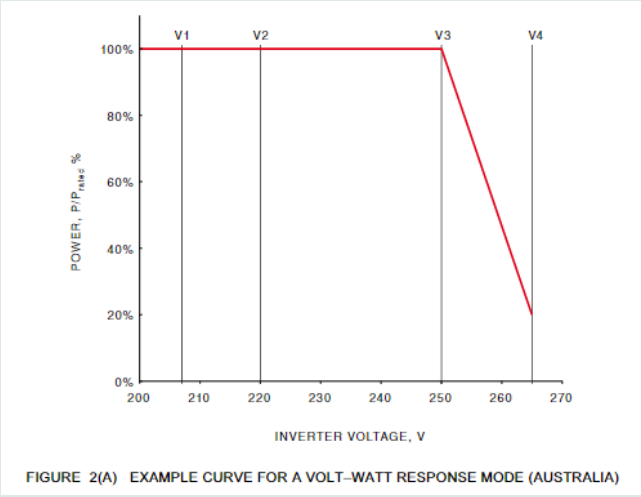


FIGURE 2(A) EXAMPLE CURVE FOR A VOLT–WATT RESPONSE MODE (AUSTRALIA)

Compliance, Measurement and Control

Compliance

- Review compliance mechanisms.
- Include new compliance requirements for new parameters.

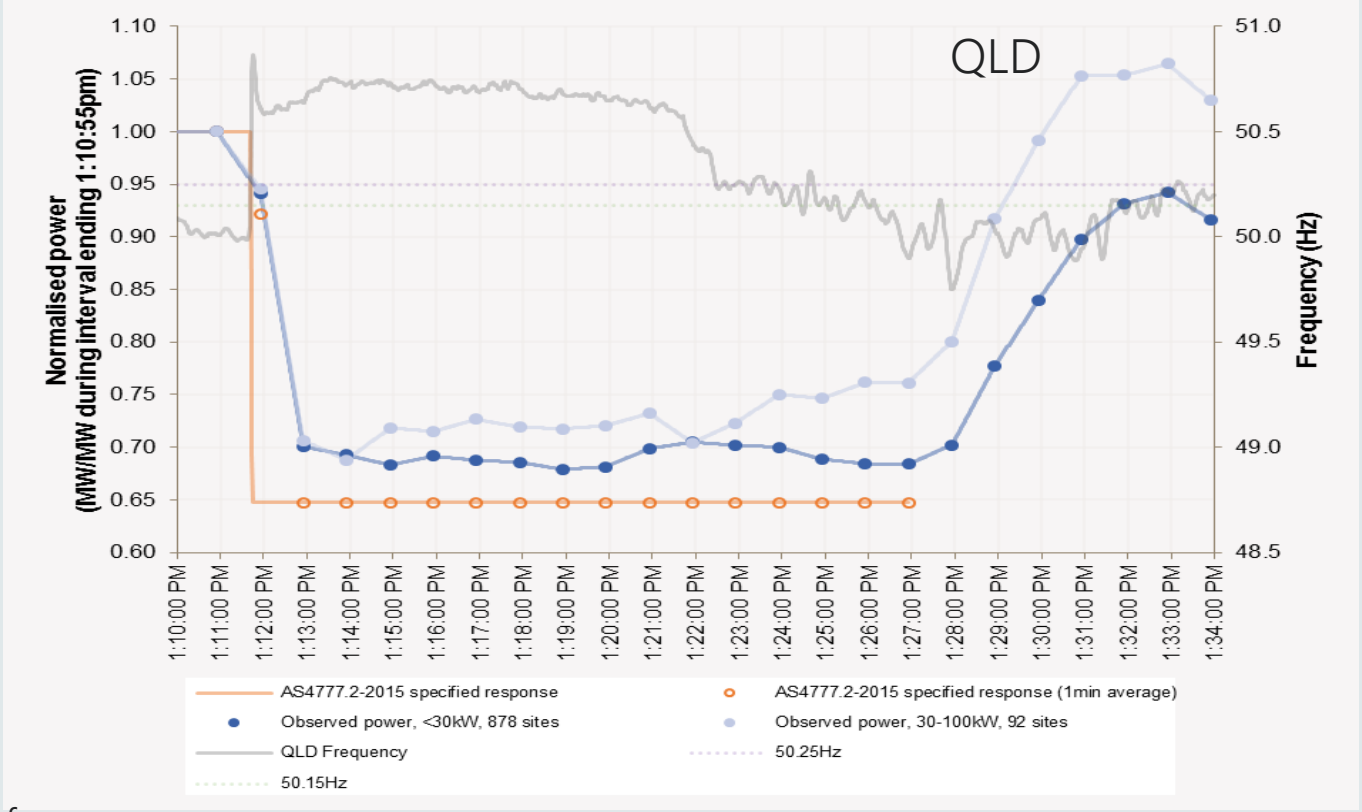
Measurement and Control Functionality

- Define minimum requirements for measurement and control system operation.
- Define prioritisation of responses.

Proposed changes are intended to:

- Provide minimum requirements for system measurement and control (provides certainty to inverter response),
- Optimise DER responses so they do not cause control system instability,
- Provide degree of certainty to AEMO on the expected response of the DER generation fleet (to incorporate into our models).

Separation event 25 Aug 2018:



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Summary

- We are seeing increasing penetrations of DER across Australia (mostly in the form of PV),
- This is creating challenges for networks and AEMO,
- Addressing *some* challenges through revising AS/NZS4777.2, includes:
  - **Disturbance withstand:** Optimise DER response so that during power system disturbances DER does not disconnect and exacerbate the event.
  - **Power Quality Support modes:** DER provides an autonomous response and increases hosting capacity.
  - **Measurement and Control:** Define minimum specifications for DER devices.
- **Consultation and Review of the Standard is currently underway.**

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