Australian National University

NATURAM PRIMUM COGNOSCERE RERUM

On the integration and coordination of distributed energy resources and assets as they participate in, and contribute to, the secure and reliable operation of the electricity system

A submission in response to the Open Energy Networks Consultation Paper

Battery Storage and Grid Integration Program

Research School of Engineering, ANU College of Engineering and Computer Science

Research School of Chemistry, ANU College of Science

lachlan.blackhall@anu.edu.au

The Australian National University

Canberra ACT 2601 Australia

www.anu.edu.au

CRICOS Provider No. 00120C

Contents

Introduction and Approach 1
The Current Context and State of Play 2
  AEMO 2
  DNSPs 3
  DER Assets 3
What are the challenges? 4
  Articulating the Challenges as Scenarios 5
The Question Being Asked 6
Defining and Measuring Success 7
Pathway to a Solution 9
  How is it done elsewhere? 9
  A Pathway for Passive DER 10
  Technical and Operational Considerations for Coordinating Active DER 11
  Customers and DER Representation 12
  DSO Models to be Investigated 13
Consultation Questions 14
  Pathways for DER to provide value 14
  Maximising passive DER potential 15
  Maximising active DER potential 16
  Frameworks for DER optimisation within distribution network limits 17
  Immediate actions to improve DER coordination 17
Conclusion 17
Appendix – Summary of Recommendations 19
About the Author 20

Introduction and Approach

We thank Energy Networks Australia (ENA) and the Australian Energy Market Operator (AEMO) for the opportunity to respond to the recently published Open Energy Networks Consultation Paper[1] (henceforth the OEN Paper). This is an important body of work (henceforth the Work) to understand how to best integrate and coordinate distributed energy resources (DER) into the electricity system in a manner that supports the reliable and secure operation of the electricity system.

As detailed in the OEN Paper, there are increasing amounts of both active and passive DER including solar PV, battery storage, load management, and demand response being installed and activated in distribution networks nationally.

Taking advantage of the increasing availability, adaptability, and flexibility of DER represents a once-in-a-generation opportunity to underpin the transition of the electricity system away from the current centralised design, towards a distributed and decentralised design.

In responding to the OEN Paper, this submission will address and respond to the following key questions:

- What is the current context and state of play for DER deployment, operation and integration in the Australian electricity system?
- What are the challenges being faced by the deployment, operation, and integration of high penetration DER?
- What is the key question being asked through this process and how does this articulate the key objective of this Work?
- How will we measure success in this Work?
- What is the best process for addressing, and identifying, answers to these questions?

The submission will conclude with responses to the consultation questions. Throughout this submission, several actionable recommendations are made that support and extend the necessary activities of this Work. These recommendations are discussed in detail in the body of the submission and a reference list of the recommendations is included in the appendix.

---

[1] AEMO and Energy Networks Australia 2018, Open Energy Networks, consultation Paper. (https://www.aemo.com.au/-/media/Files/Electricity/NEM/DER/2018/OEN-Final.pdf)

The Current Context and State of Play

We believe the consultation paper does an excellent job of setting the scene and outlining the context in which this Work is being done. It appropriately emphasises the presence of both active and passive DER and correctly identifies that any long-term solution must provide mechanisms for integrating and coordinating both active and passive DER into the electricity system.

Figure 1 provides a diagrammatic overview of the current integration and participation mechanisms for active DER in the Australian electricity system. In particular, Figure 1 articulates the key actors (namely AEMO and the DNSP), the relationship they have with DER and the DER representatives, and the information and financial flows between these parties.

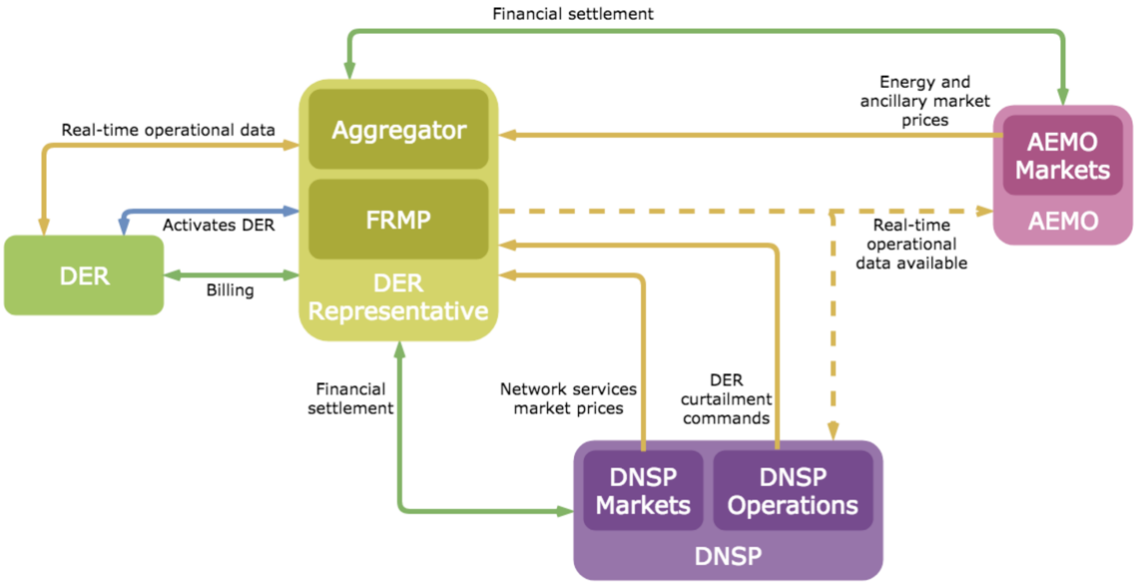

Figure 1 – The current state of interactions and market participation for active DER in the electricity system.

This current context emerged from the financial incentives and physical and operational constraints determined by the key actors in the electricity system. Further information about the source of financial incentives and operational requirements is detailed below.

AEMO

AEMO operates the National Electricity Market (NEM) which uses a market mechanism (i.e. financial incentives) for the provision of energy and ancillary services. As outlined in the OEN Paper, aggregate DER is already responding to the financial incentives for both energy and ancillary services.

DNSPs

In contrast, both physical and operational constraints as well as financial incentives are driving the participation of DER in distribution network operation. The physical and operational constraints are a consequence of the distribution network design. In turn, the design of distribution networks is determined by the network capacity necessary to satisfy forecast residential and industrial customer demand.

Fundamentally, decisions that emerge from distribution network planning inherently encode a series of physical and operating limits. The limits ensure that voltage, thermal and capacity constraints are not breached. In this way, the capital expenditure (Capex) of the networks ultimately determines the physical limits in the network. In some networks, limiting DER behaviour through DER curtailment strategies[2] is emerging as a mechanism to manage these physical limits.

In contrast, the financial incentives arise from the development and deployment of network services markets. These markets are emerging as a means of leveraging DER assets (i.e. non-network solutions) to defer network augmentation and provide operational support. In this way, networks can use operational expenditure (Opex) funded payments to incentivise DER to provide energy and capacity services.

Constraints managed in this way are often referred to as dynamic constraints. A number of Australian-based DER vendors and aggregators, including Evergen[3], Redback[4], Reposit[5], SwitchDIn[6], and WattWatchers[7], are already deploying these network market capabilities.

Finally, networks may also have emergency or contingency constraints that arise for unforeseen reasons like major equipment failure, or extreme environmental conditions. Some networks have already demonstrated capabilities to manage emergency or contingency constraints during extreme weather events[8].

DER Assets

While AEMO and the DNSPs are the source of these financial incentives and physical and operational constraints, it is interesting to note the emergence of complicated DER operating behaviours in response.

DER operating behaviours are driven by the emergence of:

1. A diversity of different passive and active DER assets, including solar PV, battery storage, controllable loads, and other home and energy automation capabilities.

[2] https://horizonpower.com.au/media/4469/2018-wa-microgrids-inquiry.pdf
[3] https://www.evergen.com.au/
[4] https://redbacktech.com/
[5] https://repositpower.com/
[6] https://www.switchdin.com/
[7] https://wattwatchers.com.au/
[8] http://energyconsumersaustralia.com.au/wp-content/uploads/FF18-Session2B-PeterPrice-EnergyQueensland.pdf

2. Smart DER controllers, particularly in the residential setting, that modulate the connection point behaviour as the result of a complicated optimisation which incorporates all of the DER assets being actively managed.

In the residential setting, we see particularly complicated DER behaviours for the following reasons:

1. Solar PV generation can be either AC or DC hybrid connected and, increasingly, is a combination of both.
2. Storage can be either AC or DC hybrid connected.
3. Not all loads are controllable, and many have regulatory requirements (i.e. hot water systems) or comfort factors (i.e. HVAC) associated with their control and optimisation.

Fundamentally, DER optimisation and control is complicated and, in the residential setting, highly personalised. These complications must be recognised when considering the impact of this Work on the behavioural implications and value of existing DER assets.

It is also instructive to note that while the OEN Paper considers both active and passive DER, they are often installed in combination (i.e. residential solar PV and battery storage). The value of this colocation in discussed later in this submission, as one pathway for managing passive DER.

What are the challenges?

In the context of this Work and the preceding sections, we believe that the core challenges can be summarised in the following way:

Challenge 1. AEMO, NEM market participants and the DNSPs have limited visibility of installed or planned DER and currently do not have reliable operational forecasts for these DER assets.

Challenge 2. The DNSPs have no visibility of the generation or demand consequences of market (NEM) responsive DER assets.

Challenge 3. AEMO and NEM market participants have no visibility of the generation or demand consequences of network responsive DER assets.

Challenge 4. AEMO, market participants, and the networks are not able to coordinate the behaviour of DER assets and virtual power plants (VPPs) to achieve security and reliability of supply across all geographies and within the control, optimisation and planning timescales of operation.

While the statement of the challenges in this form provides some clarity, we believe that these challenges need to be deconstructed into a set of atomic[9] and orthogonal[10] scenarios that the Work must address. This idea is expanded in the following section.

Articulating the Challenges as Scenarios

We believe it is important that the coordination scenarios of concern are clearly articulated to provide a deeper understanding of the challenges that must be addressed through this Work. To that end we recommend that, as an industry, we:

1. Articulate and document the atomic, orthogonal scenarios under which DER coordination will be necessary to prevent breaching network operational and physical limits. Both nominal and contingency scenarios should be considered. Scenarios could be determined based on historical occurrence or through detailed simulation studies. The documentation should include:
    a. For each scenario, what combination of financial incentives, operational requirements, and environmental conditions threaten network operational and physical limits.
    b. The evolution of these scenarios across both timescale[11] and geography[12] and
    c. A clear assessment of the lost value, reliability or security contingency that would arise if these scenarios were allowed to occur without DER coordination.
2. Develop agreed ‘optimal’ operating responses to these scenarios developed in Point 1 above. This allows AEMO, DNSPs, DER aggregators and other stakeholders to contribute to a shared understanding of the coordination requirements that best resolve each scenario.
3. Provide an open dataset that encodes the real or simulated operational data and required actions from AEMO, the DNSPs, and DER assets arising from the scenarios articulated in Point 1 and 2 above.

This activity will result in a shared and well understood set of scenarios. Importantly, these scenarios provide a mechanism to test and assess DER coordination capabilities that arise as an outcome of this Work and through related initiatives.

[9] A scenario which is indivisible and therefore can’t be decomposed into combinations of other operating scenarios.

[10] A scenario which does not have an overlapping pathology with another operating scenario.

[11] We believe the timescales of interest can be decomposed into the control timescale (sub-second to seconds), optimisation timescale (seconds to months), and the planning timescale (months and above)

[12] We believe the geography of interest could be decomposed into the following regimes; NEM Global (All DER assets), transmission network (1M+ DER assets), distribution network (100k+ DER assets), regional network (10k+ DER assets), community network (1k DER assets), individual DER asset

Furthermore, the data provided as a result of this activity will allow others to replicate modelling and assessment that is undertaken through this Work. This will provide replicability and an audit trail which will increase confidence in the outcomes of this Work.

Recommendation #1: Develop and publish the atomic, orthogonal scenarios under which DER coordination will be necessary to prevent breaching operational and physical limits as DER respond to financial incentives and operational requirements published by AEMO and the DNSPs.

The Question Being Asked

In the current context and in response to the challenges being faced, the OEN Paper outlines the objective of this body of work through asking the following question:

> *"What new capabilities, functions and roles will be required to coordinate and optimise the value of customers' DER investments whilst maintaining security and reliability across the NEM?"*

We suggest that the Work restates the question to better articulate its objective in the following way:

> *"What new capabilities, functions, roles and regulations will be required to coordinate, maximise the opportunity for, and value of, DER assets as they participate in, and contribute to, the secure and reliable operation of the electricity system?*

In reframing and reinterpreting the question we recommend that:

- This Work should not be about the development of a 'system' but rather about the development of a broader framework that will require the development of a suite of systems, capabilities, regulations, and operating principles and policies.
- This Work focuses on understanding how DER assets can *contribute* to the secure and reliable operation of the electricity system. In particular, care should be taken not to address the lesser question of how we achieve secure and reliable operation of the electricity system *despite* DER participation.
- DER assets should be valued because of their ability to contribute to energy reliability and security. Fundamentally, this requires individual and aggregate DER assets being treated on an equal footing with existing generation assets that already provide energy, ancillary and network services. To achieve regulatory and

participatory harmonisation between DER assets and existing generation assets it will be necessary to appreciate the supply and demand attributes of different DER assets. To support this understanding we recommend the development of a typology of different DER assets and their behavioural supply and demand attributes in terms of their power and energy delivery over various timescales.

- This Work provides mechanisms that are suitable for the coordination of all DER assets in distribution networks. Firstly, this means adopting a definition of DER that includes generation, storage, demand response and any other means of modulating the behaviour of a given electrical supply / connection point. Secondly, this means ensuring this Work is not restricted to a focus on residential DER assets and must include DER assets deployed in residential, commercial and industrial (C&I), or elsewhere in the distribution network. As an example, the systems and capabilities developed through this Work should be applicable to future community and grid scale energy storage connected in the low and medium voltage distribution network.

RECOMMENDATION #2: DEVELOP AN AGREED QUESTION THAT CLEARLY ARTICULATES THE OBJECTIVES OF THIS WORK.

RECOMMENDATION #3: DEVELOP A TYPOLOGY OF DIFFERENT DER ASSETS AND THEIR BEHAVIOURAL SUPPLY AND DEMAND ATTRIBUTES IN TERMS OF THEIR POWER AND ENERGY DELIVERY OVER VARIOUS TIMESCALES.

Defining and Measuring Success

For this Work to have a successful outcome it is imperative that we have a clear measure of success. In this submission we propose a set of key principles and provide some commentary and recommendations about these principles. While these principles are based on those suggested in the OEN Paper, we favour atomic principles to establish suitable measurement criteria. This ultimately provides a set of criteria for which the Work can fairly and rigorously assess different outcomes and solutions.

Table 1: Suggested principles that should underpin the analysis of capabilities, functions, roles and regulations throughout this Work.

Proposed Principles	Comments and Recommendations
Simplicity	It is important that we do not impose excessive complexity in adopting solutions for this Work. Wherever possible, new systems, capabilities, roles, and regulations should represent the simplest solution to a given problem. Through their deployment these simple solutions must address the overarching coordination challenges for DER assets.
Transparency	Transparency is vital for ensuring there is trust between all of the stakeholders for this Work. This principle directly addresses the need to eliminate potential conflict of interests that could arise in

	proposing and implementing solutions to the challenges raised by this Work. Transparency also acknowledges the requirements for audit and repeatability of the analysis this Work produces and in the ongoing operation of systems that result from this Work.
Technology neutrality	Technology neutrality is vital to ensure that DER assets can participate in the delivery of energy reliability and security services on a level playing field with existing generation assets. As a consequence, this Work should not result in two different sets of rules and regulations for the operation of DER assets and the operation of existing generation assets.
Supporting energy affordability and equity	At its core, this work must address questions of energy affordability and equity, providing positive customer outcomes and value across short, medium and long-term horizons – both for those with and without their own DER.
Promoting innovation and competition	This Work should maximise opportunities for innovative systems, capabilities, regulations and business models. This Work should seek to provide a fertile environment for innovation to occur, supporting choices that encourage flexibility going forward. Furthermore, this work should seek to create an environment where healthy competition between service providers is supported and encouraged.
Promoting efficient markets and incentives	Market based incentives offer an important mechanism for rewarding the participation of DER in the delivery of energy, ancillary and network services. It is imperative that the market mechanisms that underpin these incentives are robust and functional. In saying this, care must be taken to balance these financial incentives with important operational and physical limits of the networks.
Lowest cost	It is vital that the new capabilities, functions, roles and regulations contribute to the lowest cost of operation for customers, networks, and the system as a whole. It is important that the analysis of total cost include the potential costs for customers, DER providers, DER aggregators, DNSPs and AEMO in complying with the operation and functions of any proposed systems and capabilities developed in response to this Work.
Privacy Focussed	This Work should encourage all stakeholders to make appropriate use of customer and DER data. Stakeholders should use only the necessary data to deliver services and capabilities that will emerge from this Work. There has been fundamental work done in this area recently by the NSW Data Sharing Taskforce[13] and through the *ACS Data Sharing Frameworks - Technical White Paper*[14].

[13] https://bitre.gov.au/data_dissemination/priority_projects/nsw_data_sharing_taskforce.aspx

RECOMMENDATION #4: DEVELOP AND PUBLISH AN AGREED SET OF PRINCIPLES OR ASSESSMENT CRITERIA BY WHICH SUCCESS IN THIS WORK WILL BE MEASURED.

Pathway to a Solution

Having understood the challenges, articulated a clear question and suggested a measure of success for this Work, it is important to suggest how this Work can progress towards a set of solutions.

How is it done elsewhere?

Before undertaking extensive additional work in this area, we believe it is vital to review other complementary initiatives, projects and investigations being undertaken locally and globally. This should include:

- A review of complementary work in other jurisdictions, being careful to analyse the similarities and differences between the relevant jurisdiction and the Australian context. As a starting point, we would recommend reviewing the recent report entitled ReSHAPING REGULATION-POWERING FROM THE FUTURE[15].
- A review of systems, capabilities and technology components currently being developed in Australia. This should include a review of:
    - Existing initiatives within AEMO and the DNSPs.
    - Existing projects with industry consortia including the CONSORT[16] Bruny Island Battery Trial, and Greensync deX[17].
    - Existing and emerging projects funded through ARENA[18].

In all cases, these reviews have the potential to suggest important concepts or technology components that address the challenges being analysed in this Work and that address the necessary capabilities outlined in Table 1 of the OEN Paper.

RECOMMENDATION #5: UNDERTAKE A REVIEW OF EXISTING WORK IN THIS SPACE BOTH DOMESTICALLY AND INTERNATIONALLY.

RECOMMENDATION #6: UNDERTAKE A REVIEW OF CURRENT AND EMERGING PROJECTS IN THIS SPACE TO IDENTIFY RELEVANT SYSTEMS AND TECHNOLOGY COMPONENTS, PARTICULARLY THOSE THAT SUPPORT THE CAPABILITY REQUIREMENTS OF TABLE 1 IN THE OEN PAPER.

---

14 https://www.acs.org.au/content/dam/acs/acs-publications/ACS_Data-Sharing-Frameworks_FINAL_FA_SINGLE_LR.pdf

15 https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/collaborative-publications/Reshaping-Regulation-Powering-from-the-future.pdf

16 http://brunybatterytrial.org/
17 https://greensync.com/solutions/dex/
18 https://arena.gov.au/projects

A Pathway for Passive DER

As outlined by the OEN Paper, there is an important distinction between active and passive DER. Appropriate solutions are needed for both. We support the recommendation in the OEN Paper that there is a need for substantially greater modelling and forecasting capabilities to better understand the nominal and contingency operation of different types of DER. This will include:

- Short-, medium- and long-term forecasting of both passive and active DER including solar PV generation, battery storage, demand response and load management.
- The development and publication of reference low and medium voltage models of various distribution networks around Australia.
- A better understanding of the behaviour of DER during both nominal and contingency events in the grid.

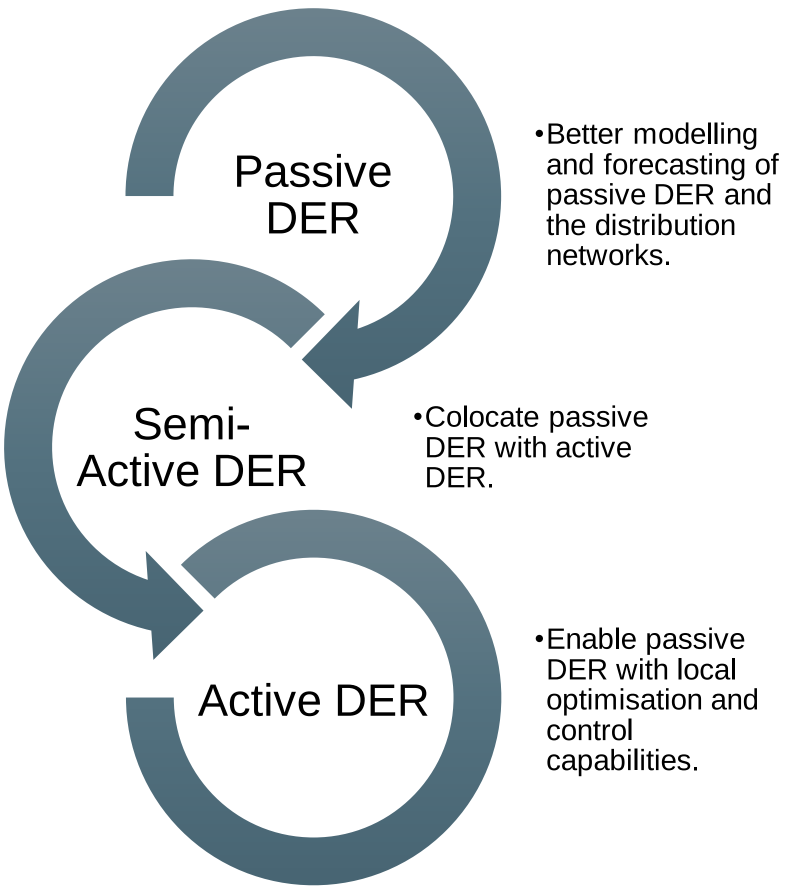

Figure 2 – A pathway for better integrating passive DER into the electricity system.

There are two other possibilities to manage passive DER.

1. Co-locate passive DER with active DER. This provides an overall solution that is semi-active and better able to be actively managed and integrated into the operation of the grid.

2. Convert passive DER to active DER through the addition of local communications, optimisation and control capabilities. Such an approach will increase the flexibility of existing DER assets. This increases the pool of active DER that can support energy security and reliability.

Recommendation #7: Increase the emphasis and support for DER and distribution network (LV and MV) modelling, forecasting and hardware in the loop testing. This should include modelling of DER and distribution network behaviour across nominal and contingency scenarios.

Recommendation #8: Undertake a review of the opportunities and mechanisms to convert passive DER to either semi-active or active DER.

Technical and Operational Considerations for Coordinating Active DER

Active DER represents a highly adaptable and flexible resource to support energy reliability and security. However, the number of DER systems, their diversity of type, and the geographic scale over which they are deployed represent fundamental challenges.

At a high-level the distribution level optimisation of DER assets is a prototypical distributed system and control problem. In this context, we must consider the following factors:

- The latency, reliability, and bandwidth of the communications systems that connect the DER assets to aggregators, network, market and emerging DSO systems. In particular, many communication channels are bandwidth constrained due to poor connectivity. This limits the volume of data transferred over these communications channels in any given time interval.
- There is no 'now' in a distributed system due to the clock drift that occurs in different systems. While there are effective means to reduce time disagreements between assets, achieving suitable levels of time synchronisation across a large number of DER assets is an important consideration in this Work.
- The computation time and complexity for the distribution level optimisation algorithms that will be implemented in an emerging DSO system. Understanding how the computational time and complexity will scale as the number of DER assets increases is a key consideration for this Work. This scaling will depend on the optimisation algorithms being used, the relationship between any local optimisation and control algorithms used by DER assets and how the optimisation is decomposed across system geographies and control and optimisation timescales.

For these and other related reasons, it will be challenging to achieve real-time coordination of DER assets. More work is needed to ensure an appropriate implementation of the systems and capabilities that will arise in response to this Work.

Recommendation #9: Increase the emphasis and support for R&D advances in distributed systems theory, distributed optimisation and control, and power

SYSTEMS MODELLING AND ANALYSIS AS IT APPLIES TO THE INTEGRATION OF DER IN DISTRIBUTION NETWORKS.

Customers and DER Representation

One of the fundamental assumptions in the OEN Paper is that individual DER assets will be represented by a Financially Responsible Market Participant (FRMP) in the form of a DER aggregator or electricity retailer. We would like to challenge this assumption on the basis that restricting the representation arrangements for DER assets through this Work has the potential to infringe several of the key principles outlined previously in this submission. We would encourage and recommend that this Work considers other representation models for DER.

We also recommend this Work also addresses the following important questions:

- Is it possible that individual DER assets are managed by multiple aggregators? And how would we coordinate assets managed in this way? This complex scenario could arise in the context of the recent rule changes that have been implemented in regard to FCAS unbundling[19].
- Can individual DER assets participate in any of the mechanisms being proposed for coordination? Must all DER assets be integrated through an approved aggregator?
- Do individual DER and non-DER customers have a 'right' to network capacity?
    - If so, should it be an 'equal' capacity allocation?
    - If not, are we going to continue with a first in best dressed approach to DER connection approvals?
- How do we balance the potential tension between the ownership of DER assets and the need for coordination of those assets?
- How does this Work relate to work being undertaken around network tariff reform, particularly in the context of envisaged community energy models, peer to peer trading and solar sponge functionality?

In response to these questions, and due to the fundamental importance to address energy affordability and equity, we recommend:

1. The inclusion of a work package related to representation arrangements for DER assets in this Work.
2. A review of the work being done in similar jurisdictions in this area. In particular, we believe that the recent publication *Retail Research into Customer Switching and Supply Disintermediation*[20] provides a substantive research base for rethinking the possible DER representation arrangements in an evolving electricity system.

[19] https://www.aemc.gov.au/rule-changes/demand-response-mechanism
[20] https://www.ofgem.gov.uk/system/files/docs/2018/07/retail_research_-_report_on_supply_disintermediation.pdf

RECOMMENDATION #10: INCLUDE A WORK PACKAGE IN THIS WORK TO INVESTIGATE REPRESENTATION ARRANGEMENTS FOR DER ASSETS. THIS SHOULD INCLUDE A REVIEW OF RELATED WORK BEING UNDERTAKEN IN THIS AREA IN SIMILAR JURISDICTIONS.

DSO Models to be Investigated

In response to the challenges articulated, the OEN paper presents three proposed operating models for the DSO system. These models are essentially variations of the notional DSO architecture demonstrated in Figure 3, where information from AEMO and the DNSPs is used to achieve coordination through a yet to be determined approach to the optimisation and control of aggregated DER assets.

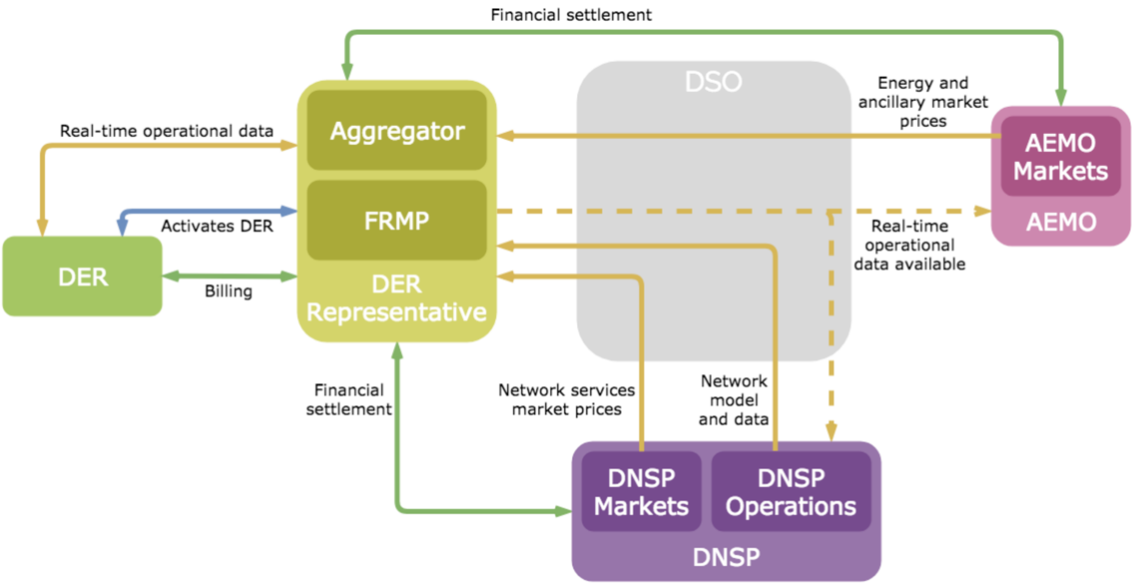

Figure 3 – The notional DSO model presented in the OEN Paper. To understand the most appropriate DSO model, more work is needed to identify the state and function of existing interfaces in the system and between existing markets and operators.

Given the very early stage of this work – with substantial work still required to properly articulate the problem, and better understand and characterise the circumstances when coordination will be necessary – we believe it is premature to identify or select DSO models at this stage. Not appropriately considering all of the possible DSO models would be a lost opportunity given the importance of this Work.

The three models in the OEN Paper appropriately articulate that there are three proponents who could operate the platform: AEMO, Individual DNSPs, or an alternate 3rd party who is yet to be identified. We believe it is premature to identify the party who will operate the DSO system and recommend that questions of the operator be addressed alongside questions of ownership and governance.

However, in articulating the models, the OEN Paper does highlight the key elements that a DSO system will need to resolve. These include:

1. The definition of the interfaces that will exist between the relevant stakeholders in Figure 3. and the systems and capabilities they already run and control.
2. The data that will be provided to different stakeholders and systems through these interfaces.
3. The optimisation and dispatch mechanisms and techniques that will be used to calculate the dispatch signals for DER.
4. The identification of a DSO operator.

We recommend that the focus should be on addressing these four preceding points prior to the final articulation of all the possible DSO models. Furthermore, we believe that more candidate DSO models will become apparent as these four points, and other no-regrets actions are pursued.

Furthermore, it will be important to address the preceding points to ensure that we implement appropriate DSO systems and functionality. For example, through this analysis we may determine that it is not necessary to have a one size fits all approach to DSO design and implementation and that as a consequence we may identify different capabilities are needed in different network geographies. In addition, we may find that certain DSO functionality is only required for a limited period each year. In this context, it would be appropriate to ensure that such capabilities are only used when needed.

Fundamentally, we should provide ourselves maximum flexibility in proceeding with this Work to ensure we do not eliminate viable approaches pre-emptively through prematurely supporting or eliminating possible DSO operating models.

RECOMMENDATION #11: BETTER DEFINE AND DOCUMENT THE EXISTING INTERFACES MAINTAINED BY AEMO, DNSP, AND DER AGGREGATORS. THIS INCLUDES DOCUMENTING THE DATA FLOWS THAT OCCUR OVER EACH INTERFACE.

RECOMMENDATION #12: CREATE A FUTURE OPPORTUNITY FOR THE DISCUSSION, INVESTIGATION AND ANALYSIS OF ALTERNATE DSO OPERATING MODELS AFTER BETTER CHARACTERISING THE CIRCUMSTANCES WHEN COORDINATION WILL BE NECESSARY.

Consultation Questions

Pathways for DER to provide value

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

The value streams outlined in the OEN Paper are presented from a high-level perspective. However, it is beneficial to articulate in greater detail the individual energy, capacity, and ancillary services that DER can or could provide to both the National Electricity Market (NEM) and to the networks. This gives much greater clarity to the breadth of services that DER provides and should quantify the value and current or potential market volume of those individual services. The development of the coordination scenarios recommended earlier in this submission would also be strengthened by providing a granular breakdown of these services.

2. Are stakeholders willing to share work they have undertaken, and may not yet be in the public domain, which would help to quantify and prioritise these value streams now and into the future?

To support the development of the coordination scenarios recommended earlier in this submission we encourage industry stakeholders to share details about the breadth, value and market volume of services that DER could provide to the NEM and to individual networks.

Maximising passive DER potential

1. Are there additional key challenges presented by passive DER beyond those identified here?

We believe the OEN Paper outlines the key challenges passive DER presents. However, we encourage a deeper analysis of co-located passive and active DER systems (i.e. residential solar and residential storage, or residential storage and community storage) to better articulate the range of challenges that integrating and coordinating these assets may encounter.

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

There is substantial need to develop a better understanding of passive DER and its interaction with distribution network assets and broader questions of system security for both nominal and contingency events. As recommended in this submission, we encourage initiatives that support:

- The development and broad availability of accurate network models, particularly for the low voltage (LV) and medium voltage (MV) segments of distribution networks nationally.
- The development and testing of accurate short-, medium- and long-term forecasting techniques and platforms for individual and aggregate behaviour of DER assets.
- The testing and characterisation of DER assets under both nominal and contingency events to better support both DER forecasting and future standards development.

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

As noted in this submission, there are opportunities to convert passive DER to either semi-active DER (through colocation with active DER), or to active DER by retrofitting smart local control systems. We believe a more detailed investigation exploring the feasibility of this approach would greatly enhance the possibilities for future coordination of currently passive DER assets.

Maximising active DER potential

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

We believe the OEN Paper outlines the key challenges active DER presents. Through this submission, we attempted to clarify these challenges. We also provided recommendations to better articulate the challenges as coordination scenarios.

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

Active DER promises to provide flexible resources for supporting energy reliability and security as the grid evolves to have a greater proportion of renewables as well as an increasing amount of distributed and decentralised assets.

Fundamentally, we believe that the value available from these active DER assets will be achievable only by successfully addressing the key question and objective of this Work. By necessity, this will require the development and implementation of systems, mechanisms, and regulations that must provide benefits for stakeholders when assessed against the key principles outlined in this submission.

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

Central to the potential of active DER (and all DER) is to ensure that individual and aggregate DER assets are treated on an equal footing with existing generation assets that provide energy, ancillary and network services. This will ensure that we identify these DER assets as central to how we maintain energy reliability and security going forward.

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

As the OEN Paper outlines, we are seeing the recent emergence of markets and market platforms for incentivising DER participation and aggregation. This will continue to occur as the industry develops a better understanding of the individual energy, capacity, and ancillary services that DER can or could provide to both the National Electricity Market (NEM) and to the networks. It is important to support these ongoing developments as part of the solution to achieving the broader objectives of this Work.

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

By definition, such coordination is necessary when the system runs the risk of breaching operational or physical limits of the grid infrastructure through DER integration, operation or participation in energy, ancillary and network services markets. To better determine when this may occur we encourage the development and publication of coordination scenarios as outlined previously, as well as support for initiatives that provide clarity through more detailed modelling, analysis and simulation studies.

Frameworks for DER optimisation within distribution network limits

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

We believe that to fully address this question it is necessary to first articulate the existence and functionality of the currently available interfaces provided by DER assets, VPP and DER Aggregators, AEMO and the networks. We included a recommendation to that effect earlier in this submission.

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

As outlined in this submission, we feel that it is premature to identify and select a high-level DSO model. We strongly recommend that further no-regrets activities must be undertaken prior to identifying possible models and ultimately making a selection.

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

As above, it is premature to identify and select a high-level DSO model at this stage of this Work. We strongly recommend a review of other existing and proposed DSO models after undertaking activities that provide a better definition of the required functionality of a DSO system.

Immediate actions to improve DER coordination

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

We provided a series of recommendation in this submission that we are confident will underpin a complementary set of activities that will improve the outcomes of this Work.

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

We believe there are several important immediate actions that can be undertaken and have suggested these as recommendations throughout this submission. Our recommendations will provide clarity to stakeholders through the provision of additional information that will underpin ongoing activities around this Work.

Conclusion

We believe that this Work creates an important opportunity to understand how to best integrate and coordinate DER into the electricity system that supports the reliable and secure operation of the electricity system. While we believe it is premature to select a high-level DSO model at this stage, we support the many important no-regrets actions proposed by the OEN Paper, and in this submission, as the most appropriate next steps to continue this Work.

Given that this is a complex body of work we also encourage ENA and AEMO to adopt a timeline that allows due consideration of all the necessary challenges and opportunities. Success in this Work has the potential to deliver numerous benefits to the electricity system and the broader community, positioning Australia as a world-leader in the adoption, integration and participation of DER assets.

Through this submission and the recommendations contained herein, we hope to contribute to the evolution of this current Work as it underpins the transition of the electricity system away from the current centralised design, towards a distributed and decentralised design. Once again, we thank ENA and AEMO for the opportunity to respond to this consultation and endorse this submission for consideration.

Appendix – Summary of Recommendations

Recommendation #1: Develop and publish the atomic, orthogonal scenarios under which DER coordination will be necessary to prevent breaching operational and physical limits as DER respond to financial incentives and operational requirements published by AEMO and the DNSPs.

Recommendation #2: Develop an agreed question that clearly articulates the objectives of this work.

Recommendation #3: Develop a typology of different DER assets and their behavioural supply and demand attributes in terms of their power and energy delivery over various timescales.

Recommendation #4: Develop and publish an agreed set of principles or assessment criteria by which success in this work will be measured.

Recommendation #5: Undertake a review of existing work in this space both domestically and internationally.

Recommendation #6: Undertake a review of current and emerging projects in this space to identify relevant systems and technology components, particularly those that support the capability requirements of Table 1 in the OEN Paper.

Recommendation #7: Increase the emphasis and support for DER and distribution network (LV and MV) modelling, forecasting and hardware in the loop testing. This should include modelling of DER and distribution network behaviour across nominal and contingency scenarios.

Recommendation #8: Undertake a review of the opportunities and mechanisms to convert passive DER to either semi-active or active DER.

Recommendation #9: Increase the emphasis and support for R&D advances in distributed systems theory, distributed optimisation and control, and power systems modelling and analysis as it applies to the integration of DER in distribution networks.

Recommendation #10: Include a work package in this Work to investigate representation arrangements for DER assets. This should include a review of related work being undertaken in this area in similar jurisdictions.

Recommendation #11: Better define and document the existing interfaces maintained by AEMO, DNSP, and DER aggregators. This includes documenting the data flows that occur over each interface.

Recommendation #12: Create a future opportunity for the discussion, investigation and analysis of alternate DSO operating models after better characterising the circumstances when coordination will be necessary.

About the Author

Dr Lachlan Blackhall is Entrepreneurial Fellow and Head, Battery Storage and Grid Integration Program at The Australian National University in Canberra, Australia. Dr Blackhall holds a BE, BSc and a PhD in engineering and applied mathematics, is a Senior Member of the Institute of Electrical and Electronics Engineers and a fellow of the Australian Academy of Technology and Engineering (ATSE).

Dr Blackhall has pioneered the development of distributed control systems to monitor, optimise and control grid-connected energy storage, as well as the development of virtual power plant technology to aggregate distributed energy storage to deliver services and capabilities to energy networks, markets and utilities.

Dr Blackhall has a history of contributing to the broader national dialogue around energy security, and was recently a member of the Expert Reference Group for The Australian Council of Learned Academies (ACOLA) research project on the Opportunities and Challenges of Energy Storage for Australia[21]. As a member of the ATSE Energy Forum, Dr Blackhall has contributed to several submissions by ATSE to recent energy enquires. Dr Blackhall is a frequent contributor to conferences nationally and internationally and was an invited presenter and panellist at the 2017 World Economic Forum Annual Meeting of the New Champions in Dalian, China.

[21] http://acola.org.au/index.php/projects/esp