Open Energy Networks Consultation

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Submission on Open Networks Consultation Paper

We welcome the opportunity to make a submission one the ENA and AEMO's consultation paper on Open Energy Networks. Monash Energy Materials and Systems Institute (MEMSI). MEMSI is Monash University's point of contact for energy related research. MEMSI is a cutting-edge, interdisciplinary research environment that brings together over 80 leading academics across 6 faculties working in the area of energy. Its mandate is to work in collaboration between academic, industry and government partners to address the grand energy challenges of today and tomorrow.

Our newly established Grid Innovation Hub (https://www.monash.edu/memsi/grid-innovation-hub) is a resource available to the entire energy industry to tackled a large range of challenges relevant to the Open Energy Networks program.

The Key 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 and WEM?"

Summary

The Open Networks Consultation Paper provides a comprehensive summary of the issues around open up networks to support and manage distributed energy resources (DER). The three options for market structure are well formulated based on who manages the distribution/DER resources: The Australian Energy Market Operator (AEMO), Distribution Network Service providers (DNSP) or a Distribution System Operator (DSO). The concept of pursuing actions that are unlikely to cause regret is laudable.

Furthermore, it is considered that:

- Automation of DER response to voltage and frequency disturbances could provide a form of distributed control that provides a background of system stability support provided it can be designed to coordinate well at the local level and not create inter-regional oscillations when combined with controls on large scale generators. In principle all devices connected to the power system that can vary their active or reactive power contribution could contribute to system control under adverse or normal conditions if provided with the appropriate controls.
- Upskilling of DNSPs to manage DER may require national training resources and support of Universities to provide the staff that will be required to design, develop and maintain the new facilities distributed throughout the power network.
- Distribution management with DER could have a side-benefit of providing infrastructure for more dynamic management of distribution network configuration to balance load and DER on the transmission system where substations can be switched between transmission connection points in major cities.
- The distribution/DER planning process which seeks to optimise distribution network development with DER control and deployment may need the Distribution Planning Agent (DPA) to manage the conflict of interest between aggregators, DNSPs and TNSPs where there may not be sufficient competition and if regulatory tests are not applied. In the early phases, public scrutiny of developments may be needed to avoid customers being scammed and costs imposed through distribution charges. It is likely that there may not be sufficient competition and customer engagement for some time to ensure efficient developments.
- There is a need for education of stakeholders and appliance manufacturers to make appliances that are DER control ready.

Specific Questions

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

Yes;

A base line for quality of supply could be provided by requiring all active DER with inverters to support network voltage control by varying reactive power automatically on a local or remote voltage control signal basis.

This could be a subcategory of bilateral agreements: automatic control services as part of connection procedures and agreements. Currently DER can be controlled off automatically due to over-voltage without the customer even being immediately aware of the resulting poor performance.

A small value stream for customers could be obtained by providing tighter voltage control which supports the low voltage and medium voltage networks. Refer (Question 5) below.

2.2. 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?

Monash University has not specifically attempted to quantify or prioritise these value streams. However, a recent PhD research project has demonstrated an algorithm for the real time orchestration of tens of thousands of household appliances in a distribution network is feasible. The algorithm minimises the total cost of network utilisation and energy supply as well as minimising the cost for the individual consumer. This method can be adapted to help quantify some of the value streams from orchestrated DER's.

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

No. Ultimately excessive quantities of DER can only be managed by limitations on penetration through regulating connections and augmentation of capacity or by adding distributed storage to the distribution system. As noted in the report this would be inefficient especially due to the potential contribution to decarbonisation from the renewable energy resources. Even limiting DER to self-consumption would be problematic in some areas where sustained periods of zero load would create excessive voltage in the network without supplementary voltage control devices.

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

Yes. The categories listed cover the range of capabilities needed.

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

Activate automatic local voltage control and possibly some response to frequency variations as part of a strategy for distributed system control.

Stabilising local voltage and providing response to deviations and rate of change of system frequency on a distributed basis would make the network more stable without requiring complex orchestration much as synchronous generator excitation and governor control have provided distributed control at a more aggregated level. This could be part of a no regrets strategy. Algorithms for design of distributed control are needed to set standard parameters to avoid conflicting operation between sets of distributed resources.

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

Yes, especially the large-scale uncoordinated response of power flow to price changes which are not incorporated into market clearing and the appropriate graduation of response to contingencies.

Integration of regulated network services with deregulated DER poses the threat to networks remaining regulated services in the future. This would potentially change the risk profile for a regulated network business and made result in corporate incentives to frustrate efficient development of DER. It places a DNSP in a potential conflict of interest between maintaining the risk profile of the distribution business versus promoting DER that could devalue the network assets and bring forward deregulated distribution services with potentially stranded network capacity.

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

Appliance control would need attention to ensure that domestic and commercial appliances are ready for DER activation. Also, customer and manufacturer education would be important for realising this value. Perhaps appliance ratings for energy efficiency need to be supplemented with a status for "DER control ready".

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

Stakeholder education will be needed to prepare the industry for these prospective changes. New appliance standards and ratings with be needed for "DER control ready" appliances.

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

- Working out the regulatory arrangements so that customers end up better off and not scammed by false claims of benefits by new businesses entering the market.
- How to promote and fund the evaluation of the alternative market models and establishing pilot programs to test them in reality.
- Identifying network locations where DER can provide immediate benefits to defer network investment or enhance supply quality so that the pilot program costs can be offset by those early benefits.

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

Coordination will be required when the distribution system performance is such as to curtail the connection of efficient DER or to create material inefficiency in the forecasting and dispatch in wholesale markets. As long as passive DER does not cause network overloads, excessive voltage variation or destabilise frequency control, the current regime could continue to serve customers satisfactorily and efficiently. However, due to the complexity of the task of deploying DER controls and orchestration, we should not wait until control problems become apparent and costly to consumers. The time to work on the regulation, control strategies and institutional arrangements has already passed, especially considering the projected growth path for solar power in the power system.

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

No comment.

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

Yes. It is expected that the coordination of tens of millions of devices across the National Electricity Market with require aggregation of control systems, decomposition of the optimisation tasks and local oversight to be efficient and result in secure electricity supply. The key to efficient coordination at the wholesale level will be to efficiently price the options available for power flow at the bulk supply points having regard to the down-stream constraints and resources. Control and transaction strategies to achieve this capability ought to be tested to inform the design of institutional arrangements to ensure that conflicts of interest within corporate entities can be avoided as much as feasible. The ultimate solution may need to anticipate the eventual deregulation of distribution services when DER has reached high levels of participation.

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

Other considerations are:

- Will the change disrupt existing activities by drawing away scarce technical resources?
- Can Australian businesses provide the required communication and control systems or will we need to facilitate international companies to bring their resources to meet the challenge of rapid expansion of these services?
- What education processes can be developed early to prepare the industry participants for the change to help manage costs?

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

Yes, these are the key issues.

There is an operational challenge around the ability of a decomposed market design that implements the following integrated process:

- DER automatic control and orchestration implemented as a sub-market with a local real-time price,
- Transformation of outcome to collectively bid virtual power plant (VPP) transactions in the wholesale energy market, that include:
    - Consideration of distribution level constraints,
    - Local DER dispatch co-optimised with constraints and wholesale market real-time prices

This is a large-scale optimisation problem that will have a large number (10,000's to 100,000's +) of DER resources in each zone substation and tens of millions of devices across the NEM. This is a large combinatorial optimisation problem. The methods used to dispatch the NEM are not going to scale to this complexity and simply dis-aggregating the dispatch at different level in the way proposed may not actually deliver a market equilibrium. It may also create local market power that impedes efficient pricing to consumers for DER services.

Monash University has done some theoretical work on this and have some useful insights to share. At a high level it is important to analyse the entire optimisation chain before settling on any particular method of decomposition of the market into arbitrarily defined DSO's and/or VPP's.

This relates to the statement relating to the disadvantages of the centralising the DSO function without AEMO:

"A multi-stage optimisation will likely be required, first dealing with components of the distribution system, aggregating to a single distribution network, then being aggregated to the NEMDE process at a system level." – p 30

It is our view is that these kinds of considerations are common to all three models proposed. They are universal as they are related to the interfacing between the different hierarchies described in the discussion paper. These include data aggregation and management, systems interfacing and API design, and communication protocols.

Whether the DSO function sits within AEMO, within a DNSP or separately, the diversity of the systems that are going to exist requires this to be considered in detail well ahead of implementation. This covers systems already in existence (SCADA, ADMS), new systems such as DER market clearing engines, and constraint forecasting models yet to be developed, and the wholesale market dispatch engines and their supporting EMS operating within each TNSP will all need to be brought into the final co-optimising architecture.

Therefore, good software engineering and distributed optimisation algorithm design needs to be considered in all of the three cases. The choice of case then is not related to the complexity of the resulting software ecosystem but to the governance (competition between DNSP's and DSO leading to potentially perverse incentives) and operational management efficiency should dictate the choice.

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

It may be helpful to develop at a strategy for distributed voltage and frequency control for existing and new inverters with future facility to adjust control set points to orchestrate voltage control through low and medium voltage networks.

Thought should be given to promoting appliance standards that enable external scheduling and control of domestic and commercial appliances, particularly refrigeration, washing machines, clothes dryers, air-conditioners, electric heaters, heat pumps, allowing for short-term interruption (5-10 minutes) and scheduling of operation within a specified window, not just a fixed time delay as is common today. Moreover, some appliances such as electric heaters could be set to switch on to provide extra load for FCAS, dealing with excess power exports from a system constraint. This would require new appliance design, or perhaps in some cases a retrofit to the control logic of the devices.