Australian Government
Australian Renewable Energy Agency

ARENA

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ARENA submission on the AEMC efficient provision of inertia rule-change

This submission provides information and insight relevant to the AEMC's consideration of the introduction of an inertia spot market.

ARENA has invested nearly $40 million in battery storage projects with advanced inverter capabilities and will be investing a further $100 million in large-scale battery projects with advanced inverters. These industry trials will demonstrate that advanced inverters can help stabilise the grid by providing inertia services and that they will play an important role in the energy transition. ARENA has also provided around $1 million to support Monash University research into grid-forming inverters, inertia and market design for storage. Additional information and detail is provided in the Appendix.

Broadly, ARENA supports this rule-change and recommends further implementation considerations. In summary:

- **Definitions of inertia services should be technology neutral**. The current framework for the procurement of inertia network services is limited to procurement from synchronous condensers and synchronous generators, see NER Clause 5.20B.4(d). Advanced inverters are able to provide inertial response and can be quantified similarly to synchronous inertia.
- **Adopt a whole-of-system approach**. Distributed energy resources (DER), including inverter-based resources and some flexible loads) are capable of providing inertia services (subject to local network thermal and voltage constraints). It is important that this is explicitly recognised in the AEMC's considerations as DER becomes more capable in the future.
- **Consider streamlining grid connection**. The emerging provision of inertia from non-synchronous generators is slowed down by the grid connection and commissioning processes.

All definitions of inertia services should be technology neutral

Inverter-based technologies with advanced capabilities can operate in virtual synchronous mode to emulate the inertial response of synchronous machines based on RoCoF and voltage changes. The synthetic inertia provided by advanced inverter-based technologies can be quantified in the same manner as synchronous inertia. Studies conducted by Monash

University and supported by ARENA have noted that inverter-based resources equipped with virtual machine mode are capable of emulating the swing equation received at their terminals.[1] Inverter-based technologies can also be controlled flexibly and are therefore positioned to provide better dynamic performances compared to synchronous technologies.[2]

Currently, under the NER, Clause 5.20B.4(d) provides that “inertia network services” are to be provided by means of a “synchronous generating unit” or “synchronous condenser” and the AEC’s rule-change proposal for an inertia ancillary markets includes “‘grid-forming inverter-based resources’ to the extent AEMO deems them capable of being inertia services providers”. In ensuring that rule-changes remain technology neutral, ARENA advocates that the scope of resources referenced in the NER be extended to include inverter-based technologies and that an inertia market is inclusive of inverter-based technologies. ARENA also suggests that there is further consideration of how to future-proof current reforms to include emerging power electronics and technologies that have not yet been developed.

Finally, in creating a spot market for inertia, the AEMC should also address related distortions in the interia network services framework so that services can be provided efficiently over both investment and operational timeframes.

Adopt a whole-of-system approach

Inertia services may also be provided by small-scale inverters and other DER with proportional control (e.g. resistive loads). These capabilities can be enabled where there is an underlying regulatory requirement or market incentive (e.g. aggregation models or appliance rebates.

AEMO’s 2022 ISP[3] has identified that over 80GW of generation capacity will be derived from DER by 2050. This represents one-quarter of total capacity. ARENA understands that some mass-market small-scale inverter manufacturers are proposing to incorporate more advanced functionality in the near future, including interia response and grid forming capability, and require direction from the market bodies as to how this will be valued in the future.

An inertia market should be designed with the future operations of DER in mind. However, customer and system outcomes would be maximised if small-scale inverter services are identified, designed and implemented in concert with inertia markets for grid-scale assets.

Designing markets, ensuring compliance and mandating settlements for DER inertia may currently be cost prohibitive from a economies-of-scale perspective. While DER inertia services may be too expensive or difficult to provide through an inertia market, there are other means of obtaining these services, including non-market options. These could be through new inverter standards (such as extensions to AS4777.2), or through rebate and subsidy programs, and/or aggregator models. Any ‘out-of-market’ solution could still materially benefit market outcomes by reducing the extent of resources that need to be centrally procured. This would flow through to cost savings for consumers and enhanced system stability.

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[1] D. B. Rathnayake *et al*., "Grid Forming Inverter Modelling, Control, and Applications," in *IEEE Access*, vol. 9, pp. 114781-114807, 2021, doi: 10.1109/ACCESS.2021.3104617.
[2] D. B. Rathnayake, R. Razzaghi and B. Bahrani, "Generalized Virtual Synchronous Generator Control Design for Renewable Power Systems," in *IEEE Transactions on Sustainable Energy*, vol. 13, no. 2, pp. 1021-1036, April 2022, doi: 10.1109/TSTE.2022.3143664.
[3] See: https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp

ARENA supports the deployment of renewable energy models at both the large and small scale. As such we strongly urge for a coordinated approach to inertia services that utilises all the assets that will be capable of providing these services.

Consider implications for grid connection

Separate from this rule-change, ARENA suggests consideration of other whole-of-system implications including grid connection for generation and storage with advanced inverters. As an emerging technology capability, the interaction of advanced inverter-based technologies operating in virtual synchronous mode with the grid is novel. Any delay to the commissioning of advanced inverters will detriment spot market outcomes.

Due to the complexities of receiving grid connection approvals for advanced inverters, to support bankability, some projects have adopted an approach of receiving GPS approvals via the 5.3.4a process and then retro-fitting the projects with through a 5.3.9 process. This increases the time and resources required to achieve grid connection and creates a high risk premium for advanced inverter projects. Navigating the grid connection and commissioning process for advanced inverter storage technologies has slowed down the uptake of advanced inverter-based resources in the network.

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.

Please contact Gina Zheng, Knowledge Sharing Manager (gina.zheng@arena.gov.au) if you would like to discuss any aspect of ARENA’s submission.

Yours sincerely

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Appendix. Relevant ARENA-funded projects

Project	Funding	Information
Demonstrations		
Neoen Hornsdale Power Reserve Expansion (50MW/65MWh)	$8 million (2019)	This project is co-located with the Hornsdale Wind Farm in Jamestown, SA and has advanced inverters.
TransGrid Wallgrove Battery (50MW/75MWh)	$10 million (2019)	This project is located in a strong part of the NSW network, near Sydney, and has advanced inverters.
AGL Broken Hill Battery (50MW/50MWh)	$14.8 million (2021)	This project is located in a weak part of the NSW network and has advanced inverters.
Edify Darlington Point Battery (25MW/50MWh)	$6.6 million (2022)	This project is located in a weak part of the NSW network and has advanced inverters.
Studies		
Powerlink Cost-Effective System Strength	$491,629 (2019)	This study examines measures that can be used to manage system strength, including the role of grid-forming batteries in supporting system stability.
Monash University Stability-Enhancing Measures for Weak Grids	$495,000 (2020)	This study examines issues and mitigation strategies to connect variable renewable energy into weak grids, including interaction of grid-forming inverters with the network.
Monash University Integrating Energy Storage into the NEM	$495,000 (2021)	This study examines the integration of energy storage into the NEM and will outline potential market design solutions to improve valuation of energy storage services, including inertia.