DER Market Integration Consultative Forum

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

23 March 2023

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We pay respect to their Elders past, present and emerging.

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- Make independent and unilateral decisions about their commercial positions and approach in relation to the matters under discussion with AEMO
- Immediately and clearly raise an objection with AEMO or the Chair of the meeting if a matter is discussed that the participant is concerned may give rise to competition law risks or a breach of this Protocol

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- Which customers they will supply or market to
- The price or other terms at which Participants will supply
- Bids or tenders, including the nature of a bid that a Participant intends to make or whether the Participant will participate in the bid
- Which suppliers Participants will acquire from (or the price or other terms on which they acquire goods or services)
- Refusing to supply a person or company access to any products, services or inputs they require

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Today's meeting

Time	Item	Speaker
11:00 – 11:05	Welcome and Introductions	Rachel Rodrigues McGown (AEMO)
11:05 – 12:05	EDGE Preliminary Results: DOE Conformance	Nick Regan (AEMO)
12.05 - 12:30	Q&A & Meeting Close	All

Project EDGE

Preliminary Results – Dynamic Operating Envelope (DOE) Conformance

Nick Regan (AEMO)

Conforming with DOEs is key to aggregated DER operating within network limits while providing energy services

Focus of this analysis

Subset of the research question 4 regarding the ability of aggregated DER to **operate within network limits** while participating in wholesale dispatch. The analysis:

- Tested the ability for aggregators to **dispatch in compliance with DOEs** at the:
  - DUID level (portfolio), and
  - NMI level.
- Explored the **implications** of DOE breaches on networks, AEMO and consumers.

Relates to Research Question 4:

How can the Distributed Energy Resource (DER) Marketplace facilitate activation of DER to respond to wholesale price signals, operate within network limits and progress to participation in wholesale dispatch over time?

Within Project EDGE, Dynamic Operating Envelopes (DOE) breaches are defined as the limits set by the Distribution Network Service Providers (DNSP) to constrain both load and generation. There are differing DOE calculation methods and allocation principles being explored within this trial.

Specifically, the trial looks at DOE conformance from two views:

Market Operator Visibility = DUID Level DOE

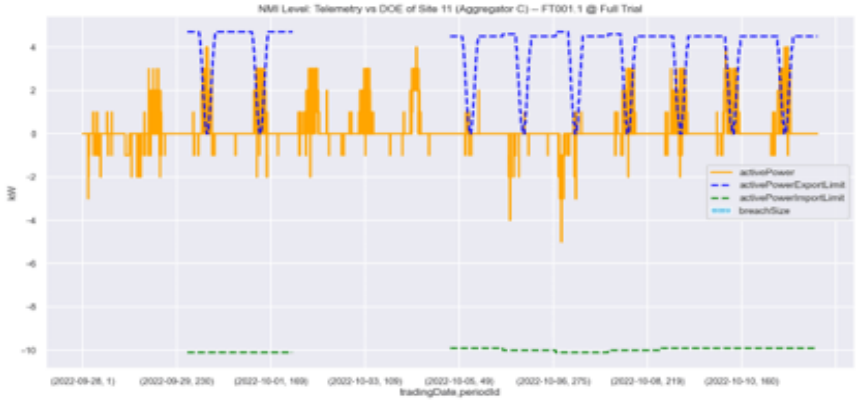
DSO Visibility = NMI Level DOE

In the trial, AEMO considers DUID-level DOEs (sum of all NMI level) as a coarse check against DER aggregator bid qty but doesn't reveal whether individual sites within the portfolio will breach.

DOE conformance is of interest to both DNSPs and AEMO, DER aggregators need capability to self constrain their bids and manage conformance operationally

NMI level DOE breaches are being observed in EDGE, severity and duration are greater in constrained areas

Flat profile
Network locations without much constraints and comfortable hosting capacity



Convex profile
Network locations with high constraints and insufficient hosting capacity at the sub-station

Network locations with higher constraints have longer and higher breaches.

Given these are the key times when the network is likely to be constrained, it is important to work with aggregators to remedy material breaches before wide-scale roll out of DOEs.

Initially identified contributing factors
- Site uncontrolled load forecasting error (weather and behavioural)
- Customer manual override
- Others TBC

EDGE is testing two different bidding definitions 'Net NMI' and 'Flex' for visibility purposes

A key research topic for Project EDGE is around gaining operational visibility of DER. Aggregator bids can have 2x definitions of quantity, 'Net' (including uncontrolled load) and 'Flex' (DER only).

Operational visibility of DER is required at the aggregated DER fleet level, not individual devices.

This topic aligns with the current Scheduled Lite rule change and is independent of current FTA rule change.

Flex

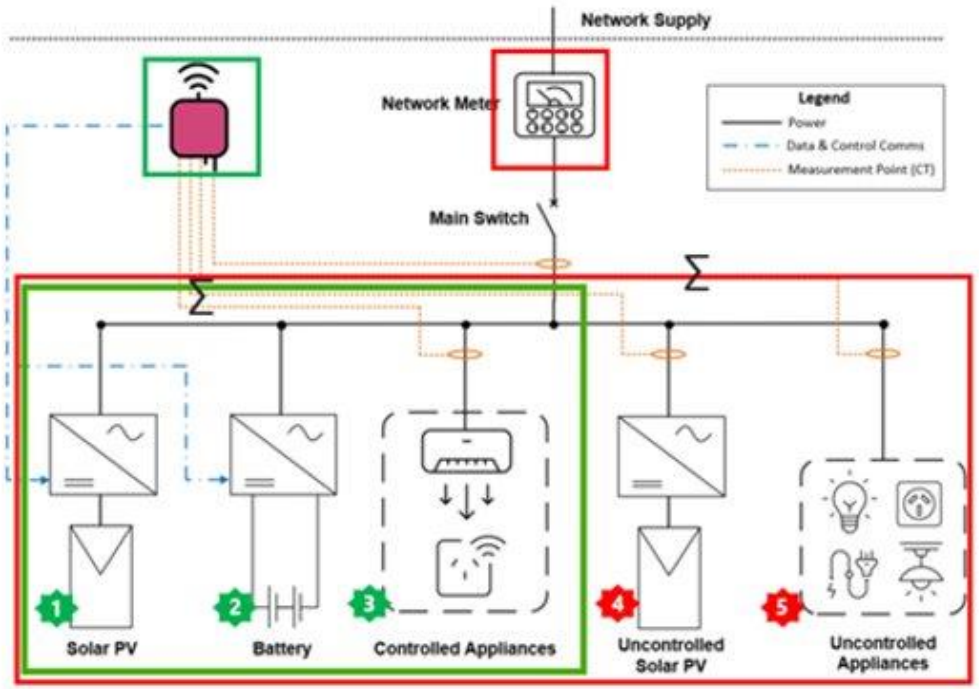
Controllable (Load and/or Generation) : Sum of controllable devices (load and/or generation; *not individual devices*) across the participant's registered portfolio of NMIs

-> Only controllable assets are considered when calculating the capacity

-> Measurement at a real/virtual measurement point
ps: not individual devices but aggregated of all controllable devices

-> Visibility of 'summation of' all controlled assets is provided via Bi-directional offer and telemetry

-> ∑ (1 + 2 + 3)



Net NMI

Aggregated Net Connection Point Flow: Sum of net connection point flows across the participant's registered portfolio of NMIs i.e. Net at NMI

-> All Controllable and un-controllable assets considered when calculating the net connection point flow value

-> Measured at Connection point (i.e. NMI)

-> Visibility of Net position at NMI is provided via Bi-directional offer and telemetry
Separation of controlled & uncontrolled assets is not required or visible

-> ∑(1 + 2 + 3 + 4 + 5)

NMI level DOE breaches are being observed in EDGE, Contributing factors require further investigation

The results observed generally within each field trial are outlined below. Analysis to date is limited to Aggregator C, analysis across full sample planned.

Under Net NMI Bidding Mode	Under Flex Bidding Mode (noting smaller sample to date)
50 % of active NMIs breach DOE limits at least once	20 % of active NMIs breach DOE limits at least once
Export limits are breached around 20 % of the time	Export limits are breached around 11 % of the time
Import limits are never breached	Import limits are never breached
The average breach size was 1.92 kW	The average breach size was 1.29 kW
The average consecutive breach duration was around 22 minutes	The average consecutive breach duration was around 4 minutes
96% of compliant periods had more than 50% of headroom, averaging 6 kW	99% of compliant periods had more than 50% of headroom, averaging 5.81 kW

Could DOEs applied just to DER help?

- Aggregators expressed that a DOE applied to Flexible DER could help mitigate breaches caused by uncontrolled load / solar.
- DNSP has noted that Flex DOEs would likely be more conservative than Net NMI to cover uncontrolled load forecasting errors.
- An open question is whether the initial conservatism can be overcome with time through machine learning
- Further analysis is planned to inform assessment of benefits of the respective DOE allocation approaches (Net & Flex)

Potential impacts of DOE breaches being investigated

Operational planning

- Impact to visibility
- How do NMI breaches affect operational forecasting and planning?

Economic optimisation

- Could the unused limits be re-allocated to NMIs more likely to breach instead?

Customer

System security

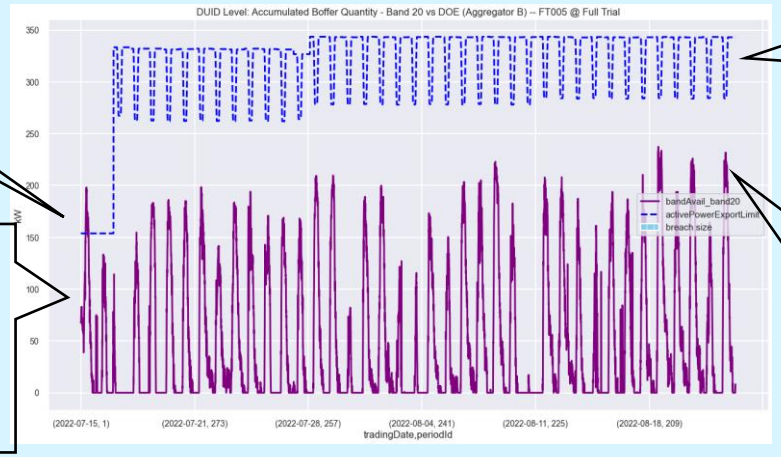
- How do NMI breaches impact system security (local & NEM)?
- How material could these breaches become as DOEs are used more and more to manage PV flows to the grid during min demand times?

Although rare, DUID level DOE breaches have been observed, impacts look manageable but work is needed to protect customers

Bidding breach (intention)

DUID level DOE bid breach

DUID level DOE export limit

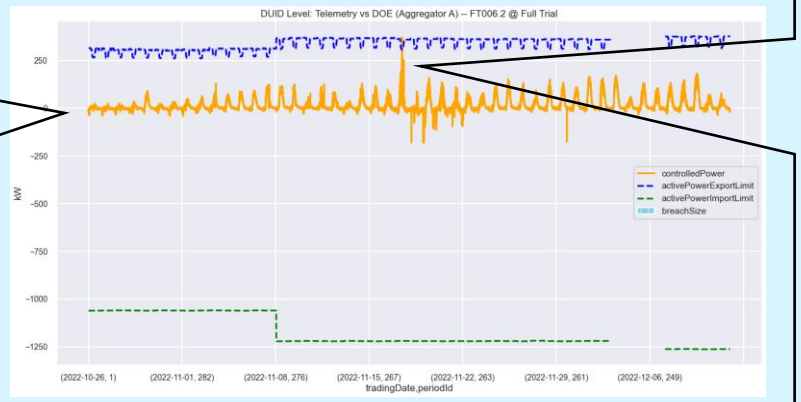


There is an increase in the scale of DOE limits a day after new NMIs were registered, **indicating a delayed reflection of increased fleet size in DOEs.**

DUID level cumulative generation bid quantity (band 20)

Performance breach (actual)

DUID level telemetry (net controlled generation and load)



- The aggregator's aggregated net controlled generation and load exceeded the aggregated DOE export limits.
- The breach size is 53.97 kW (20%), 1 min duration
- Cause is under investigation

Influencing factors

There is no established method to synchronise new NMI enrolment in an aggregator portfolio with DOE updates from the DSO for those NMIs. This means for a period of time aggregators do not have all DOE limits that apply to their portfolio.

Implications of DOE breaches

- **Economic (TBC):** Value of unutilised DOE capacity vs constrained bid underway
- **Operational Planning (TBC):** Under investigation
- **System Security**
  AEMO: Manageable if Dx limits provided at the distribution and transmission network interfaces (e.g TNI) align with the bid qty received by aggregators (controllable DER qty only required for visibility) so that Security Constrained Economic Dispatch is preserved
  DNSP: Curtailment triggers are protection mechanisms for networks, meaning that DOE breaches have a lower impact on the network itself than on customers (e.g Inverter Power Quality settings)
- **Customer:** DOE breaches can impact voltage level (gradually reducing the life of electronic equipment) and power quality (flicker).
  - Voltage increases trigger curtailment of export in newer PV inverters with a power quality setting, reducing the use of their PV and export of neighbouring customers.
  - Net NMI DOEs hold customer to account for uncontrolled load/ generation causing a breach.

Summary Findings: DOE Conformance

Focus of this analysis

Tested the ability for aggregators to **dispatch in compliance with DOEs** at the:

- DUID level (portfolio), and
- NMI level.

- Explored the **implications** of DOE breaches on networks and consumers.

Question 4:
How can the Distributed Energy Resource (DER) Marketplace facilitate activation of DER to respond to wholesale price signals, operate within network limits and progress to participation in wholesale dispatch over time?

Hypothesis A:
DER participation in wholesale energy markets can be achieved progressively, as DER fleets reach materiality thresholds, aligning with Energy Security Board (ESB) Visibility and Dispatchability models.

Preliminary Insights:

- NMI DOE compliance in constrained areas is currently poor and would need to be improved in a wide-scale roll out of DOEs
- An imbalance between active and passive DER customers could diminish participation incentives and value to active customers
- Models that allow separate trading of controllable (Flex) devices could enable more efficient participation by aggregators
- Aggregators need highly integrated and scalable systems to manage portfolios in a high-participation future
- Need to define DSO-AEMO limit interface in a way that aligns with DER bids
- Coordination process to be defined between active start date of new aggregator site after enrolment and corresponding DOE update from DSO

The impacts of these results are?

- Industry preferences differ between Net NMI DOE (export/import) and Flex DOE applied to the controllable DER (aligns with aggregators control and ability to conform) – need to be resolved
- The trade-off could be that Flex DOEs are potentially more conservative initially
- System Security at the local and transmission network levels is largely manageable, focus should be on customer protections
- NMI DOE compliance needs to improve to mitigate the need for network solutions, Solar PV disconnection and voltage rise that add more costs and lost revenue to customers
- DER aggregators need capability to self constrain their bids and manage conformance operationally

Turning insights into action: Industry Discussion

How should industry progress this discussion?

DOE point of allocation – resolving different industry preferences for Net and Flex

- Raised in AER Flexible Export Limits Issues Paper (Oct 2022)*
- Consider aggregator and DNSP capabilities to manage risk
- Consider Roles & Responsibilities required for each option:
  - Responsibility for whole site (Net)
  - Multi-trader sites (exists now without FTA2): Access to uncontrolled load, division of DOE among traders (Net or Flex)

- Who should drive this definition? Who should be involved?

DOE capacity allocation among customers*

- Previous EDGE forums presented Uni Melb results showing a spectrum of Dynamic Operating Envelope 'Objective Functions' that guide the allocation of spare network capacity among DER customers and how this relates to the idea of "fairness" for customers.
- Increasing "fairness" to participating DER customers will directly reduce the total capacity that can be allocated, dispatchable DER capacity and the social welfare of the network (benefits to all consumers including those without DER).

- How should capacity allocation policies be set? Who should drive this? Who should be involved?

Improving DOE Conformance (esp in constrained network locations)

- DOE compliance needs to improve to mitigate the need for more costly network solutions
- More sophisticated applications of DOEs (e.g. reallocation mechanisms) could mitigate risks but need further exploration
- Severe penalties could deter active DER market participation, limiting whole of system benefit and customer value
- ***What incentives/penalties are appropriate for non-compliance with DOEs?***
- ***Who should identify non-conformance? Who should define the penalties? Who should enforce them?***

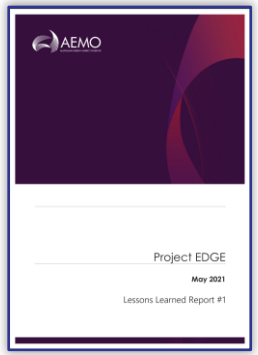
*https://www.aer.gov.au/system/files/Flexible%20Exports%20-%20final%20Issues%20Paper_0.pdf

Questions?

Project EDGE Publications

Knowledge Sharing Reports

Fact Sheet

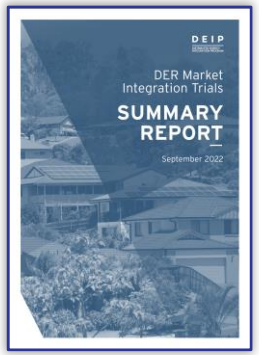


Lessons Learned # 1

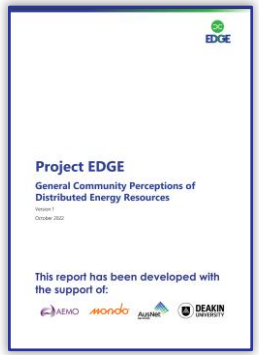
Public Interim Report

Customer Insights Study

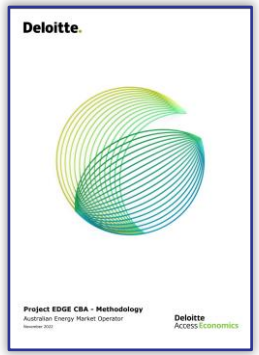
Customer Insights Literature Review



DEIP DER Market Integration Report



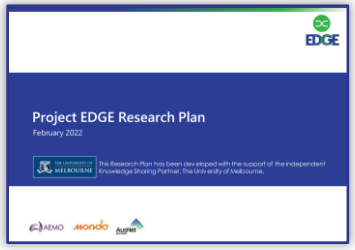
Community Perceptions of DER



Cost Benefit Analysis

Lesson Learnt #2

Presentations & Webinars



Research Plan

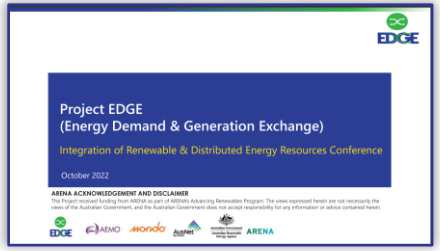
Webinar #1

Public Interim Report Webinar

Conferences

Energy Systems Integration Conference

DEIP Dive DER Market Integration Conference



Renewable and Distributed Resources International Conference

For further news and knowledge sharing publications, please visit the Project EDGE website

For any questions, comments or feedback please contact: EDGE@aemo.com.au

Next meeting: 27 April 2023

Future Meetings & Close

For more information visit

aemo.com.au