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ARENA submission to the Post-2025 Market Design Review Consultation

Thank you for the opportunity to provide input into the Energy Security Board's post-2025 market design initiative through the current consultation and the various working group processes we have been involved in. This submission responds to issues raised in the ESB Consultation Paper drawing on information and insights from projects funded by the Australian Renewable Energy Agency (ARENA).

In summary -

- *Trials and regulatory sandboxes* - ARENA is able to work with the ESB to consider the funding of priority trials identified through the post-2025 market design review process.
- *Essential system services* - The ESB's approach to mandatory primary frequency response appears less likely to make the best use of new technologies, and achieve efficient and effective outcomes, than a voluntary incentives-based approach.
- *Achieving resource adequacy at the lowest cost* - Resource adequacy mechanisms need to be evaluated with regard to the method of cost recovery as this can either strengthen or undermine resource adequacy objectives. It is also important to consider the hidden costs associated with the various capacity mechanisms and how they can drive or hinder the use of new technologies and management approaches.
- *Managing for greater demand side participation* - Noting that this work is at a relatively early stage, we highlight some key priorities we see for the DER and two-sided markets workstreams. Each Market Design Initiative should be assessed with regard to how compatible with a high DER power system and to illustrate to consumers how they can participate in the new market systems that are being proposed.

Attachment A provides summaries and links to some of the projects referred to in this submission.

Trials and regulatory sandboxes

The Energy Security Board has highlighted how trials and regulatory sandboxes can support reforms and technology innovation in the electricity sector, especially with regard to novel sources of essential system services, new access arrangements for generators in renewable energy zones and in integrating distributed energy resources. Specifically:

“The ESB proposes the continuation of trials, including ‘live’ trials, for participants to gain practical experience with new approaches to procurement and/or scheduling of Essential System Services, and to better understand their benefits and pitfalls... This could include allowing third parties to put forward proposed solutions to identified shortfalls in system services, testing measures via regulatory sandboxing...” (p.73)

ARENA sees significant value in introducing more flexibility into the energy regulatory framework to support trials and we have been closely involved in the AEMC rule change that will establish a formal regulatory sandbox mechanism in the NEM¹.

The First Low Emissions Technology Statement under Australia’s Technology Investment Roadmap notes that ARENA and the CEFC will *“continue their important role in supporting the reliability and security of the current grid through their work on enabling technologies such as distributed energy management and energy efficiency”*.² As such, ARENA funding could work alongside the new regulatory sandbox mechanism to support trials of high value innovation in the electricity system.

ARENA has established MOUs with each of the market bodies to facilitate greater coordination of trials and studies. We are also able to work with the ESB and consider funding priorities identified through the post-2025 market design review process where they align with our funding priorities as informed by the Technology Investment Roadmap.

Essential system services

ARENA is funding a range of projects that are demonstrating the provision of essential system services from non-conventional sources. For example, large batteries have become major players in FCAS markets. ARENA projects and studies are now exploring the role of batteries in providing **inertia substitutes** (e.g. Hornsdale Power Reserve 2) and contribution to voltage waveform stability (*Renewable Energy Zone* and *Cost Effective System Strength* studies). ARENA funded projects have demonstrated wind farm participation in all contingency FCAS markets (Hornsdale Wind Farm Stage 2, Musselroe Wind Farm) and a current project is exploring the potential for wind farms to provide an Inertia-Based Fast Frequency Response (Goldwind IBFFR). We support the ESB’s consideration of more flexible incentives-based arrangements for the procurement of these services.

¹ <http://www.coagenergycouncil.gov.au/publications/regulatory-sandboxing-legislation-consultation>

² [https://www.industry.gov.au\[...\]/first-low-emissions-technology-statement-2020.pdf](https://www.industry.gov.au[...]/first-low-emissions-technology-statement-2020.pdf)

Large waste-to-energy projects including the Kwinana and East Rockingham demonstration projects will also be able to provide synchronous inertia and system strength, which have so far been provided by fossil generators and synchronous condensers.

ARENA encourages the ESB to reconsider its preference³ to maintain the mandatory provision of **primary frequency control** as opposed to moving to a more flexible incentives regime. We draw your attention to a recent study into the comparative performance of synchronous and synthetic inertia provided by batteries. The study found that the performance of the BESS is at least equal to synchronous generators in high inertia systems and BESSs become more effective than the conventional primary frequency controllers as inertia declines (Arrigo, 2020)⁴.

Inverter-based controllers for wind and solar are able to provide an equivalent service when the headroom and footroom exists. Flexible incentives for PFR are required to ensure that appropriate levels of headroom and footroom is maintained and that services are provided at the lowest system cost. Given the resilience benefits of surplus PFR, market design will lend itself to the use of 'demand curves' that allow more to be procured when it is cost effective to do so. The cost of providing frequency control from renewables will vary based on market and weather conditions, highlighting the importance of procurement mechanisms that allow co-optimisation across different services.⁵ The benefits of flexible incentives-based PFR procurement (and the need to move away from inefficient mandatory requirements) are strongly underlined by submissions to the AEMC's Mandatory Primary Frequency Control rule change process⁶ and are central to the AEMC's proposal to sunset the mandatory requirement after 3 years.

Achieving resource adequacy at the lowest cost

In considering the benefits of an **operating reserve** market or other resource adequacy mechanisms, ESB should outline how cost recovery is intended to occur. If the goal of the mechanism is to achieve (and fund) a material improvement in resource adequacy, it follows that the cost of this scheme could be quite high.⁷ Cost recovery in the NEM can create distortions when costs are recovered from some market participants and not others (e.g. between generation and load, or between retail and auxiliary loads). This can increase complexity and risk and impact the decisions of new market entrants. If costs are to be smeared across market participants (irrespective of their contribution to resource scarcity), this will weaken price signals for demand side participation thereby increasing the costs of achieving resource adequacy.

³ See Consultation Paper, Figure 23. The ESBs preference to maintain a mandatory requirement was confirmed through the Technical Working Group meeting of 30 September 2020.

⁴ <https://www.sciencedirect.com/science/article/abs/pii/S0142061519307598>

⁵ [https://www.ethree.com/\[...\]-Flexible-Solar-Power-Plant-Operation.pdf](https://www.ethree.com/[...]-Flexible-Solar-Power-Plant-Operation.pdf)

⁶ <https://www.aemc.gov.au/rule-changes/mandatory-primary-frequency-response>

⁷ For example, the capital cost of 1GW of gas turbine capacity in 2030 is around \$1.4 billion (based on \$1400/kW, Gencost 2019-20, <https://publications.csiro.au/publications/#publication/Plcsirop:EP201952>)

In this context it would be useful for the ESB to assess all candidate mechanisms with regard to their method of cost recovery. This could include the previously favoured ‘scarcity price adder’ and adjustments to the market price cap, and reveal a natural ‘causer pays’ cost recovery outcome for these options.

The consultation paper points to a number of limitations of **capacity markets**. For example capacity markets require the level of firmness of the capacity product to be administratively determined. Where the performance of new technologies are not well demonstrated, this can result in heavy discounting as has been observed in Europe with regard to batteries and demand response, resulting in a conservative bias against new entrants. In theory, energy markets should settle on a more balanced outcome with liable parties adopting a range of risk profiles which would adapt organically as capacity product firmness is demonstrated and improved over time. Decentralised capacity markets, where targets are set for each retailer, may also lead to retailers retaining ‘long positions’ in each trading interval to avoid administrative penalties that, in aggregate, are significantly in excess of the needs of the market, at a cost to customers. In determining capacity obligations it would be important to factor in the portfolio benefits of blended VRE and flexible demand side participation which will contribute to reliability but may allow retailers, individually, to be long or short in any given trading interval.

Another feature of the transition to higher shares of variable renewables is the increased importance of short-term forecasting and an increase in the value of real time information (at pre-dispatch). This situation is amplified by the inherent energy limitations on storage and demand response which can be highly dynamic. In this context, ARENA supports the direction of ESB in exploring **ahead markets** based only on voluntary commitments. While there is significant detail to work through, allowing market participants to optimise their bids up to real time should ensure the best use of available resources and lead to lower costs for consumers.

Managing for greater demand side participation

The consultation paper highlights the increased complexity in scheduling resulting from increasing demand-side participation, including variable and flexible DER. A key feature of the NEM is its capacity to stimulate **innovation through contestable markets** and ARENA has observed this accelerating in recent years. In particular, we have seen the early signs of serious attempts by retailers to incorporate demand response into their customer portfolios. All three of the major retailers now have in-market behavioural demand response programs with AGL and Energy Australia also participating in the ARENA-supported Reliability and Emergency Reserve Trader demand response trial⁸.

We are also starting to see significant innovation in tariff products from retailers such as Flow Power and Pooled Energy combining flexible tariffs with demand response services. Through the ARENA-supported AEMO Virtual Power Plant (VPP) trial, and under the Market Ancillary Services Specification, we now have VPPs providing FCAS and returning significant value to their customers. ARENA Electric Vehicle (EV) managed charging trials are demonstrating how

⁸ <https://arena.gov.au/knowledge-bank/demand-response-rert-trial-year-2-report/>

EV charging could become a multi-GW resource for the system over the coming decades. Overall, the question is becoming less about 'If or when will demand side resources become abundant?', but rather 'How do we ensure they are put to the best use?'

This is a significant challenge and we appreciate the opportunity to contribute to the ESB's work in this area. Noting that this work is at a relatively early stage, we highlight some key priority issues we see for the DER and Two-Sided Markets workstreams:

- Retailers and Small Generation Aggregators should face price signals that encourage efficient participation of demand side resources in markets. There is a need to better understand the role of the market cap and floor prices in shaping minimum and maximum demand. For example, it is clear that DER owners should be incentivised to not export during negative price events. Why isn't this happening? More direct price signalling to customers would enhance incentives for optimising the operation of storage and load shifting, mitigating many of the reliability and security issues we face in the energy transition.
- The short window of time we have before EV charging is rolled out at scale creates the opportunity to ensure that network business and charging infrastructure investment decisions are aligned with consumer interest.⁹ While unmanaged charging could be a significant driver of inefficient network investment, managed charging, including the use of dynamic operating envelopes¹⁰, could increase overall network and system utilisation reducing costs for all customers¹¹. ARENA is exploring this potential through a range of trials and, with AEMO, is jointly leading EV workstream under the Distributed Energy Integration Program¹² to proactively develop solutions to these issues.
- Digitalisation is driving new opportunities for demand side participation in markets but it also creates new risks. The coincident operation of a fleet of PV inverters or electric vehicle chargers in response to, for example, the changeover of a retail price band, or for a firmware update, could become a major new class of contingency event. Smaller variations will contribute to the ongoing costs of regulating system frequency. The

⁹ Managed charging is when a third party incentivises or remotely controls vehicle charging in a way that better corresponds with the needs of the grid. ARENA's [smart charging trial with Origin Energy](#) will test a variety of incentive approaches to alter residential and fleet customer charging, and our [vehicle-to-grid trial with ActewAGL](#) will link FCAS signals to an EV fleet.

¹⁰ Three current ARENA projects are exploring dynamic operating envelopes to better understand, and operate within, the technical limits of the distribution grid (Dynamic Limits) as well as the potential to allow flexible rather than static export limits from solar PV (evolveDER) and batteries (SA Power Networks).

¹¹ Modelling by CSIRO for Electricity Networks Australia suggests that with reforms to encourage managed charging, the electricity sector could see increased consumption without significant additional peak demand, lowering electricity bills by \$162 per annum for consumers without an EV ([https://www.energynetworks.com.au/sites/\[...\]/wp7_report_19-12-2016.pdf](https://www.energynetworks.com.au/sites/[...]/wp7_report_19-12-2016.pdf))

¹² The [DEIP EV Grid Integration Working Group](#) is a group of nine organisations formed to facilitate the efficient integration of EVs into existing electricity networks and markets. It aims to provide a central forum for key industry and government stakeholders to collaborate and coordinate EV activities; approach EVs from an energy sector perspective but with transport and infrastructure partners and promote policy and regulatory development before wide scale EV adoption begins. Four work streams have been established to investigate standards, data, residential tariffs and incentives and high capacity tariffs and connections.

significant market design choice will be between inefficient and intrusive centralised controls over resources at the asset or NMI level, or a more flexible systems of incentives that steer retailers and aggregators to optimising the management of their fleets within the physical bounds of the system. This latter approach appears more likely to drive economic efficiencies while aligning with consumer preferences for flexibility, choice and autonomy.

- Reforms of network regulatory arrangements (such as those currently being considered by the AEMC¹³) reflect the need to reimagine distribution networks as platforms that facilitate the physical two-way exchange of services. This includes redefining network service definitions and reviewing customer access and pricing arrangements. We expect retail tariffs (including re-bundled network tariffs) will be the major driver of demand side decision-making until at least 2030 and we agree with the ESB's observation that the move to more cost-reflective pricing can be complemented by further technology investment (such as programmable appliances) and standards to ensure that customers are able to translate tariff changes into bill savings.
- Each of the market design initiatives will be shaped by the transition to much higher levels of demand side participation but this is not specifically drawn out in the ESB's analysis to date. It may be beneficial to require that each of the MDI's is reviewed to ensure it is compatible with a high DER power system and to illustrate to consumers how they can participate in the new market systems that are being proposed.

The Distributed Energy Integration Program (DEIP) is addressing some of these challenges¹⁴. Having completed its Network Access and Pricing work plan, its current focus is on facilitating collaboration on electric vehicles and, with the ESB's DER working group, dynamic operating envelopes. As a voluntary initiative, DEIP has developed industry recognition and some momentum. ARENA has helped to establish DEIP and provides supporting resources. We welcome the opportunity to discuss how it could evolve to support knowledge sharing, trials and reforms in support of the ESB's post-2025 market design initiative.

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.

¹³ [https://www.aemc.gov.au/\[...\]/access-pricing-and-incentive-arrangements-distributed-energy-resources](https://www.aemc.gov.au/[...]/access-pricing-and-incentive-arrangements-distributed-energy-resources)

¹⁴ <https://arena.gov.au/knowledge-innovation/distributed-energy-integration-program/>

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 - Summary of ARENA reference projects

ARENA Project	Description
AGL Virtual Power Plant (VPP)	Connecting 1000 residential and business solar battery power systems in South Australia to create a 5 MW solar power plant. Final results are expected late 2020.
Demand Response Short Notice Reliability and Emergency Reserve Trader (DR SN RERT) Trial	Three-year trial across 2017 to 2020 is separated into two periods — Period 1 and Period 2. Participants have demonstrated their ability to deliver the contracted amount of DR capacity in their portfolios across residential, commercial, industrial and utility loads). The results from the trial have informed the development of the Wholesale Demand Response Mechanism ¹⁵ .
East Rockingham (development) and Kwinana (in construction) Waste-to-Energy demonstrations	Two moving grate, incineration demonstration projects will produce 28.5 and 34MW of baseload power respectively and process 700,000 tonnes of waste per annum. The generators will be able to provide inertia and system strength akin to traditional thermal generation.
evolveDER	This project developing capabilities to calculate and publish operating envelopes that apply to individual or aggregated DER operating within an electrical distribution network to allow for increased hosting capacity on distribution networks within safe operating parameters.
Flexible Solar Exports Trial	This SA Power Networks Flexible Exports for Solar PV Trial project will allow solar owners to access flexible connection agreements based around the use of Dynamic Operating Envelopes.
Flow Power	Flow Power will demonstrate and commercialise the use of demand response for grid security and reliability. Results expected in mid 2021.
Goldwind IBFFR	Goldwind is demonstrating virtual synchronous generator control systems at the Gullen Range Wind Farm. This uses the mechanical inertia of rotating turbines to produce a fast frequency response to under frequency contingency events. Results expected late 2020.
Hornsedale Power Reserve 2	The project will demonstrate the ability for large scale batteries to provide an inertia-like product (rapid response proportional to RoCoF) and an enhanced

¹⁵ <https://www.aemc.gov.au/rule-changes/wholesale-demand-response-mechanism>

	FCAS response, enhancing the ability of large batteries to support grid stability. The first project operations report is due in July 2022.
Hornsedale Wind Farm Stage 2	This trial led to the participation by HPR in 6 of 8 FCAS markets (not fast raise or lower). On the 14 January 2018 during a planned Heywood Interconnector outage, HWF2 contributed to regulation prices peaking at \$248/MW compared to an average of more than \$9000/MW during previous Heywood Interconnector outages. Autonomous response to a number of other frequency excursions also occurred during the trial, and in normal market operation following the trial.
Musselroe Wind Farm	Musselroe Wind Farm is demonstrating the potential for wind farms to participate in all FCAS markets - including fast raise and lower, which HWF2 did not participate in. Results are expected in early 2021.
Pooled Energy	This demonstration project utilises pool pumps to provide between 3 and 5MW (3000-5000 pools) of demand response.
Powerlink cost effective system strength study	This study investigated the technical, commercial and regulatory solutions to system strength challenges on the NEM in Queensland and explored the use of synchronous condensers and emerging inverter technologies.
Realising Electric Vehicle-to-Grid Services	Among other ARENA funded EV projects, ActewAGL are leading a project to demonstrate electric vehicle-to-grid (V2G) services in Australia with a focus on the provision of FCAS. Results are available from late 2021.
Renewable Energy Zones study	Bananga led a study into the technical, commercial and regulatory challenges of developing REZs in the NEM, identifying potential commercial and regulatory solutions that could facilitate the development of REZs in an efficient and sustainable manner.
Tesla VPP	Phase 3A of the trial will see the installation of 3000 solar and battery systems on residences owned by Housing SA with the potential for the VPP to be extended to 50000 systems.