



Australian Government
Australian Renewable
Energy Agency

ARENA

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Suzanne Falvi
Executive General Manager, Security and Reliability
Australian Energy Market Commission
PO Box A2449
Sydney South NSW 1235

GPO Box 643
Canberra ACT 2601
Tel: +61 2 9243 7773
ABN: 35 931 927 899
www.arena.gov.au

Frequency Control Frameworks Review - Draft Report - ARENA submission

This submission provides information on the outcomes of projects funded by the Australian Renewable Energy Agency (ARENA) as relevant to matters raised in the Commission's Frequency Control Frameworks Review Directions Paper.

About ARENA

The Australian Renewable Energy Agency (ARENA) was established with the aim of improving the competitiveness of renewable energy technologies and increasing the supply of renewable energy in Australia.

ARENA provides financial assistance to support innovation and commercialisation of renewable energy and enabling technologies. This assistance is designed to accelerate the commercialisation of these 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.

Summary

ARENA is supporting a range of projects that are demonstrating different ways system security can be achieved in a high-penetration renewable energy grid.

Our experience suggests that, in summary:

- System security can be most efficiently delivered by various elements contributing in different ways. In this context, a flexible and adaptive system of market incentives is most likely to deliver the lowest cost outcome in the long term. ARENA considers that an

enhanced causer pays-based framework (as identified by the Commission) has potential to support rapid response (sub second) services including from batteries and demand response.

- Contingency FCAS service capacity is likely to be abundant in the future as a result of the growth in distributed energy resources (DER). The key challenge for market operation will be to optimise DER participation in local grid support, energy and system security markets and this will require changes to current frameworks for ancillary services and small generator aggregation.
- It is technically feasible to maintain or potentially reduce short term (5-minute ahead) generation forecasting error with new and emerging technologies. This will become increasingly important as variable renewable energy (VRE) penetration levels increase.
- ARENA sees demand forecasting as an increasingly complex challenge, but one that can be overcome with the right framework of market incentives. In particular, ARENA considers that proposals for self-forecasting by Financially Responsible Market Participants (FRMPs) have merit and are worth exploring further.
- ARENA supports the Commission's recommendation that arrangements be established for Small Generation Aggregators (SGAs) to participate as Market Ancillary Service Providers (MASPs). An expedited rule change process should be considered to support trials which would allow the DER market to continue to develop and provide experience to inform future reforms in this space. This rule change process should also address limitations imposed by 1MW block bidding.
- As a result of our experience to date with the Hornsdale and forthcoming Musselroe FCAS trials, ARENA expects that it is likely that wind and solar farms will be capable of providing all eight FCAS market services in the future. A question remains as to whether it is optimal to obtain these services from VRE generators or other system resources. This is a matter that competitive markets may be best placed to resolve.

Primary regulating response

ARENA notes the analysis presented in the Draft Report which highlights that the recent degradation of frequency performance in the NEM to date is associated with a reduction in primary regulating response services being provided by coal and gas generators and the performance of AEMO's frequency regulating systems, rather than the increased penetration of non-synchronous generation, such as solar and wind.

ARENA considers that system security can be delivered by various elements contributing in different ways, rather than individual generators (or demand side resources) needing to contribute in the same way. In this context, relying on prescriptive minimum access standards for all new generator connections could risk locking in currently available technologies (and crowding out more preferable emerging technologies in the future) which is likely to be suboptimal from a whole of system perspective. As there is a finite need for primary regulating response services within each region, mandatory standards-based approaches also create the risk of over-supply which may have a material cost to providers, and ultimately electricity consumers.

ARENA therefore considers that a flexible and adaptive system of market incentives is most likely to deliver the lowest cost outcome. As noted by the Commission, market-based approaches could include tightening contingency markets to better incentivise primary

regulating response, or an expansion of the causer pays systems to include a continuum of positive and negative incentives.

A causer pays-based approach also opens the option of market participants being able to net positive and negative 'contributions' from different locations within a region, rather than having to manage this through the co-location of assets or financial transfers. This may provide additional flexibility in the market which may promote innovation and efficient investments and reduce costs for consumers.

Reducing generation forecasting error

ARENA notes the analysis presented in the Draft Report which indicates there has been no material decrease in short-term (5 minute ahead) forecast accuracy in the NEM, despite increasing penetration of VRE generation in recent years. We agree with the Commission that, *if unaddressed*, the increasing penetration of VRE and unscheduled demand response creates the risk of forecasting error increasing into the future. This would reduce system security and/or increase regulating FCAS costs.

The nature of renewable resource variability means that, as the share of VRE increases, so will the system-wide error in longer term VRE generation forecasts, although there will also be a strong geographical smoothing effect. In >5-minute timescales, ARENA understands that forecasting is principally a reliability, rather than a system security issue, that can be addressed by ensuring energy market signals are effective in the short term, and are driving investment in sufficient dispatchable generation, demand management and demand response capacity. ARENA's submissions to the Reliability Frameworks Review have highlighted how, in the future, demand response and dispatchable renewables can contribute to a reliable power system. We note the AEMC's observation that geographical smoothing effects need to be better understood, especially for solar and are investigating further work in this area.

As VRE penetration increases, we consider that it is technically feasible to maintain or potentially reduce short term (5-minute ahead) generation forecasting error with new and emerging technologies. ARENA has partnered with AEMO and made available up to \$10 million to support generator self-forecasting trials and their deployment into market dispatch. Trials will be conducted from the second half of 2018 with trial results available in or before 2019. Through these trials ARENA is seeking to demonstrate that the accuracy of short term generation forecasting can be maintained or enhanced as the penetration of VRE increases in the system, and to facilitate its use in existing operating processes.

Current indications are that:

- Existing approaches can substantially improve the accuracy of short-term forecasting (5 minute ahead) for individual generators. These include a range of competing technology approaches such as cloud cameras, satellite imaging, and neural network algorithms;
- Australian researchers and businesses are at the forefront of innovation in this area, especially in short-term solar forecasting;
- There is strong interest among wind and solar farm operators to self-forecast so as to reduce causer pays liabilities, however, the technologies and approaches to reducing forecast errors are not necessarily well understood by all asset owners. There is also potential to improve forecasting techniques (and therefore accuracy) over time.

Incentives to do so would likely be greater under the enhanced causer pays regime (as canvassed by the Commission and discussed above);

- There are significant potential operational benefits from more accurate generator self-forecasting and this is reflected in AEMO's investments in IT changes and new procedures to facilitate the self-forecasting trials.

Demand forecasting and demand response

The Commission's analysis highlights the potential for Distributed Energy Resources (DER) (including battery storage) to contribute to errors in demand forecasting. A less predictable demand side could contribute to higher costs for regulating FCAS services or reduced system security. ARENA sees this as a complex issue, but one that can be overcome with the right framework of market incentives.

Bloomberg New Energy Finance has forecast 2.7 million behind the meter solar-battery systems could be installed by 2030¹. Based on an average sustained peak output of 5kW, this could represent over 13GW of dispatchable capacity, many times the size of current regulation and contingency FCAS requirements. This capacity, if orchestrated effectively, could help underpin system security. If not orchestrated effectively, it could undermine both demand forecasting and frequency control systems.

Optimising DER participation in markets

As noted by the Commission in its Distribution Market Model Final Report, a key advantage of DER is its ability to provide both local network, market and system-wide services.

While AEMO will require a high degree of confidence in forecasts and frequency response service availability, DER aggregators will seek positions that allow them to access the most prospective markets, and these may change from one dispatch interval to the next, potentially causing their participation to shift between frequency, energy or local grid support.

ARENA considers that allowing such flexibility can support optimisation of DER participation across the system, reducing costs for consumers. Any market framework that utilises DER contribution to contingency frequency control will benefit from near-real-time pricing and short-term re-bidding such that DER can continuously co-optimize service delivery between alternative market opportunities. This in turn suggests that an open and competitive market will be required in each region to prevent potential market power issues arising.

ARENA is supporting a number of Virtual Power Plant (VPP) proposals that have the technical potential to provide energy market, local grid support and primary and secondary frequency control services. A number of VPP proponents are seeking to register under the Market and Ancillary Services Specification framework for Aggregated Ancillary Service Facilities but there are significant barriers to doing so.

ARENA is aware of concerns of DER aggregators that, under the current regime, retailers are generally reluctant to allow frequency control services to be provided from their customer base. This is partly because of uncertainty regarding what compliance action may flow if the aggregator were to inadvertently breach AEMO requirements. This highlights the challenges

¹ Bloomberg New Energy Finance, February 2017.

faced by new providers when bringing new approaches to market where their technical and commercial potential cannot be readily demonstrated within current regulations. ARENA considers it important that trials proceed to demonstrate the technical and commercial potential for aggregators supplying contingency FCAS services.

Clauses 2.3A.1 (SGA registration) and 2.3AA.1 of the NER (MASP registration) are effectively mutually exclusive, each limited to generation and load respectively. ARENA considers that technology innovation is making this an increasingly artificial distinction; with changes in load, or generation having principally the same (inverse) effect with regard to reliability and security outcomes. It therefore makes sense for them to be treated under a common simplified framework. This would support the goal of encouraging the most efficient participation of system resources in markets.

While SGAs are able to sell generation into the wholesale market and receive the spot price, they are not able to aggregate generating units to provide market ancillary services. ARENA considers this is a barrier in the Rules that needs to be addressed as soon as possible. At a minimum ARENA considers that an expedited (and limited) rule change should be considered to ensure trials can progress (and to support AEMO making corresponding changes to the MASS if required). This would allow the DER market to continue develop while providing valuable experience to inform broader market reforms in this space, and an appraisal of risk and benefits to inform retailers' consideration of frequency response aggregator services.

A further barrier, noted by the Commission, is the requirement for 1 MW block bidding. ARENA notes that at least one small-scale aggregator already has significantly more total capacity than this to bid, however the MASS requires that bids are assigned to each individual FRMP by region. This fragments available capacity and makes it harder for aggregators to assemble bids in whole MWs. ARENA expects lowering the bid size will facilitate greater (and earlier) participation of DER in FCAS markets although system upgrade costs for AEMO would need to be considered. We expect there may be a continuing requirement for a regional minimum capacity threshold for aggregator registration to create administrative efficiency.

Self-forecasting demand

The Commission also notes the potential for FRMPs to self-forecast their demand and be subject to an enhanced causer pays regime. As with the generator self-forecasting trials being undertaken by ARENA and AEMO, ARENA considers that FRMP self-forecasting could have significant benefits. While this would be a complex reform, it is worth exploring further.

FRMPs are closer to their customer base, and associated 'retailer-bundled' demand side services/contracts, and may therefore be better placed to predict changes in short and medium term demand. In addition to providing AEMO greater confidence in short term demand forecasts, FRMP self-forecasting could:

- Reduce the need for AEMO to require direct visibility (or centralised control) of DER which, in a high penetration DER future, could place significant costs on industry and consumers;
- Align with an enhanced causer pays-based frequency response market, creating greater symmetry of risk in frequency response markets, while reducing forecasting error;

- Increase the incentive for FRMPs to gain visibility of their small customer loads by deploying smart meters; and
- Increase incentives for FRMPs to support more effective generation/load management among their customer base, which could have benefits for frequency control, energy and local grid support markets.

ARENA is able to work with the Commission and other industry stakeholders to support proof-of-concept demonstrations that can inform future reforms in this space.

Outcomes of the ARENA-AEMO demand response trial

ARENA has identified a number of general and specific market barriers to increased demand response in its submission on the Reliability Frameworks Review Interim Report and under the COAG Energy Council's Energy Customer Data consultation.² While this is not a consideration in the current Review, these barriers have implications for how quickly and flexibly demand response capacity may emerge and be available to supply frequency control services. ARENA expects the broader issue of barriers to enhanced demand side participation will be a consideration for parallel reforms including the development of a demand response mechanism and the Register for Distributed Energy Resources rule change process.

The ARENA-AEMO RERT trial has also highlighted the diverse types of demand side resources that can come forward in a competitive environment.

An interesting example is the United Energy zone substation dynamic voltage management system trial. Under the trial, United Energy is able to reduce the voltage (within regulatory voltage limits) on selected parts of its network by around 3% on average to deliver demand reductions of at least 30 MW, although only 12 MW is currently contracted to AEMO. At present this process requires a mixture of automatic and manual processes with an overall response time of up to 10 minutes (the contracted response time). If the process were to be fully automated, with local frequency monitoring, it is expected that frequency response times could be reduced to around 2-5 minutes, a timeframe suitable to support frequency management.

ARENA notes that, in shorter timescales, Enernoc has identified that it can deliver demand response from industrial load and behind-the-meter batteries in 250 milliseconds.³

The United Energy trial highlights the technical potential for non-market participants (including Distribution Network Service Providers) to provide demand response including contingency FCAS (raise) services to benefit the broader market and consumers. The provision of these services would be expected to have marginal additional costs for United Energy in relation to set-up and greater duty on voltage regulation equipment, however trial results indicate that the solution could be implemented reliably and with no discernible adverse impacts to customers on the network (especially when voltage changes remain within regulatory limits, as is being delivered by the United Energy trial).

² Pending upload to:

<http://www.coagenergycouncil.gov.au/publications/call-submissions-facilitating-access-consumer-energy-data>. A copy can be made available on request.

³ <https://www.aemc.gov.au/sites/default/files/2018-02/EnerNOC.pdf>

Contingency FCAS from variable renewable energy sources

ARENA is supporting trials that are demonstrating the ability of wind farms to provide primary and secondary frequency response services at the Hornsdale (SA) and Musselroe (Tas) wind farms.

Hornsdale has now successfully registered and is testing participation in six of the eight FCAS markets. Hornsdale was not able to register for 6-second raise/lower services due to technical configuration requirements which could not be resolved within the timeframe of the trial. ARENA is advised that, in principle, there is no technical issue with an individual generator providing 6-second response services but the interaction between generator technical performance standards, how these are met by a particular site, FCAS provision and overall grid power quality need to be further considered. Of the 100 MW total capacity of the wind farm (HDWF2), Hornsdale is making 20 MW available for frequency response in the trial.

The Hornsdale trial has also revealed that the market conditions that would incentivise a wind farm to provide FCAS raise services are currently rare due to the need to maintain response headroom and the opportunity cost associated with lost energy market and Large-scale Generation Certificate revenue (with current prices for both being relatively high). This commercial preference is commonly reflected in Power Purchase Agreements, which have historically not considered FCAS services. ARENA understands that, largely because of these commercial issues, current market conditions would not support a windfarm such as Hornsdale providing FCAS raise services on a regular basis.

Given FCAS is a real-time market, it is conceivable that variable renewable energy generators could provide frequency control services (including raise) occasionally if the service is in high demand and there were few other providers at the time. Establishing the technical capability appears relatively low cost. It is yet to be seen whether the commercial opportunity will be attractive enough for contracting arrangements to contemplate these services.

The trial at the 168 MW Musselroe Wind Farm is currently under development with trial results to be completed by the end of 2018. Musselroe is seeking to register for all eight FCAS services, and will evaluate how a hybrid wind farm and energy storage solution could be used to provide FCAS. A key focus of the Musselroe outcomes will be a further examination of the commerciality of wind farms providing frequency response services.

The commercial barriers to wind farms providing FCAS raise services are due to the requirement for generators to maintain headroom capacity that could otherwise be supplying the market at near-zero marginal cost. This can be compared to demand response which has, in principle, near-zero marginal cost for maintaining headroom for providing raise services (by reducing load). This supports the view that a flexible and open market-based approach to incentivising frequency response service provision is most likely to deliver the most efficient outcome from a whole of system perspective.

Contingency FCAS from batteries

Battery technology also appears to be a very promising technology for managing frequency. ARENA has supported ElectraNet's Energy Storage for Commercial Renewable Integration

(ESCRI) project at Dalrymple, which is currently under construction. The 30 MW/8 MWh battery will provide frequency control services including contingency FCAS and fast frequency response. In addition, the battery will be connected to ElectraNet's proposed System Integrity Protection Scheme (SIPS), which will create a communication link between the battery and the Heywood interconnector. This communication link is intended to provide even faster response from the battery such that it can prevent separation events at the interconnector following major disturbances. The ESCRI project is scheduled to be commissioned by mid-2018.

ARENA notes AEMO's analysis⁴ which indicates that the regulating FCAS delivery from the Hornsdale Power Reserve is "both rapid and precise, compared to the service typically provided by a conventional generation unit". This faster and more accurate response is clearly more valuable as a frequency control service but it is unclear whether current market frameworks allow this to be fully valued. Resolving this question will help unlock new investment in fast frequency response technology.

ARENA has a strong interest in supporting further proof-of concept demonstrations in this area where they identify solutions to system security requirements in high-share renewable energy scenarios.

Please don't hesitate to contact me if you would like to discuss any aspect of ARENA's submission.

Yours sincerely

Jon Sibley

Principal Policy Adviser, ARENA

⁴ AEMO - initial operation of the Hornsdale Power Reserve Battery Energy Storage System