Australian Government
Australian Renewable Energy Agency

ARENA

1 November 2019

Sebastien Henry
Primary Frequency Response Requirements Rule Change
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

ARENA submission to Primary Frequency Response (PFR) Requirements Rule Change Consultation Paper

This submission provides information and insights from Australian Renewable Energy Agency's (ARENA's) project portfolio as relevant to the current Rule Change process.

In summary -

- Lessons from ARENA funded projects suggest that the barriers to PFR under the causer pays regime are material and should be treated as a priority,
- The mandatory approach advocated by the rule change proponents appears likely to achieve an oversupply of PFR and poor productive and dynamic efficiency. However, there is little quantitative information available to determine the cost of this approach or the relative benefits of more flexible, market-based options,
- In the short term, a contact approach (Option D) may provide an effective interim solution while preserving optionality with regard to the consideration of the other options, and
- ARENA considers that PFR is able to be provided by a wide range of sources, including Distributed Energy Resources (DER), and market design needs to be mindful that DER is growing rapidly as a proportion of instantaneous demand.

About ARENA

The Australian Renewable Energy Agency (ARENA) was established in 2012 by the Australian Government. ARENA's function 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.

ARENA funded projects and project outcomes relevant to the PFR Requirements rule change process are listed in Attachment A. ARENA has a number of projects in its pipeline which are exploring various aspects of frequency management in the context of the energy transition and we would welcome the opportunity to discuss how these could contribute to future market reforms.

Response to the issues raised in the Consultation Paper

ARENA supports approaches to better incentivise primary frequency response (PFR) in the NEM and the AEMC's proposed assessment framework for the options presented (Options A - G). A key consideration for ARENA is the impact of different solutions on the cost of renewable energy and ultimately the cost of the energy transition to consumers.

The process by which incentives for effective PFR are established will contribute to learning around how other system services, that are likely to become more scarce in the energy transition, may be acquired (e.g. inertia). Ultimately the underlying consideration should be to ensure the right quantity of service is available at the right time and location at the lowest cost.

Removing disincentives to providing PFR

Feedback from ARENA project proponents reinforces the view that the current causer pays regime acts as a disincentive to providing PFR. For example, it has been reported that the temporal mismatch between the Regulation FCAS spot price and causer pays liabilities leads to an incentive to hedge financially – by selling Regulation FCAS rather than providing PFR to avoid causer pays liabilities. ARENA therefore agrees that a first priority for reform is to remove disincentives to the provision of PFR by scheduled generators.

Flexible whole-of-system solution

Frequency is a feature of the system as a whole rather than the performance of any individual generator. It therefore makes sense for PFR to be geographically neutral (within a region) with market participants able to balance portfolios of supply and demand across the market, rather than requiring each asset to have the same performance obligations. Such an approach should allow supply and demand to be balanced at the lowest cost and provide the maximum opportunity for lowest cost suppliers of PFR, including demand side resources.

Ideally, any price signals for PFR should be symmetrical to cost recovery charges (based on a causer pays principle) to allow the greatest opportunity for physical hedging within or between market participant asset portfolios.

Determining an efficient volume of PFR

The requirement for PFR flows from the combined result of error in load forecasts and generation forecasts and dispatch compliance. PFR works alongside Regulation FCAS to maintain frequency within the NOFB while also making frequency more resilient to large imbalances. Ultimately, well functioning PFR could reduce requirements for Regulation and

Contingency FCAS, reducing costs for consumers while enhancing system security and resilience.

The PFR Requirements rule change process should consider how much PFR (MW per region) is actually required under current and possible future market conditions and ways that the overall requirement for PFR may be reduced in the future. A better understanding of this will allow for a more informed comparison of options including the benefits of flexible schemes that can adapt to changing system needs over time and can take advantage of new technologies and commercial approaches.

In the absence of any specific assessment, it may be concluded the likely required amount of PFR may be comparable to Regulation FCAS volumes - in the hundreds of MWs. This would imply that only a fraction of the NEMs generation fleet would be needed to be frequency responsive. If procured through a competitive, technology neutral process, requirements could be met at the lowest price and by the most capable service providers. This suggests that a mandatory approach applied to all generators risks a major oversupply and poor productive efficiency with increased costs to consumers.

Responding to changing volumes over time

Changes in the capability and make-up of the generation fleet and demand side resources may influence long run requirements for PFR.

For example, ARENA's short term forecasting trial (see Attachment A) will demonstrate reduced forecast error from variable renewable energy generation while reducing constraints on generation. AEMO's DER register and ARENA-supported VPP trials will provide greater visibility of DER resources. The AEMC's vision for a more symmetrical system of incentives for generators and load could also result in more accurate load forecasting and additional PFR capacity from DER (including roof-top solar, batteries, EVs and demand response).

These examples illustrate the potential role of complementary reforms and also the importance of ensuring that any new framework for PFR is flexible and able to respond to changing market conditions over time.

DER participation

The penetration of DER continues to grow rapidly and long term growth is difficult to predict. By way of example, it is noted that the preliminary outcomes of the 2019-20 ISP modelling have the central case growth rate for roof-top PV being higher than the 2018-19 high case. In addition, the range of potential DER penetration scenarios to 2040 has significantly widened.[1] In SA, minimum net demand has fallen to record lows due to growth in DER.[2]

The approach of the rule change proponents does not account for DER providing a PFR service despite them being technically capable of doing so. ARENA considers that an efficient market design should be adaptable to a wide range of potential outcomes including very high penetrations of DER as a proportion of instantaneous demand. The approach of the rule change proponents, by relying solely on large-scale generators for PFR, seems to assume that

[1] https://www.aemo.com.au/[...]/ISP-Prelim-Outcomes-presentation-10-Oct-2019.pdf (p.20)
[2] https://energylive.aemo.com.au/News/South-Australia-new-minimum-demand-record

large-scale generation will always maintain a material market share of instantaneous demand and this assumption could distort and undermine efficient market development through the energy transmission.

Projects within ARENA's project pipeline that are exploring the use of DER for managing frequency are listed in Attachment A. Other relevant projects in the market include the ActewAGL VPP currently providing 3 FCAS lower services, and Enel X participating in all 6 contingency FCAS markets.[3] Baselines for DER PFR performance verification may be more complex for assets that are not currently scheduled in the energy market. However, ARENA expects that solutions can be built off current approaches to FCAS provision by unscheduled participants such as ActewAGL and Enel X.

Batteries as a source of fast and precise frequency response

Large-scale battery projects are demonstrating that they can provide fast, precise and reliable frequency response services. For example, Hornsdale Power Reserve has shown superior responsiveness compared to conventional steam turbines in responding to AGC dispatch instructions for Regulating FCAS.[4] The ARENA-supported Lake Bonney Battery project (see Attachment A) will demonstrate response to locally measured frequency as an offset to causer pays liabilities at the neighbouring wind farm. A key area of focus will be co-optimising battery operation with wind farm operation and AGC dispatch instructions.

Batteries are inherently capable of providing PFR services and the current fleet of existing and committed battery projects may be able to contribute to a material improvement in frequency stability in the short to medium term, especially in SA and Victoria. The proposed initial >200MW threshold proposed by AEMO will not capture these batteries as a resource but instead will require upgrades to older less capable generators. This seems to be an inefficient outcome that conflicts with the objective of achieving rapid improvements in frequency stability in the short term at the lowest cost.

Contracting approaches to address short term needs

The AEMC's approach to this rule change must balance the need for urgent action to restore frequency performance in an efficient manner while providing for dynamic efficiency in the longer term. Feedback from ARENA project proponents indicates that a contracting approach (Option D) may receive broad interest, including from VRE generators, batteries and DER aggregators. This feedback also indicates that multi year contracting may be required to stimulate market interest and investment.

Any procurement process would need to factor in the differential cost of maintaining headroom seasonally and at different times of the day and any physical constraints (e.g. solar PV would not be able to provide services at night). A flexible approach that accommodated a wide range of potential supply sources is likely to achieve the required level of PFR at the lowest cost, while generating the greatest learning for industry stakeholders and policy makers. One approach may be for the procurer of PFR services to build a 'book' of different sources of supply across the contract period reflecting their varying availability at different times.

[3] https://www.aemo.com.au/-/[...]/NEM-Registration-and-Exemption-List.xlsx (Ancillary Services Tab)
[4] https://arena.gov.au//[...]/presentation-large-scale-battery-storage-services-value-streams.pdf (Slide 9)

If there are concerns over the capacity of a market-based approach to deliver the required services in a reasonable timeframe, it may be appropriate to have a backstop arrangement that allows AEMO to direct generators to provide the required level of service.

Following the agreement of a short term solution, ARENA considers that all options (A - G) should be open for consideration, noting the issues raised above.

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

Darren Miller

Chief Executive Officer, ARENA

Attachment A - ARENA funded projects and project outcomes relevant to the PFRR rule change process

Type	Project title	Project Start Date	Key Demonstration Outcomes
Portfolio Report	Large-Scale Battery Storage Knowledge Sharing Report	On going	This report summarises the key lessons and innovation opportunities for Large-Scale Battery Storage (LSBS) projects in Australia based on specific project insights gathered through the Australian Renewable Energy Agency (ARENA), Aurecon's industry experience, and publicly available information.
Grid-scale battery	ElectraNet Energy Storage for Commercial Renewable Integration (ESCRI) Phase 2 (South Australia) - Deployment and Testing	October 2018	The ESCRI project is the first LSBS project in Australia to operate in voltage source mode as a virtual synchronous generator while grid connected (grid forming). It generates revenue through energy arbitrage and contingency FCAS services. The ESCRI battery provides islanding service for the local network in conjunction with the Wattle Point Wind Farm and rooftop PV. It also provides System Integrity Protection Scheme (SIPS) between SA and Victoria and reduces constraint on the Heywood interconnector by providing Fast Frequency Response (FFR).
Grid-scale battery	Gannawarra Energy Storage System (GESS)	January 2019	It is the first retrofit model where a LSBS was installed at an existing renewable energy generator site (solar farm). It generates revenue through energy arbitrage and Regulation FCAS service.
Grid-scale battery	Ballarat Terminal Station Battery Energy Storage System (BESS)	November 2018	It is the first standalone battery-based energy storage asset in Australia. It generates revenue through energy arbitrage, Contingency and Regulation FCAS services.
Grid-scale battery	Lake Bonney LSBS	December 2019	This project aims to generate revenue through energy arbitrage, Contingency and Regulation FCAS services. It plans to reduce the curtailment of generation of Wind Farm by working in tandem with the automated bidding software that will be deployed alongside the battery. It also aims to reduce its Causer Pays Factor and firm its solar and wind portfolios to enable additional opportunities for Power Purchase Agreements (PPAs) with Commercial and Industrial (C&I) customers.
Short-term forecasting	Windlab Ltd	December 2018	Applying machine learning algorithms and custom hardware (Light Detection and Ranging device) to refine the accuracy of short-term forecasts at two Windlab sites.
Short-term forecasting	Industrial Monitoring & Control Pty Ltd	March 2019	Further developing CSIRO's cloud camera that is currently used in remote applications adapting it for large scale grid connected solar farms. The project will also develop the Solar Power Ensemble Forecaster product

			with Uni Sa and UNSW, utilising satellite based and statistical forecasting tools.
Short-term forecasting	Meridian Energy Australia Pty Ltd	January 2019	Developing a real-time wind forecasting engine and demonstrating forecasts at horizons greater than 5 minutes ahead, prepared through numerical weather prediction and mesoscale models.
Short-term forecasting	Solar and Storage Modelling Pty Ltd (Solcast)	January 2019	Delivering 8 stand-alone self-forecasting trials at semi-scheduled farms in the NEM over a two year period. Projects will leverage Solcast's global satellite based nowcasting services, combined with real-time solar farm SCADA data and sky-imagers to generate short-term power output predictions.
Short-term forecasting	Advisian Pty Ltd	November 2018	Advisian Digital will develop ensemble machine learning models trained on historical data within a prediction framework that considers a wide range of variables, including cross-series information. They will be deployed at wind and solar farms in QLD & SA.
Short-term forecasting	DNV GL Pty Ltd	December 2018	Deploying a multi-model wind forecasting approach at Ararat Wind Farm using on-site feedback data and weather models, plus development of advanced machine learning capability for short time horizons.
Short-term forecasting	Fulcrum 3D Pty Ltd (Wind Project)	February 2019	Developing turbine agnostic real time models using wind data from site installed equipment to develop an accurate wind and operational forecast for each turbine.
Short-term forecasting	Fulcrum 3D Pty Ltd (Solar Project)	September 2018	Fulcrum3D aim to generate and optimise solar farm forecasts, using ground based sky imaging devices (CloudCAMs) at Genex's Kidston 1 Solar Project. The CloudCAMs and other solar farm data will allow Fulcrum3D to submit self-generated forecasts into AEMOs market dispatch system.
Short-term forecasting	Vestas Australian Wind Technology Pty Ltd	March 2019	Deployment of a forecasting tool that integrates plant level data and other sensors, alongside short-term weather forecasts and meteorological data to provide accurate generation forecasts.
Short-term forecasting	Aeolius Wind Systems Pty Ltd	January 2019	Developing and demonstrating the capability and value of a long-range dual doppler based forecasting system to develop a precision wind power output forecast.
Short-term forecasting	Proa Analytics Pty Ltd	December 2018	Demonstration of the Proa Forecasting System which uses skycam, satellite, live data and weather forecasts at three solar farms in different climate regions. The project will also infrared skycam and satellite techniques to improve cloud characterisation during both day and night.
Wind farm	Hornsdale Wind Farm	Completed	The success of this trial in providing frequency control

	Stage 2 FCAS Trial Supporting Knowledge Sharing Report by Neoen	July 2018	services is compelling evidence of the commercial and technical maturation of wind energy technology. The ability to offer frequency control services to the market is no longer a novel concept for pilot projects; it is an important and flexible tool in the operational kit of utility scale renewable generators that provides value to the generator and to the power system. The results from the HDWF2 trial show that wind farms of similar design and functionality to the HDWF2 and operating in similar conditions to the Hornsdale 2 WF can provide FCAS services in 6 of the 8 FCAS markets. This is provided they can meet the relevant requirements of the MASS for registration and testing and operation/post event performance verification. HDWF2 trial did not meet the requirements of AEMO for the fast raise and lower (6 seconds) market: the wind farm does not currently provide adequate active power injection for fast raise (6 seconds) services in the event of a combined frequency and voltage ride through event.
Wind farm	Musselroe Wind Farm FCAS Trial	January 2018	Demonstration of utility-scale storage to capture energy currently not dispatched by the Musselroe Wind Farm due to a combination of network and wholesale market conditions, as well as providing all eight FCAS services. ARENA understands that trials of Regulation FCAS have been positive to date.
DER	United Energy FCAS	TBA	The United Energy Voltage Controlled Frequency Regulation System[5] will test the capability of distribution system operators to deliver FCAS (delayed raise) using dynamic voltage management and explore the potential for faster response. The potential for dynamic control of distribution network voltage to contribute to frequency stability is vast.
DER	AEMO VPP Trial	TBA	AEMO's ARENA-supported VPP trial[6] will facilitate the provision on FCAS raise/lower by VPP providers and optimisation against wholesale market participation.

[5] https://arena.gov.au/projects/united-energy-voltage-controlled-frequency-regulation-system/
[6] https://arena.gov.au/news/aemo-to-trial-integrating-virtual-power-plants-into-the-nem/