Integrating Distributed Energy Resources in Australia

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Group Manager, DER & Flexible Demand

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR
About AEMO

AEMO is a member-based, not-for-profit organisation.

We are the independent energy market and system operator and system planner 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.
Distributed PV

• Significant proportion of demand now met by distributed PV

<table>
<thead>
<tr>
<th>State</th>
<th>Maximum % of underlying load met by distributed PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA</td>
<td>92% (2 Oct 2021)</td>
</tr>
<tr>
<td>WA</td>
<td>53% (14 Mar 2021)</td>
</tr>
<tr>
<td>VIC</td>
<td>47% (31 Oct 2021)</td>
</tr>
<tr>
<td>QLD</td>
<td>44% (13 Nov 2021)</td>
</tr>
<tr>
<td>NSW</td>
<td>40% (17 Oct 2021)</td>
</tr>
<tr>
<td>TAS</td>
<td>14% (26 Oct 2021)</td>
</tr>
</tbody>
</table>
South Australia

- 1.8 GW of distributed PV
- Growing at ~20 MW per month
- Supplying up to 92% of underlying demand
- Minimum operational demand record to date: 104 MW
• How do we operate a major power grid on only distributed resources?
• What challenges will arise?
• How do we address challenges, removing barriers to growth in distributed resources?
Challenges identified

Unintended disconnection of distributed PV in disturbances

Insufficient load to operate necessary units for essential services

Under Frequency Load Shedding

• Different but related issues
• Each requires different approaches
Challenge 1: Distributed PV unintended disconnection

- Up to 40% of distributed PV in a region disconnects in response to power system disturbances
- Contingency sizes projected to rapidly become unmanageably large
- Without intervention, AEMO will not be able to maintain the power system in a secure state

Managing DPV unintended disconnections

Improve DER ride-through standards

- Reduce unintended disconnection of future distributed PV installations – “Stop the rot”
- AS/NZS4777.2:2020 mandatory from Dec 2021
- Compliance???
- Will it be sufficient and effective???

Then to manage legacy systems:

**Network constraints**
- Operate network within stability limits, accounting for larger contingency sizes

**Frequency Control**
- Enable sufficient frequency reserves to manage larger contingencies

**Operating procedures**
- Maintain contingency sizes within limits when operating with line outages
- Revoke permission for line outages if need be
- Curtail distributed PV as last resort

Need to accurately estimate distributed PV tripping behaviour
• Significant DER behaviours interacting with grid behaviour
• Cross-matching Solar Analytics datasets with others (Tesla)
• Project MATCH
• Data, data, data!
  • Reduce uncertainty
  • More confidence in intervention measures
  • Reduce need for conservative intervention

Challenge 2: Essential power system services

- With present operational toolkit, need to maintain a minimum number of synchronous generating units online at all times to provide essential system services:
  - System strength, inertia, frequency control, voltage control
- These units need to operate above minimum loading levels
- Operational demand is projected to fall below minimum thresholds by 2024 – 2026 for the entire NEM mainland under system normal conditions
- Will reach thresholds sooner during periods with line outages, regions operating as an island, or extreme conditions (e.g. bushfires, storms, explosions, etc.)

Incidence below thresholds

- Demand below thresholds occurs very rarely
- “Perfect Storm” conditions
  - Clear skies
  - Mild weather
  - Low demand (e.g. public holidays, weekends)


Multiple simulations with varying POE were run to determine the number of hours in which demand fell below 6,000 MW. This represents a wider spread of possibilities than used in Figure 24.
Emergency backstop PV curtailment

• Introduce emergency capability to curtail distributed PV when required for system security
• Analogous to load shedding
• Used as a last resort, after all other measures have been exhausted
• Anticipate using very rarely
• Can be simple implementation, with more sophisticated capabilities to follow
• In parallel:
  • Explore other ways of providing essential services in minimum demand periods
  • Market development
Challenge 3: Under Frequency Load Shedding

• UFLS is the “safety net”, designed to arrest severe under-frequency events
• Controlled disconnection of load in less than a second, to rebalance a large supply-demand imbalance
• Automatic arming of distribution system protection mechanisms
Melbourne
Inner East

25 Jan 2019
1100 to 1130

NMIs coloured by energy usage for interval 1100 to 1130

Average Power (MWh)

- Shed demand: 11 MWh
- Shed generation: 0 MWh

All values relate to NMIs shown on map region only (55,572 NMIs): 14.99E to 145.29E and -37.99S to -37.71S
Melbourne Inner East

25 Jan 2019
1130 to 1200

NMIs coloured by energy usage for interval 1130 to 1200

AEMO
Australian Energy Market Operator
Melbourne
Inner East

25 Jan 2019
1200 to 1230
Melbourne
Inner East

25 Jan 2019
1230 to 1300
Melbourne
Inner East

25 Jan 2019
1300 to 1330
Melbourne
Inner East

25 Jan 2019
1400 to 1430
Trials & Demonstrations

Virtual Power Plant Demonstrations & Project EDGE
VPP objectives

Test VPPs delivering contingency Frequency Control Ancillary Service (FCAS), obtain operational visibility, use learnings to inform changes to regulatory and operational frameworks.

1. Participants demonstrate basic control and orchestration capability for VPPs providing real time energy and Frequency Control Ancillary Services (FCAS).

2. Develop systems to deliver operational visibility of VPPs via new AEMO APIs.

3. Assess current regulatory and operational arrangements affecting market participation of VPPs.

4. Provide insights on how to improve consumers’ experience of VPPs in future.

5. Understand what cyber security measures VPPs currently implement, and whether they should be augmented in future.
### VPP Participants, 31MW, all mainland NEM states

<table>
<thead>
<tr>
<th>Energy Locals (Tesla SA VPP)</th>
<th>AGL</th>
<th>Simply Energy</th>
<th>sonnen</th>
<th>ShineHub</th>
<th>Energy Locals (Members Energy)</th>
<th>Hydro Tasmania</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSSELTV1</td>
<td>VSSAEIV1</td>
<td>VSSS1</td>
<td>VNSNIV1</td>
<td>VSSS1</td>
<td>VSVEL2S1, VSNL2S1</td>
<td>VSQHTIV1</td>
</tr>
<tr>
<td>Jurisdiction</td>
<td>SA</td>
<td>SA</td>
<td>NSW</td>
<td>SA</td>
<td>VIC and NSW</td>
<td>QLD</td>
</tr>
<tr>
<td>Registration *</td>
<td>MC</td>
<td>MC</td>
<td>MASP</td>
<td>MASP</td>
<td>MC</td>
<td>MASP</td>
</tr>
<tr>
<td>Battery technology</td>
<td>Tesla PowerWalls</td>
<td>Tesla PowerWalls</td>
<td>sonnen</td>
<td>AlphaESS</td>
<td>Alpha ESS Saj/Eveready</td>
<td>Tesla PowerPack</td>
</tr>
<tr>
<td>FCAS delivery</td>
<td>Proportional</td>
<td>Proportional</td>
<td>Proportional</td>
<td>Switched</td>
<td>Switched</td>
<td>Proportional</td>
</tr>
<tr>
<td>Registered capacity (Aug 2021)</td>
<td>16 MW All cont FCAS</td>
<td>6 MW All cont FCAS</td>
<td>4 MW All cont FCAS</td>
<td>1 MW All cont FCAS</td>
<td>1 MW All 6 cont FCAS</td>
<td>1 MW (x2) All 6 cont FCAS, except L6</td>
</tr>
</tbody>
</table>

*Registration types are MC = Market Customer, MASP = Market Ancillary Services Provider*
VPP Demos: Key takeaways

- VPPs have **proven their capability to deliver contingency FCAS** and respond to energy price signals.
- The VPP sector has grown in size and capability over the last 2 years, is still in early development, but with a material capacity in South Australia.
- AEMO is completing a **DER MASS consultation** to determine the ongoing arrangements for FCAS (including measurement & verification).
- Consumers’ experiences mostly translate into **high levels of satisfaction**.
- **ESB P2025 emphasises role of aggregators** in future arrangements, including Flexible Traders, and to allow participation in ancillary services.
- VPP Demos aimed to adopt a **collaborative approach** to the integration of an emerging sector – **informing change with evidence** – with great feedback.
- Ongoing **collaboration with industry and development of** operational visibility, forecast-ability and coordination of VPPs will be critical to ensuring efficient integration into the power system.
Project EDGE interactions with DER Implementation Plan

Examining the cyber security risks and requirements throughout the information architecture to support a DER marketplace.

ESB/DEIP Interoperability objectives:
- Enable ease of customer switching between aggregators
- Functionality for consumer, markets & operational requirements

Testing efficient and secure ways to share information between industry actors at scale (e.g. DOEs, dynamic network tariffs, visibility, portfolio info).

Utilising the dispatchability model aligning with FTA, testing whether the quantity used in dispatch should be at the connection point or controllable device level, including how this interacts with OEs.

Obtaining basic visibility via real-time portfolio telemetry via DER marketplace data hub.
Progressing basic visibility to forecasting via aggregator self-dispatch bid files.

Understanding the perception of consumers and experience pre, during and post participation.

Not in scope but considering what test could be included
Project EDGE Marketplace Process

- **DSO activity**
  - DNSP operates as the DSO
  - DSO procures services from local DER
  - DSO optimising network performance

- **AEMO activity**
  - AEMO runs the NEMDE pre-dispatch to provide pre-dispatch price and volumes

- **Aggregator activity**
  - Aggregator orchestrates the DER portfolio to deliver services

Using DNSP network model, calculate:
- Max output
- Equitable output
- Engineering parameters & constraints (thermal, voltage, other)

Aggregators prepare bids and offers using DOEs
- Submit bids and offers

DOE published to market
- Bids / Offers submitted

Local Service Procured
- DOE re-calculated
- NEMDE dispatch run
- Aggregators Respond
- Markets Settled

AEMO activity

DSO activity
Questions?

For more information please visit www.aemo.com.au