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Submission to the Open Energy Networks Consultation Paper

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About CEEM

The UNSW Centre for Energy and Environmental Markets (CEEM) undertakes interdisciplinary research in the design, analysis and performance monitoring of energy and environmental markets and their associated policy frameworks. CEEM brings together UNSW researchers from the Faculty of Engineering, the Australian School of Business, the Faculty of Arts and Social Sciences, the CRC for Low Carbon Living, the Faculty of Built Environment and the Faculty of Law, working alongside a number of Australian and International partners.

CEEM's research focuses on the challenges and opportunities of clean energy transition within market oriented electricity industries. Key aspects of this transition are the integration of large-scale renewable technologies and distributed energy technologies – generation, storage and 'smart' loads – into the electricity industry. Facilitating this integration requires appropriate spot, ancillary and forward wholesale electricity markets, retail markets, monopoly network regulation and broader energy and climate policies.

Distributed Energy Resources (DERs) are a vitally important set of technologies, with vitally important stakeholders, for achieving low carbon energy transition and CEEM has been exploring the opportunities and challenges they raise for the future electricity industry for over a decade. More details of this work can be found at the Centre website. We welcome comments, suggestions and corrections on this submission, and all our work in this area. Please feel free to contact Associate Professor Iain MacGill, Joint Director of the Centre at i.macgill@unsw.edu.au.

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Introduction

The key role of consultation:

We commend the Australian Energy Market Operator and the Energy Networks Association for their work on this important issue of better integrating Distributed Energy Resources (DERs) into the electricity industry, and appreciate the opportunity to respond to this consultation paper. There are, of course, a number of other key stakeholders exploring these questions including governance institutions AEMC, AER and ECA; relevant government departments and agencies, both State and Federal; industry, individually and through their various Associations, both incumbent and new entrant; and others including NGOs and the Research Community. It would be useful for subsequent stages of this consultation process to better draw out the similarities and differences between these varied efforts, and look to establish more formal mechanisms to strengthen this discussion over the years ahead.

When considering consultation, we would like to emphasise that the lack of genuine, diverse, inclusive stakeholder engagement in NEM governance arrangements, in particular the near complete absence of distributed technology and service vendors, as well as energy users, at the 'table', has proved very problematic during the extraordinary uptake of rooftop PV from 2010 onwards. For one thing, it has damaged trust in the process. More importantly, the incumbent industry was totally blindsided by how quickly the technology could be deployed, how quickly costs were falling and how much their 'consumers' wanted to deploy it. It is fair to say that many in the renewables industry were similarly surprised, but there were certainly industry participants and researchers who could see some of these changes coming, and it would have been very valuable to have them at the table earlier.

CEEM aims to contribute to this consultation as a University Research Centre with a team of around twenty researchers – academic staff and research students – all working on aspects of Australia's clean energy transition challenges and opportunities. One of the Centre's three research streams is focussed on DERs, and our submission draws upon a range of this work. Our starting point is the urgent need for rapid decarbonisation of the electricity sector. DER integration needs to be assessed, and managed, with this objective in mind. Optimal integration of DER in this context has less to do with cost-minimisation and, instead, should focus on robust frameworks that can rapidly drive down industry emissions through deployment of clean supply and demand technologies and associated behaviours. Such transition also requires a high level of social consensus, and this will hinge on the perceived fairness, for both consumers with and without DER, of these arrangements. The omission of these drivers from the Consultation paper is perhaps not surprising in the present policy environment, but is still disheartening.

Terminology:

As always with rapidly emerging areas, agreed definitions and terminology are still being established for DERs. This is evident in the Consultation paper itself and is problematic:

- We suggest the use of energy consumers rather than customers. Customers don't sell back to the seller but consumers may, and this is at the heart of obtaining greatest societal value from the services that DERs can provide.
- The definitions of active and passive DER are particularly problematic. It is not passive to operate your PV, battery storage system and loads to achieve your own objectives. Indeed, you could argue its more passive to be remotely controlled by a third party, which you define as active. Perhaps it would be better to describe external control and orchestration as 'coordinated DR'.
- It is not entirely clear how the terms distributed and decentralised are being used. We prefer to use the term distributed to describe spatial distribution of resources across the distribution

network, and decentralised as referring to 'coordination' of DERs rather than strict centralised control of them.

- There is too much focus on lowering costs for consumers, rather than increasing the net societal value associated with their energy service provision. Environmental harm reductions, as noted above, are a key part of this value proposition. So is the value of reliability. The future electricity industry will need more sophisticated approaches to reliability and power quality than the present fixed standards, given the potential for some of these DERs to provide reliability and power quality outcomes locally and potentially privately, depending on consumer preferences. The current discussion around cost minimisation doesn't capture this adequately.
- Finally, we think that the term DSO itself needs to be better defined. At wholesale level, a system operator's role is generally seen in terms of engineering focussed on security, while a market operator's role is focussed on commercial arrangements. The Consultation paper seems unclear here – certainly the DSO appears to have a market as well as security and reliability role. For example, you don't get optimal dispatch of DER based only on constraints, while you would envisage potential market based approaches to dealing with such constraints, as well as other network services.

Platform design:

The AEMO/ENA *Open Energy Networks* consultation paper discusses the need for some form of platform that both coordinates DER resources and integrates them with wholesale markets such as spot prices and ancillary services (e.g. FCAS). It describes three possible designs: a Single Integrated Platform (SIP), a Two Step Tiered Regulated Platform and some form of an independent Distribution System Operator (DSO). There is a significant amount of work being undertaken in the UK around the optimal design of a DSO, and some work is also taking place in the US.

There is broad agreement around the need for the organisations that manage the networks to become more involved in active management of DER resources. There is, however, less agreement on the extent of the role that DERs will eventually play in the electricity industry, the pathway for uptake, and the interest of consumers with DERs to participate in the broader electricity sector – after all, many of these technologies can now support consumers to become *less* reliant on the security, reliability and affordability of electricity available through the sector. The nature, extent and speed of necessary NEM enhancements therefore remains unclear. Proactive efforts to better understand the challenges and opportunities are certainly worthwhile, rushed implementation of poorly thought through changes could make things worse.

All the AEMO/ENA options assume the need for a DSO and for coordinated dispatch of DER aggregators. The AEMO/ENA options can be summarised as follows.

Single Integrated Platform (SIP): DNSP provides real time network constraint signals to AEMO, aggregators can then bid into the market through AEMO's market platform (which is acting as the DSO), which takes the network constraints into consideration.

Two Step Tiered Platform: Aggregators provide dispatch bids to the DNSP (which acts as the DSO), which then aggregates them and bids them into AEMO's markets taking into account local network constraints.

Independent DSO: DNSP provides real time network constraint signals to the DSO, aggregators provide dispatch bids to the 3rd party DSO, which then aggregates them and bids them into AEMO's markets taking into account local network constraints.

The key driver here is the need to enable DERs access to energy, network and ancillary service markets, should consumers wish to participate, while maintaining the effectiveness and integrity of network management. However, it is not clear at this stage that achieving this requires either large-scale coordinated dispatch of aggregated DER or a DSO to manage it.

The DSO options proposed in the consultation paper might introduce unnecessary amounts of complexity trying to deal with all the markets and all the potential network constraints simultaneously, before this is actually required. This would have very intensive data and communication requirements, and a computationally would be very difficult to optimise.

Instead, all that might be required, certainly in the near to medium term, is for the DNSP to provide real time network constraint signals to DER systems, or to aggregators, who can then optimise local DER operation or to bid into the market through AEMO as they wish. This is most similar to the Independent DSO option described in the AEMO/ENA paper, but without the DSO.

It is important to recognise that there are different categories of electricity consumer. These range from:

i) Consumers with no DER,
ii) Consumers with DER (possibly just solar PV) who are happy with passive controls such as fixed export limits,
iii) Consumers who are happy to have dynamic export limits,
iv) Consumers who have some level of aggregated participation through, for example, remote control of A/C and/or batteries during occasional critical network events, to
v) Consumers who want to participate as an actively aggregated end user and bid into wholesale spot and FCAS markets.

It is only this latter category that could conceivably require any overarching coordination and dispatch above and beyond local network control. Even in this case, the aggregator in question could either receive set parameters for particular times of the day (much like a TOU tariff), or at higher levels of penetration (and sophistication) receive real-time signals (say at SCADA intervals) if they want to operate in the FCAS market, or 5 mins if only the wholesale spot price market). Thus, the DNSPs would be providing a hierarchy of constraint signals within which the various participants connected to the network must operate. This does not require either coordinated dispatch of aggregated DER or any form of DSO to bid this into the market. It only requires the DNSP to set an operational envelope. All categories of consumer could then optimise their operation within that envelope as they saw fit.

Much of this can be automated, but would still require the DNSP to develop much greater capabilities around having a real-time understanding of the current state of its LV networks, as well as some forecasting capabilities, and the ability to convert these into constraints that are transmitted to any aggregator (and possibly individual DER) operating in relevant regions of its network. The DNSPs can of course still have bilateral contracts for DER services as they currently do (e.g. through A/C control through a third party, and calls for network support in specific locations through RIT-D). There are a number of trials of this sort of capability either underway or under development, and we recommend that AEMO incorporate these approaches into their proposals.

The level of consumer participation in aggregation is also uncertain. Participation in wholesale markets is currently restricted by size, which is why aggregator business models are being developed. The key question, however, is the consumer's 'willingness to participate' in aggregated markets and the costs/benefits to them of doing so. As far as we are aware, there is no publicly available information regarding the interest of consumers to participate in these markets, and therefore of the relative percentage of consumers that would fall into the five categories described above. Although we do have a number of trials, including of consumer participation in FCAS markets via an aggregator, at present, costs would generally appear to outweigh benefits, unless other market participants are willing to contribute towards to cost of the platforms. A consumer's willingness to participate will also be affected by their attitude towards increased network, retailer and aggregator control of their DER systems and loads, which may be counter to their desire for increased independence.

The discussion paper focuses on DER operation, but DERs will also need to be considered in planning processes. Current arrangements have done a poor job of delivering non-network solutions for providing grid support, and there currently appears to be conflicting incentives for DNSPs in this regard. With any of the DSO options, or the 'constraint envelope', described above, there could be a justification for DNSPs to increase the size of the network in order to facilitate aggregators or individuals participating in wholesale spot/FCAS markets. The AER will need to balance the needs of such participation against the increase in Regulated Asset Base and resultant increase in network costs for all. For this reason, also, there is a need to examine options to minimise grid use via optimised operation of DER at household, feeder and local level before large-scale export, import or service delivery is considered.

We broadly agree with the proposed immediate actions, and can envisage the potential need for one of the AEMO/ENA proposed platform approaches in the future. However, we feel that it would be worthwhile to explore more graduated NEM changes as our understanding increases, and uncertainties decrease. An important point was made in the consultation paper that there will be conflicting interests, particularly for DNSPs when considering network vs non-network solutions. Further challenges may arise in terms of organisational inertia within AEMO (large scale), DNSPs (technical, focus on RAB) and distributional impacts on consumers without DERs, fairness for consumers *with* DERs. In the short term, confusion over the term 'DSO' is likely to be problematic, and efforts should be made to clearly articulate its meaning.

Interim steps – improve existing mechanisms?

Whilst we commend AEMO and Energy Networks Australia for developing a vision for the potential future high penetration DER electricity system, and broadly agree with the outlined immediate actions, we also recommend that there is robust review of the existing mechanisms for DER integration and barriers that may exist. For instance:

- Review probabilistic network planning methods in terms of consideration given to DER access and potential accommodation of reverse power flows.
- Review of the RIT-D to establish whether it is achieving its objectives, and the effectiveness of incentives designed to overcome supply-side bias such as DMIS/DMIA

Given the level of complexity in the LV grid, careful consideration should be given to whether a market based method for coordinating DERs is the most appropriate, and to any potential impacts on wholesale and FCAS markets.

Organisational culture and conflicted interests:

If it is determined that a DSO as envisaged by AEMO/ENA should exist (i.e. one involved in aggregation of DER into external markets), we note that neither AEMO nor DNSPs would necessarily be best placed to fill the role.

AEMO is not ideally placed because as taking on a DSO role could distract from primary (and critical) focus on transmission scale operations. Although we note that a 'branch' of AEMO or sister organisation could potentially take on the DSO role effectively (if indeed it is determined to be necessary to establish a DSO), so long as there is sufficient independence and ability to consider operations at the distribution scale.

DNSPs may not be best placed to take on a DSO role due to the perceived or actual conflict of interest between being a provider of network services for the general consumer base and acting as an agent for aggregators who have a financial incentive for maximising the size of the network (so they can bid into spot markets). This role would also require significant changes to the regulatory environment so that a regulated monopoly can participate in competitive markets

Responses to questions

Section 1

In addition to our responses to the specific consultation questions below, we have provided a brief comment on each section of the report. Regarding section 1, we are entirely agreed regarding the potential transformation driven by DERs, although question all forecasts given the inherently high uncertainties involved.

We note that Australia is certainly a leader with regards to household solar PV [1] although some definitional issues means that there are other countries, e.g. Denmark, which, if you include distribution connected wind turbines and district heating, are already far more decentralised than the countries listed.

The consultation provides considerable discussion around existing power quality impacts of DERs, including voltage management, however it would be useful to see further details on published work in order to support this discussion. Our own work highlights that high voltage is an issue for the distribution network quite independently of PV, although PV is certainly contributing to challenges. Also there exists a low voltage issue which seems likely to be driven by A/C and other peak demand drivers [2, 3].

Lack of visibility in the LV network is also a key issue and some initial work has been undertaken in this space, including the development of the APVI solar map [1] which uses data from the Clean Energy Regulator and PVOutput.org to estimate the generation from distributed PV systems. Improved use of existing data sources such as these is strongly recommended.

We agree on the importance and present uncertainties regarding response of DER to disturbances and refer in **Question 3** below to a forthcoming publication on this issue.

Finally, we agree that poor management of DERs will lead to increased costs, but note that inappropriate restrictions on DER uptake can also lead to increased costs given the potential environmental, reliability as well as economic values that they bring.

Section 2

As flagged in the introduction above, the **definitions of active and passive DER** are particularly problematic. It is not passive to operate your PV, battery storage system and loads to achieve your own objectives. Indeed, you could argue its more passive to be remotely controlled by a third party, which you define as active. Perhaps it would be better to describe external control and orchestration as 'coordinated DR'.

We note that the discussion could **also cover embedded networks**, which already provide opportunities for consumer coordination as well as NEM participation and bilateral agreements.

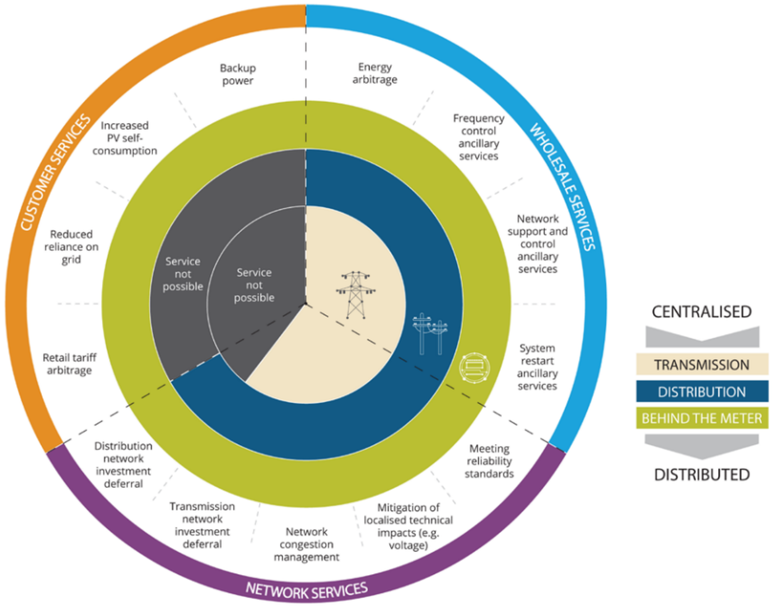
1. *Are these sources of value comprehensive and do they represent a suitable set of key use-cases to test potential value release mechanisms?*

These sources of value are all financial, and are consistent with the consultation paper's apparent assumption that a significant number of consumers are driven by financial concerns and so will want to participate in aggregated services, and therefore require coordinated dispatch. The key values missing here are:

- The desire to **reduce greenhouse gas emissions** and
- The desire for **independence** (even if still connected to the grid).

The former source of value occurs for all five types of consumers described above, and the latter actively discourages any participation in any sort of aggregated market. Of course, as the use of DER becomes more widespread, a greater proportion of consumers will be driven by financial outcomes. However, assuming that the only sources of value are based on financial outcomes quite likely creates a false sense of consumer interest in participation in aggregated services.

Further, the sources of value listed are specifically sources of financial value only for consumers with DERs. We believe that this view is too narrow, and that 'value' should be considered on an economic basis, and that a broad range of beneficiaries should be considered. The range of values (or services) which DERs can generate is summarised well in the figure below:



Source: This is based on a diagram that was developed by the Rocky Mountain Institute but has been adapted for the Australian context.

Note: The coloured concentric circles in the centre illustrate where the asset is connected. The grey areas indicate where the physical location of an asset means it cannot provide particular services. For example, battery storage system connected at the distribution or transmission level cannot help an individual consumer reduce their reliance on the grid.

Figure 1 DER sources of value [4]

It is also critical that the *distribution of benefits* (or value derived) is considered. Specifically we recommend that the following are considered (in addition to the 'key principals' set out in the consultation paper):

- How will the proposed DSO model impact consumers without DER?
- How will the proposed DSO model impact different groups of consumers with DER? (e.g. those with 'legacy' inverters installed prior to the current standard AS4777.2(2015), those with passive DERs, those with active DERs)

Finally, we recommend that along with values produced currently, avoidance of future costs should also be considered.

2. *Are stakeholders willing to share work they have undertaken?*

A number of prior and current research projects underway at CEEM are of significant relevance to the Open Energy Networks process. Please find details of some listed below, noting that we would be happy to meet with your team and discuss.

Equitable voltage curtailment

UNSW work led by Dr Simon Heslop[1] modelled probabilistic voltage behaviour on LV networks for a wide range of potential household demand and PV deployment profiles. Voltages at all residential connection points in these LV networks were modelled at 30 minute intervals over a year of actual sampled household loads and PV output. The work highlighted the potential wide voltage range seen at different times and locations across the network. High voltages were associated with times of low load and high PV generation, low voltages with periods of high loads and low or no PV generation. High transformer tap settings saw more PV curtailment, low tap settings saw more periods of low voltages. The work highlights that voltage excursions on the LV network are an outcome of many factors rather than just PV. In particular, highly correlated peaky household appliances such as reverse cycle air-conditioners can be a major cause of low voltage excursions, potentially forcing tap settings up. Interestingly, PV is at present one of the only household 'appliances' that is actually required to be controlled in a way that reduces its voltage impacts.

This raises interesting questions of network access and equity - for example, is it reasonable to push transformer tap settings high to ensure voltage doesn't fall too low during those few periods of peak demand, even though such settings reduce the 'headroom' for PV to generate at times of low load? And why shouldn't appliances such as air-conditioners be required to assist in managing low voltage excursions by curtailing their demand at these times, just as PV systems are asked to do?

There are also locational issues to consider. Work previously completed by Simon Heslop used probabilistic models to examine voltages in the LV network with high penetrations of PV. The work showed that without management, the need for PV curtailment to avoid out-of-range voltages fell predominantly on those consumers at the end of feeders. The concept of fair curtailment of solar PV and operation of controllable load to manage voltage equitably was also explored.

This work is not yet formally published, however is extremely relevant to any discussion of voltage management mechanisms in a high penetration DER future. It sets out an approach to PV curtailment and operation of controlled load which ensures that the loss of generation is shared evenly between consumers within one region of the network. This mechanism is practical as it does not rely on extensive communication systems. Please note that a publication of this work entitled *'A practical distributed voltage control method to ensure efficient and equitable intervention of distributed devices'* is forthcoming.

Further relevant work is currently under review on the effects of high penetration PV, battery energy storage and the critical role of tariffs, including on the wholesale impacts of high penetration PV and battery energy storage systems. CEEM also has work underway on engaging and empowering consumers, and the potential role for Embedded Networks, in particular in apartments [Roberts et al., 2015; Roberts et al., 2017; Roberts et al., 2018]. A forthcoming publication led by Dr Declan Kuch also sets out recommendations for good data practises in energy.

Visibility of voltage conditions in the LV network

Through collaboration with Solar Analytics, we are undertaking a research project that provides visibility of actual voltage conditions occurring on the LV network across Australia. It shows that the distribution networks set voltage very high, with the bulk of voltages well above the local nominal value, for example NSW is shown below. This publication is publicly available: *'Data driven exploration of voltage conditions in the Low Voltage network for sites with distributed solar PV'* (2017), here.

[1] Simon Heslop completed this work as part of his PhD at CEEM, Simon is now based at Intelligent Energy Systems

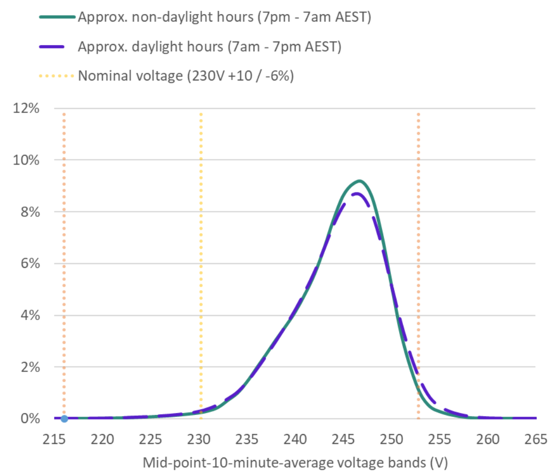


Figure 2 NSW voltage distribution [2]

Possible system security impacts of distribution PV

Please refer to our response to question 3. A publication entitled *'Possible System Security Impacts of Distributed Photovoltaics Response to Voltage Excursions'* has been submitted for publication.

Section 3

As noted in the introduction and in the consultation question responses above, the term passive DER is problematic and should be revisited. It is not passive to operate your PV, battery storage system and loads to achieve your own objectives. Indeed, you could argue its more passive to be remotely controlled by a third party, which you define as active. Perhaps it would be better to describe external control and orchestration as 'coordinated DR'.

We agreed that dynamic range of power flows is key to voltage management but note that PV systems are actually the only end-user equipment at present that actively participates in voltage management, given the AS4777.2 requirement to switch off when voltage exceeds an allowable range. In contrast, a/c units remain a key driver of low voltage excursions but there exists very little information on a/c behaviour under disturbance, no direct visibility and only a few trials of control.

We note that reverse power flows present a key issue and that it would be useful to see discussion of comparison of PV with aggregate after diversity maximum demand.

Regarding actions we make the following observations and recommendations:

- We emphasise the need to be very careful regarding network upgrades; such upgrades are typically expensive and inflexible whilst the need for investment is also subject to future uncertainties.
- We note that restricting new DER connection applications goes against open access principles and presents equity concerns. Management approaches are best practices, however we note that these don't necessarily have to be particularly sophisticated – e.g. hosting capacity can be increased by reducing voltage through network transformer tap settings.
- We highlight that management thinking has to go beyond DERs – voltage and flow outcomes arise from operation of all equipment – DERS and loads.
- Finally, we note that new players are providing a new level of visibility in the distribution system – for example Solar Analytics – and that there may be opportunities for networks to work with such providers; and for regulators to work with them as well.

As noted in response to questions 2 and 3, security of supply issues are certainly significant and the CEEM research team are working on these challenges in collaboration with AEMO.

On management strategies more broadly, we recommend the following:

- Network voltage management should be added to static management strategies.
- A greater focus on voltage and disturbance behaviour of loads is required.

Further, whilst we appreciate that tariff reform is not considered to be in the scope of this document, we see it as a crucial piece to the DER integration puzzle. Indeed, the UK ENA Open Networks project is considering a 'Future World' in which tariff reform is the basis for DER integration with forward looking charges playing a critical role. We therefore highlight the need to be quite thoughtful and consider risks such as the potential for TOU tariffs to highly correlate DER behaviour, which would be problematic. CEEM has forthcoming publications in this space and would be happy to discuss the results.

3. *Are there additional key challenges presented by passive DER beyond those presented here?*

Yes. In addition to the system security challenges listed, the behaviour of passive DERs during major system disruptions is of key concern. The response of inverters to frequency excursions is not a particularly new challenge (refer to 50.2Hz issues in Germany for instance) however recent work undertaken by CEEM has indicated that response of inverters to voltage excursions following major events is also of concern.

The current inverter connection standard (AS4777.2 (2015)) focuses primarily on responding to voltage conditions on a day to day basis, in order to manage over voltage (amongst other critical functions). As a result, there are no specific high or low voltage *ride through* requirements, and subsequently the voltage set points specified are extremely important for determining how the PV fleet is likely to behave following contingency events. In contrast, the inverter connection standard widely adopted across the USA (IEEE 1547 April 2018) was recently updated to include voltage ride through requirements during 'abnormal' conditions.

CEEM's work

CEEM's analysis has shown that a large volume of solar inverters disconnected following two separate non-credible contingency events in the NEM during the past 18 months. The first was located in South Australia on 3 March 2017 and closely resembled the conditions that resulted in the 2016 South Australia system black event. In this instance, the loss of PV exacerbated conditions.

Figure 3 below indicates the demand across South Australia over the event period. It initially dropped by ~400MW, then increased by ~150MW, which is believed to have been due to solar PV disconnection, and presented additional challenges for AEMO. Figure 4 shows the aggregate response of solar PV based on Solar Analytics data – it shows that PV generation did indeed reduce substantially for a short time at the time of the event. Figure 4 also shows the average local voltage and frequency conditions, with a voltage spike registered[2], likely the trigger for the PV response.

[2] There are some limitations to this analysis due to the method of data collection.

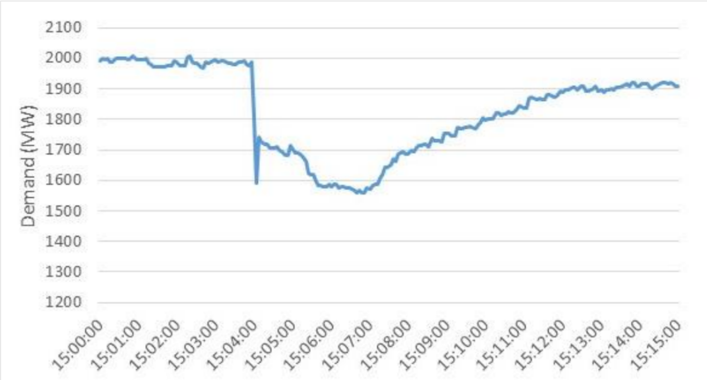


Figure 3 Demand in South Australia, AEMO 2017[3]

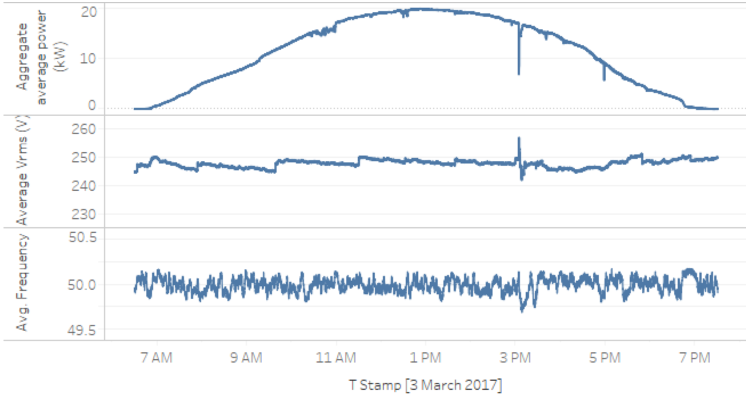


Figure 4 Aggregate solar PV response to event (top), average local voltage (middle), average local frequency (bottom)

The second event occurred in Victoria on 18 January 2018, when the loss of solar PV similarly exacerbated conditions. Notably, preliminary analysis has indicated that the response of PV inverters was centred in Melbourne, whereas in the South Australian case there was disconnection observed across the state.

A publication on this work entitled *'Possible system security impacts of distributed photovoltaics response to voltage excursions'* is forthcoming.

4. Is this an appropriate list of new capabilities and actions required to maximise network hosting potential for passive DER ?

We believe there are other actions that could be taken: please refer to the next question.

5. What other actions might need to be taken to maximise passive DER potential?

The following additional actions should be taken in order to maximise 'passive' DER potential:

- Consideration of fairness in network planning and operations, for example which passive system should be curtailed if there is a need to do so. We recommend that the following occur:
    - Develop principles

[3] Incident report available here: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Market_Notices_and_Events/Power_System_Incident_Reports/2017/Report-SA-on-3-March-2017.pdf

    - Develop a transparent method to apply principles to network decision making processes
- Consideration of energy data, particularly which parties should have access and under what circumstances (e.g. regulators)
- Review AS4777.2(2015) connection standards to consider ride through requirements. In this process, refer to:
    - IEEE1547 (2018) which is widely adopted in the US
    - Californian rule 21
    - Italy
    - Germany
    - Netherlands
    - Japan

Section 4

We agree that VPPs are promising but note that they also pose some challenges. For instance, correlation creates challenges, and can potentially result from weather conditions, tariffs or active control of many DERs via a VPP or similar.

We need to be careful about the idea of out-of-market arrangements. Ideally, even tendering processes for services need to be seen as form of market approach as much as possible. Non-transparent bilateral negotiations are potentially problematic. In the longer-term, we agree with the potential for market approaches for foundational 1, 2 and 3 (4 seems potentially possible but there are questions around practicality) . However it is important to note that real time pricing doesn't necessarily drive efficient investment. We will need mechanisms for future pricing as seen in the wholesale markts to achieve this.

6. Are these the key challenges presented by active DER?

See our response above (question 3). System security challenges should also consider behaviour of DERs during credible and noncredible contingency events.

7. Would resolution of the key impediments listed be sufficient to release the additional value available from active DER?

In addition to the key impediments listed, we suggest the following should be taken into account:

- Consideration of fairness
- Deeper understanding of legacy DERs (particularly rooftop PV) and how the inverter set points may prevent other DERs from accessing markets.

For example, over voltage caused by legacy PV preventing battery energy storage from providing FCAS.

8. What other actions might need to be taken to maximise active DER potential?

In addition to what we have discussed above, there is a very large body of work that needs to be undertaken to maximise DER's 'active' potential. Some of this is the focus of trials being supported by ARENA. We recommend that ARENA be asked to provide details on these trials to AEMO.

9. What are the challenges in managing the new and emerging markets for DER?

Key challenges include protecting consumers interests. This might include ensuring transparency and minimising complexity (thereby minimising opportunities for gaming). There is also a need to ensure that existing network incentives don't create inefficient outcomes (where network solutions may be favoured despite more economically efficient alternatives)

10. At what point is coordination of the Wholesale, FCAS and new markets for DER required?

As discussed above, we do not believe that an argument has been made that justifies the need for this type of overall coordination, or that it is even feasible.

Section 5

It is noted in the consultation paper that the third option presented (the creation of an 'iDSO') was not considered to be preferable by AEMO or Energy Networks Australia. We recommend that, assuming a DSO model as described in the consultation paper is to be pursued, this third option is seriously considered, particularly in light of similar consideration by the Energy Networks Association in the UK through their Open Networks project [5] and believe that it should at least be discussed here.

11. How do aggregators best see themselves interfacing with the market?

No response provided to this question.

12. Have the advantages and disadvantages of each model been appropriately described?

We recommend that AEMO and Energy Networks Australia refer to the highly detailed work being undertaken in the United Kingdom by the Energy Networks Association under the Open Networks project and the recently published Future Worlds report [5]. This project considers five possible 'worlds' (difference possible models) which would be worth considering in the Australian context. Initial work has resulted in detailed specification of these future worlds via 'Smart Grid Architecture Models' (SGAM) available here:

http://www.energynetworks.org/electricity/futures/open-networks-project/future-worlds/future-worlds-consultation.html

On a separate note, we recommend that AEMO and Energy Networks Australia consider the degree to which each of the three models proposed in the consultation paper may result in increased complexity and reduced transparency within the wholesale and FCAS markets. We note that this may have negative impacts on competition.

With regards to the second proposed model, we would like to emphasise the listed disadvantage that DNSPs 'may not be perceived as adequately independent and unbiased to fulfil this role' (p32). We believe that DNSPs are not suitably independent and unbiased and should not be placed in this role. Further, it is noted that this would 'require an expansion of resources, and change the way in which DNSPs are currently funded' (p32) which is a considerable undertaking.

13. Are there other reasons why any of these (or alternative) models should be preferred?

As detailed in the introduction, we recommend a further option is considered in which the 'DSO' function is limited to providing a set of network constraints and allowing a market based evolution of services.

The DSO options proposed in the consultation paper might introduce unnecessary amounts of complexity trying to deal with all the markets and all the potential network constraints simultaneously, before this is required. This would have very intense data and communication requirements, and a computationally would be very difficult to optimise.

Instead, all that might be required, certainly in the near to medium term, is for the DNSP to provide real time network constraint signals to DER systems, or to aggregators, who can then optimise local DER operation or to bid into the market through AEMO as they wish. This is most similar to the Independent DSO option described in the AEMO/ENA paper, but without the DSO.

It is important to recognise that there are different categories of electricity consumer. These range from:

i) Consumers with no DER,
ii) Consumers with DER (possibly just solar PV) who are happy with passive controls such as fixed export limits,
iii) Consumers who are happy to have dynamic export limits,
iv) Consumers who have some level of aggregated participation through, for example, remote control of A/C and/or batteries during occasional critical network events, to
v) Consumers who want to participate as an actively aggregated end user and bid into wholesale spot and FCAS markets.

It is only this latter category that could conceivably require any overarching coordination and dispatch above and beyond local network control. Even in this case, the aggregator in question could either receive set parameters for particular times of the day (much like a TOU tariff), or at higher levels of penetration (and sophistication) receive real-time signals (say at SCADA intervals) if they want to operate in the FCAS market, or 5 mins if only the wholesale spot price market). Thus, the DNSPs would be providing a hierarchy of constraint signals within which the various participants connected to the network must operate. This does not require either coordinated dispatch of aggregated DER or any form of DSO to bid this into the market. It only requires the DNSP to set an operational envelope. All categories of consumer could then optimise their operation within that envelope as they saw fit.

The discussion paper focuses on DER operation, but DERs will also need to be considered in planning processes. Current arrangements have done a poor job of delivering non-network solutions for providing grid support, and there currently appears to be conflicting incentives for DNSPs in this regard. With any of the DSO options, or the 'constraint envelope', described above, there could be a justification for DNSPs to increase the size of the network in order to facilitate aggregators or individuals participating in wholesale spot/FCAS markets. The AER will need to balance the needs of such participation against the increase in Regulated Asset Base and resultant increase in network costs for all. For this reason, also, there is a need to examine options to minimise grid use via optimised operation of DER at household, feeder and local level before large-scale export, import or service delivery is considered.

Section 6

We need greater information exchange not just between DNSPs and AEMO, but also information to assist a wide range of stakeholders to explore potential opportunities for participation. We strongly agree with value of piloting and testing arrangements given the scale of the change.

14. Are these the right actions for the AEMO and Energy Networks Australia to consider to improve the coordination of DER?

Please refer to our introduction section.

15. Are there other immediate actions that could be undertaken to aid the coordination of DER?

We recommend that the following activities are undertaken in the near term:

- Review of AS4777.2(2015) for ride through requirements.
  - Gap analysis of international standards of relevance, such as IEEE 1547 (2018).
- Use existing data sets to learn what we can – helpful to not be 'flying blind' for example:
  - Solar Analytics data,
  - Smart meter data,
  - inverter manufacturer data,
  - DNSPs
- International review of relevant work, for example:
  - Scottish DSO trial also UK work on energy data
  - California
  - HECO solar connection maps
- Collaborate with AEMC to consider what NSP incentives might need to be changed (and to what degree) under models considered.

Clarification of terminology: as flagged in the introduction, several key terms are not adequately defined:

- We suggest the use of energy consumers rather than customers. Customers don't sell back to the seller but consumers may, and this is at the heart of obtaining greatest societal value from the services that DERs can provide.
- The definitions of active and passive DER are particularly problematic. It is not passive to operate your PV, battery storage system and loads to achieve your own objectives. Indeed, you could argue its more passive to be remotely controlled by a third party, which you define as active. Perhaps it would be better to describe external control and orchestration as 'coordinated DR'
- It is not entirely clear how the terms distributed and decentralised are being used. We prefer to use the term distributed to describe spatial distribution of resources across the distribution network, and decentralised as referring to 'coordination' of DERs rather than strict control of them.
- There is too much focus regarding lowering costs for consumers, rather than increasing the net societal value associated with their energy service provision. Environmental harm reductions, as noted above, are a key part of this value proposition. So is the value of reliability. The future electricity industry will need more sophisticated approaches to reliability and power quality than the present fixed standards given the potential for some of these DERs to provide local, private, reliability and power quality outcomes depending on consumer preferences. Cost minimisation doesn't capture this adequately.

Finally, we think that the term DSO itself needs to be better defined. At wholesale level, a system operator's role is generally seen in terms of engineering focussed on security, while a market operator's role is focussed on commercial arrangements. The Consultation paper seems unclear here – certainly the DSO appears to have a market as well as security and reliability role. For example, you don't get optimal dispatch of DER based only on constraints, while you would envisage potential market based approaches to dealing with such constraints, as well as other network services.

Collaboration across industry processes: There are of course a number of other key stakeholders exploring these questions including those in governance including the AEMC, AER, ECA and relevant government departments and agencies – State and Federal; the industry – individually and through their various Associations, incumbent and new entrant; and others including NGOs and the Research Community. It would be useful for subsequent stages of this consultation process to better draw together the similarities and differences between these varied efforts, and look to establish more formal mechanisms to strengthen this discussion over the years ahead.

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