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ARENA

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Technical Standards on DER Rule Change
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ARENA submission to the Technical Standards on DER Rule Change

This submission provides information from ARENA projects and our broader insights as relevant to the current rule change process.

In summary -

- **Supporting innovation** - Standards for Distributed Energy Resources (DER) should not become a barrier to innovation and efficient levels of DER participation in energy and essential services markets. Consumer interests will be best served if security outcomes are achieved at the lowest cost and in a way that is able to take advantage of emerging technologies and grid management practices as they evolve over time.
- **Definition of Distributed Energy Resources (DER)** - A broad definition of DER should be adopted to include the full range of technologies (inverters, Electric Vehicles (EVs), demand response enabled devices etc.) however it is important that AEMO's ability to make standards are explicitly limited to a specific set of functional areas relevant to power system security. There may also be a benefit in a materiality test being set in the Rules such that the DER Standard is only applied to devices that have a real bearing on power system security due to their individual size and/or the risk of coincident behaviour.
- **Governance** - A new DER standard could have a material impact on industry and consumer costs in the short to long-term. As such, it is appropriate that the standard-setting process is subject to appropriate controls, consultation and cost-benefit analysis. ARENA agrees with the view that interim governance arrangements should be put in place while the ESB finalises its Review of the Governance of DER Technical Standards.
- **Voltage ride-through** - ARENA recognises the need for consistency in the obligations on small-scale and large scale generating systems to withstand short-term voltage

disturbances. Any requirement of electric vehicles (EVs) providing vehicle-to-grid services need to be internationally consistent where possible to ensure that it does not disrupt EV market development.

- **Considering alternatives to standard-based approaches to Under Frequency Load Shedding (UFLS)** - The power for AEMO to make new standards for DER can be considered in light of the underlying power system security concerns that it is seeking to address. In the case of UFLS a variety of non-standards-based approaches are emerging. It is important that standards-based approaches are not adopted because they are convenient but at the expense of more favourable options for the long term. It is appropriate to consider any potential reforms to UFLS through a broader review of its effectiveness and alongside the consideration of incentives for primary frequency response.

About ARENA

The Australian Renewable Energy Agency (ARENA) was established in 2012 by the Australian Government. ARENA's functions and objectives are set out in the *Australian Renewable Energy Agency Act 2011.*

ARENA provides financial assistance to support innovation and the commercialisation of renewable energy and enabling technologies by helping to overcome technical and commercial barriers. A key part of ARENA's role is to collect, store and disseminate knowledge gained from the projects and activities it supports for use by the wider industry and Australia’s energy market institutions.

Response to the rule change proposal

The DER Technical Standards Rule Change Request request submitted by the Australian Energy Market Operator (AEMO) would allow it to create an initial set of technical standards that will apply to new DER across the NEM and update these standards over time. In AEMO's view, if it does not get these powers, then growth in DER would necessarily be restrained, daily generation would be inefficiently curtailed, and the risks of larger shut-downs would be raised.

It is appropriate that AEMO has the tools to ensure the system can operate in a secure state as DER penetrations grow. It is also important that adequate controls are put in place to ensure that AEMO does not overly prejudice DER in favour of large-scale resource or historical grid management approaches. As a guiding principle, security outcomes should be achieved at the lowest cost to consumers and in a way that is able to take advantage of emerging technologies and grid management practices as they evolve over time.

Fostering dynamic efficiency and innovation

Attachment A provides a summary of relevant ARENA-funded projects for your reference including how they relate to the current rule change process. These illustrate the state of innovation that has developed under current incentives structures and initiatives that may be most directly impacted by, or complementary to, the proposed DER standard.

Projects such as CONSORT and various VPP demonstrations illustrate the ability of individual DER to respond precisely and reliably to price signals or locally measured power system variables (e.g. frequency, volts) in near real-time. They have emerged in response to current incentives provided in the framework for parties to contribute to power system security or in anticipation of new incentives. In some cases these projects also demonstrate alternative approaches to managing issues such as those related to UFLS that AEMO have put forward as a central justification for the Rule Change (this is discussed further below).

Overall, ARENA's experience indicates that market-based approaches can unlock significant technology innovation while providing strong incentives for business and consumer investment. It is therefore important that the need to enhance the underlying incentives, for market participants to contribute to power system security, is not lost in the consideration of technical standards. This is an issue that can be further considered through the ESB's post 2025 market design initiative and the AEMC's incentives for primary frequency control rule change process[1] and system strength frameworks review[2].

The definition of DER and standards governance

The contents of the DER Standard, and its governance, will have significant implications for DER innovation and investment over the next decade. ARENA's experience indicates that while DER will be a strong contributor to future grid operation, many of the required commercial and technology models are still emergent and the direction of their development is somewhat open-ended. Pressing too hard on standardisation at this relatively early stage of the industry's development could be detrimental to innovation in the long run. In some cases, the issues raised by AEMO may be more appropriately addressed through incentives that foster innovation and service delivery at the lowest cost. Governance of the standards process is therefore critical to ensure standards are used only when they are the best option available. ARENA agrees with the proposal that interim governance arrangements should be put in place while the ESB finalises its *Review of governance of DER technical standards*[3]*.*

We note that the AEMC has suggested the working definition of DER from ARENA's State of DER Technical Integration study[4] could be adopted in the Rules:

> *Distributed Energy Resources (DER) are non-registered resources connected to the distribution system that generate electricity or manage electricity demand.*

It is important to clarify that 'non-registered' in the context of the above definition means 'not market-registered' rather than referring to the AEMO DER Register. That said, some alignment between the scope of the DER Standard and the scope of the DER Register would reduce the potential for confusion in industry.

It is appropriate that a broad definition of DER be adopted to include the full range of technologies (solar inverters, EVs, Demand Response Enabled Devices etc.) however it is important that AEMO's power to make standards is limited to the specific set of functional areas relevant to power system security. This will reduce any perception that AEMO may encroach on

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[1] https://www.aemc.gov.au/rule-changes/primary-frequency-response-incentive-arrangements
[2] https://www.aemc.gov.au/market-reviews-advice/investigation-system-strength-frameworks-nem
[3] http://coagenergycouncil.gov.au/governance-der-technical-standards
[4] https://arena.gov.au/knowledge-innovation/state-of-der-technical-integration/

other areas (e.g. electrical safety standards) that are outside its remit. It may also be beneficial to include a materiality test in the National Electricity Rules so the DER Standard is only applied to devices and equipment that have a real bearing on power system security due to their scale and the risk of coincident behaviour.[5]

Given the substantial impact that any new standard could have on industry and consumers, it is appropriate that it be subject to a cost-benefit analysis which would include non standards-based options to address the underlying issues (e.g. UFLS, described below).

In considering governance options, it is appropriate that the DER Standard be subject to approval (e.g. by the AER or the Reliability Panel) who may be well placed to balance all relevant factors such as the broader interests of energy consumers in terms of costs and promoting innovation in technology and service delivery. To ensure that the standard setting process is not unduly delayed, the approver could be provided with a limited time period to disallow a standard only if it considers either that the standard is not consistent with the National Electricity Objective or that AEMO has not adhered to the prescribed consultation/cost-benefit analysis process.

Inverter standards and EVs

DER inverters are not currently subject to similar bulk system disturbance and voltage ride-through requirements as utility-scale generation. We understand that the next version of Australia's inverter standard (AS4777.2) will meet AEMO desired requirements for small-scale inverters but that it is seeking to bring forward their implementation from 2022. ARENA-funded projects have developed inverter and power quality data sets and undertaken analysis to assess the performance of inverters in laboratory and in-field conditions.[6] This work has fed into the recent ESB commissioned study into the state of voltage across the NEM and the possible extent of losses to prosumers from inverter over-voltage tripping.[7] This work illustrates both the importance of verifying technology performance in the field as well the role of installers who are often responsible for commissioning systems to be compliant.

In the case of EVs and charging infrastructure (acting as a generator or a load) it is important that voltage ride-through requirements are internationally consistent so as not to provide a barrier to Australian consumers accessing overseas EV makes and models. Given the relatively small size of the Australian vehicle market, there is a risk that any inconsistent local requirements could deter EV manufacturers from making vehicles available in the local market to the detriment of consumers. The Distributed Energy Integration Program (DEIP) EV Working Group provides an appropriate forum for AEMO to engage with industry on this issue.

Enhancing the integrity of Under Frequency Load Shedding (UFLS)

One of AEMO's objectives with this rule change request is to enhance the integrity of protection schemes like UFLS. While it provides a critical system security function, UFLS has a number of inherent inefficiencies that could be exacerbated by the rule change proposal.

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[5] For example, plug in timers for smaller devices may be deemed immaterial whereas demand -responsive water heaters may be material.
[6] https://arena.gov.au/projects/addressing-barriers-efficient-renewable-integration/
[7] https://prod-energycouncil.energy.slicedtech.com.au/[...]Voltage%20Report.pdf

Traditional UFLS schemes operate to automatically disconnect load (typically at the substation/feeder level) in the event of a major under-frequency event (e.g. loss of a major generation or transmission asset). It does not generally discriminate between the economic or social value of loads (other than protecting critical infrastructure) that may be disconnected or factor in the relative efficacy of the load-shedding action in real time. Substations are broadly shed on a rotating basis. As DER (especially rooftop PV) grows, it becomes increasingly likely that areas of the grid will be at low or negative load meaning that UFLS could have a low or negative benefit for system frequency.

To address this, AEMO is seeking the ability to manage active power flows directly by reducing load or increasing generation (assumedly flexible resources such as batteries and EVs). In approaching this problem the rules should limit the extent these controls can be used to curtail generation. In many instances, such as strengthening the UFLS scheme, this could be an inefficient response that could have significantly detrimental impacts for energy prices and the consumer uptake of renewables.

There is a lot of innovation occurring in the area in underfrequency contingency management and it is appropriate to consider any reforms to UFLS through a broader review of its effectiveness in the transition to renewables in tandem with a consideration of incentives for primary frequency response[8]. Such a review could identify holistic approaches that align with solutions developed to complementary challenges.

Various international studies have considered how effective frequency and voltage management can be achieved in the transition to higher penetrations of DER and renewables.[9] In particular, future UFLS schemes will need to be highly adaptive and adjust their response dynamically in light of real-time power system conditions.[10] Advancements in Wide Area Monitoring, drawing on high deployments of phasor measurement units (PMUs), can assist the transition to more intelligent and adaptive UFLS schemes, as well as contributing frequency and voltage stability more broadly[11]. International studies indicate a change in active power can occur in response to a central signal or local sensing of frequency or Rate of Change of Frequency (RoCoF). Computational approaches, including the use of machine learning, combined with enhanced sensing, have been found to strengthen UFLS schemes by supporting optimal and accurate load curtailment.[12]

Aggregated demand response is now proven to be an effective (but potentially underutilised) way of managing under frequency events. A good example is Enel X's response when Loy Yang A power station unexpectedly tripped offline on 23 April 2019. Enel X's resource in aggregate removed 27 MW of demand from the grid within 280 milliseconds.[13] A key benefit of an incentives-based demand response regime is that it can achieve load reduction in the most economical way, precisely targeting load with the lowest cost of unserved energy.

Fast-acting resources like demand response and batteries make the distinction between UFLS and contingency frequency response appear increasingly arbitrary. Next generation UFLS

[8] https://www.aemc.gov.au/rule-changes/primary-frequency-response-incentive-arrangements
[9] https://ieeexplore.ieee.org/abstract/document/7112528
[10] https://www.sciencedirect.com/science/article/abs/pii/S0142061517323967
[11] https://www.mdpi.com/1996-1073/13/1/190/htm
[12] https://www.sciencedirect.com/science/article/abs/pii/S0378779619303736
[13] https://energysmart.enelxnorthamerica.com/[...]-australias-ancillary-services-markets

schemes could bridge UFLS with fast frequency response that inverter based technologies and demand response are well placed to deliver (e.g. batteries can change power output typically within 50ms of a locally measured frequency deviation). ARENA's experience indicates that future UFLS schemes could better utilise fast frequency response, with voluntary participation of DER, that is co-optimised with the delivery of energy and other essential system services and local network constraints. This could reduce the inefficient curtailment of distributed solar and load shedding while contributing to the value stack for flexible resources such as demand response, controllable solar, batteries and EVs.

This is a complex area where further work is required to determine the best medium to long-term approach. Building on our existing project investments to date, ARENA would welcome proposals for studies and trials that could demonstrate how advanced approaches to managing under frequency events, and related challenges, can best support the integration of renewables into the grid.

Please contact Jon Sibley, Principal Policy Advisor (jon.sibley@arena.gov.au) if you would like to discuss any aspect of ARENA's submission.

Yours sincerely

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Attachment A - Project examples

These projects illustrate the range of innovative strategies that have emerged to manage DER integration including the potential for DER to be operated to achieve critical security/reliability outcomes. Also relevant is where network states are dynamically estimated or assessed as could inform the development of UFLS strategies.

Project	Summary
CONSORT Bruny Island Battery Trial	The primary task of the Network Aware Coordination (NAC) is to automatically coordinate household energy systems in a non intrusive way, enabling them to adhere to and alleviate network constraints. NAC consists of algorithms, techniques, and software for automatically coordinating DER in a way that both respects network constraints, and minimises the total cost to the network provider and the DER owners. In effect, it achieves optimal power flow for the distribution system. The NAC preserves participants' privacy and agency, and implements a distributed algorithm that enables it to scale to larger problems. The Bruny Island trial effectively demonstrated this approach to manage high renewable penetration and other constraints at a much lower cost than is conventionally possible. The NAC technology has been designed to not just solve the Bruny Island problem, but to also expand to a larger range of network conditions, to different types of DER including electric vehicles, and to enable load flexibility to the wider wholesale markets. See the NAC report and Reward Structures report for more information.
University of Tasmania Optimal DER Scheduling for Frequency Stability project	This active project builds on the findings from the CONSORT Bruny Island Battery trial to demonstrate the frequency response capabilities of a range of inverter-interfaced DER and flexible loads, and the extent to which they can assist with frequency stability in power systems with decreasing conventional generation. The project will also develop optimisation software that enables fleets of DER in distribution networks to be operated so that this frequency response can be enabled while simultaneously respecting the physical constraints and limitations of distribution networks. Finally, the project will establish methods for and thus provide insights into how fleets of aggregated DER might actively participate in energy and FCAS markets in Australia so as to allow their frequency response capabilities to be harnessed in future. During the first year of the project, the team developed detailed models of inverter power electronics control for a number of DER types and inverter-based resistive loads. The models demonstrated the capability to provide fast responses with less frequency deviation and smaller settling time, particularly in power systems with decreasing levels of physical inertia. The project team is also developing network constrained bidding optimisation strategies to support and coordinate the participation of aggregators of DER in the electricity (wholesale energy and frequency reserve) markets.
Zepben *evolve* DER project	This active project is developing mechanisms to orchestrate the operation of DER assets by continuously providing 'operating envelopes' to the DER assets via integration with aggregator systems. The project includes integrating Zepben's existing Energy Workbench platform with DNSP partner systems to obtain MV and

	LV network models and measurement data that will be used as inputs into the algorithms to calculate the operating envelopes. The operating envelopes will ensure that the secure technical limits of electricity distribution networks are not breached, and will allow for greater integration of DER assets into the grid. A common information model (CIM) standard-based data platform (designed to marshal network asset models and data) has been developed and made available via open source: https://bitbucket.org/account/user/zepben/projects/OS https://zepben.bitbucket.io/docs/cim/zepben/ Zepben's principle project partner, the ANU, is building the aggregator-facing API that will be used to register DER assets with the evolve platform, as well as designing the operating envelope engine. The first end-to-end testing is scheduled for July 2020.
Solar Enablement Initiative	Queensland University of Technology led a consortium of technology specialists and DNSPs to build tools to forecast solar exports using limited and dispersed data sets. The project focused on increasing the visibility of distribution networks to enable DNSPs to approve more customer photovoltaic connections. It developed the state estimation algorithm (SEA) to identify network operational conditions. SEA was trialled on seven medium voltage (MV) distribution feeders in South-east QLD, VIC and TAS using MV level data. The project helped DNSPs operate their networks more effectively to maintain safe loading of their distribution networks and facilitate more efficient network investment planning decisions. This type of state estimation technology can be used to support the development of more adaptable UFLS schemes that are consistent with the uptake of DER.
AEMO VPP trial	The AGL VPP is a centrally-managed network of behind-the-meter battery systems that can be controlled to deliver multiple benefits. The battery is charged and discharged to maximise the benefits to the consumer, while ensuring that the network and retailer can also realise value from the battery during specific network or wholesale events. The ability of the VPP to realise multiple benefit streams can ultimately reduce the costs of the system to the end customer, while reducing the energy charges of all grid uses by making the most efficient use of the battery as a DER. AEMO's first lessons learnt report illustrates how the AGL VPP provided fast FCAS response during three frequency events last summer. Other registered FCAS aggregators are demonstrating the ability of DER to respond to locally detected frequency events while optimising benefits for end-customers.
Realising Electric Vehicle-to-grid Services (REVS)	The REVS project will install 51 bi-directional chargers and deploy a fleet of 51 V2G capable vehicles in the ACT. A system will monitor charger and vehicle availability, as well as a range of electrical parameters, which will enable the delivery of market contingency Frequency Control Ancillary Services (FCAS) at a fleet scale. This project focuses on demonstrating frequency support services from EVs including 6-second raise/lower services. EVs could be well suited to providing contingency response considering they are based on capacity payment rather than requiring continuous battery cycling. The project demonstrates that EVs could be a contributor to frequency stability including in major under frequency events. This

	could, in principle, be extended to UFLS if appropriate incentives were created.
Solcast - Gridded Renewables Nowcasting Demonstration over South Australia	Solcast aims to enhance existing weather forecast services by demonstrating a forecasting tool which will track and predict renewable output in real time. Solcast's forecasting tool will aim to predict up to six hours ahead in five-minute increments, distributed into 1-2km grids across SA. With regard to the DER standard proposal, this project is developing the ability to predict the net solar generation at the substation level thereby informing dynamic power system management strategies, without the need for device-level real-time telemetry. Solcast's progress to determine the spatial distribution of installed distributed >30MW solar PV capacity across South Australia will be published by the end of July). This forecasting approach can utilise static data collected through the DER Registry.
Reliability and Reserve Trader (demand response) Trial	In 2017, ARENA and AEMO entered into a Memorandum of Understanding to jointly develop 'proof of concept' demand response projects to enhance energy energy reserves. While not focussed on system security, the project highlights that incentives can be effective in enabling fast-acting demand response and some of the issues associated with recruiting, retaining and measuring capacity across different market segments. The role of demand response, and demand side management more broadly, will become an increasingly important resource for the power system in the transition to renewables, including in managing minimum demand, frequency and voltage issues. DER standards are likely to realise the economic potential benefits of demand response in enhancing system security unless corresponding incentives are established (E.g. incentives to address minimum demand and UFLS issues).