



Australian Government
Australian Renewable
Energy Agency

ARENA

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Five minute settlement review
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National Electricity Amendment (Five Minute Settlement) Rule 2017 - consultation on draft rule determination - ARENA submission

This submission provides background information on projects funded by the Australian Renewable Energy Agency (ARENA) as relevant to the AEMC's consideration of the five minute settlement rule.

To assist AEMC with its review, this submission outlines key characteristics of emerging renewable energy generation technologies, storage technologies, and demand response as relevant to the rule. In summary:

- Several significant and scalable technologies involved in ARENA projects are technically able to change their output or consumption of energy well within a five minute period, providing the physical capacity to respond quickly to wholesale price changes
- This suggests there is potential for new entrants or existing market participants to underpin cap contract volume in the long term
- Existing market participants could be expected to adopt new technology to bridge any performance gap in their existing physical portfolio, if this were necessary to continue underwriting cap contract volume
- Forecasting price events will continue to be important, just as it is today for participants not able to respond within a 30-minute period
- More granular incentives would be likely to encourage other innovative approaches to shorter-term supply-demand balancing.

About ARENA

ARENA was established to make renewable energy solutions more affordable and increase 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.

ARENA and the review

The growing share of solar PV and wind energy is one source of projected increases in the variability in the supply-demand balance, leading to increased demand for flexibility in the long term. A major focus for ARENA is supporting industry in developing, testing and commercialising a range of solutions that will be able to deliver secure and reliable electricity with higher shares of variable renewable energy. This includes both large scale generation and coordination of distributed energy resources.

ARENA supports the AEMC's draft decision to adopt five minute settlement. ARENA expects five minute settlement will contribute to system security and reliability in the long term, because it will align financial incentives with the underlying need to balance the electricity system. In particular, flexibility to respond within a five minute timeframe provides an economic benefit, but the financial rewards for that flexibility are diluted in today's settlement regime by averaging across a thirty minute period.

Technical potential to respond to price changes within five minutes

This section outlines technical approaches evident in ARENA-funded projects and studies with physical capability to respond to changes in price within a five minute period.

The list is not comprehensive but rather focuses on technologies likely to be important in a higher-renewables electricity system.

Other established technologies, such as gas turbines, will also be able to respond within a short period - indeed many already do in order to participate in the NEM frequency control markets and meet five-minute dispatch instructions.

Battery storage - both large-scale and small-scale - is able to change its output in less than a second. This is a key reason for its potential value in providing system security services such as frequency control, and make it very suitable for operating in a five minute settlement regime. Large battery projects can be constructed in a short time period (less than six months) once contracts are in place.

- The ARENA-funded ESCRI project illustrates one approach to contracting: the retail partner AGL has purchased a right to dispatch the battery to support wholesale energy trading. The ARENA-funded Lakeland project illustrates how battery storage can be combined with solar to supply local energy services to a fringe-of-grid location as an alternative to network upgrades.
- ARENA is aware of significant market interest from several providers and purchasers for larger-scale projects.
- Battery storage has been more competitive than people expected in fast-response, short-term energy balancing tasks in overseas markets such as the UK National Grid's Enhanced Frequency Response (EFR) 200 MW tender in the UK.

Modern **pumped hydro** facilities are able to ramp to full output within one to two minutes. Faster responses are possible depending on the specific technology choice. Such facilities could be a cost-effective option for larger-volume flexible capacity in future. Pumped hydro facilities will require longer to build (several years) but have the technical potential for significant capacity.

Demand response technical capabilities, including response time, are improving as communications and control technology gets cheaper.

- The demand response round jointly run by ARENA and AEMO, with NSW support, includes 160 MW required to respond within ten minutes, and maintain a response for four hours. Other projects are required to respond in a longer, sixty-minute time period. The ten-minute and sixty-minute time periods were chosen as standard product definitions aligned with the operational needs of AEMO. During consultation for the design of the program, proponents indicated they would be able to respond faster if required. Indeed, EnerNOC is intending its portfolio to also participate in frequency control markets, for which required response times are within seconds. They have experience doing this already in other markets, such as New Zealand and some US markets. Some parties are concerned that five minute settlement will reduce the incentive for demand response because some sites require longer periods to respond. Aggregation across multiple sites means the technical capability to respond within a short period (e.g. five minutes) at one site can be paired with slower-response sites that need longer to respond. This would deliver a fast and sustained response across sites. Funded projects are summarised at the end of this submission.

Concentrating solar thermal can include thermal storage, providing a high degree of control over the timing of electricity production. Concentrating solar thermal typically uses a steam turbine to power a generator. While small turbines are possible - and are the subject of research, development and demonstration - larger turbines are more efficient and have been preferred in existing projects around the world. Engineering constraints limit the ramp rate of these large turbines, just as they do with large gas combined-cycle or coal plants today. To operate in today's market, parties with slower-response equipment requiring advance notice need to forecast high-price periods in order to be ready when they occur. This will continue to be important with five minute settlement.

Solar PV and wind energy technology is able to change output quickly, up to the lesser of the (time-varying) resource availability and the plant's energy conversion capability. The more

granular incentives created by the five-minute settlement rule may make it worthwhile for contract counterparties such as retailers to pay solar and wind facility owners to forego some output in order to manage the ramp rate of their own facilities. It would be in the financial interests of the retailer to do this if the cost of the foregone output is less than the value of having output from slower-response facilities during high-priced times. A similar engineering approach has been used in small grids. Some wind farm power purchase agreements today contain clauses designed to reduce wind farm output during periods of potential negative prices.

- ARENA has supported several projects integrating solar PV and complementary technology into small grids, such as at mine sites and remote communities. A technical integration requirement for these sites is to limit the expected rate of change in output from solar PV to the ramp rate of complementary technologies. - in this context generally diesel generators. A variety of methods have been used to achieve this including cloud forecasting, integration of renewable generation with discretionary loads and use of advanced control systems. The common feature of all these systems is the ability to smooth generation from multiple sources to deliver power needs in a predictable manner. If connected to a grid, they could generally appear as a hybrid generator with a degree of dispatchability.
- ARENA's large-scale solar PV funding round, and commercial projects that have followed on from this, illustrate that new capacity can be constructed quickly. From zero to more than 20 plants in five years, Australia's large-scale solar industry has grown at a tremendous pace.
- Innovative approaches to managing ramp rates could be adopted at existing solar and wind facilities, if the incentives are appropriate.

Contracting approaches

ARENA has some limited visibility of contract structures through the due diligence process it conducts on proposals for grant funding. A key concern in some stakeholders' submissions to the AEMC is that there will be a lower ability to underwrite futures contracts, in particular cap contracts, under five-minute settlement. The below observations suggest combinations new and existing technologies could support existing contracting approaches, to the extent existing physical equipment lacks desirable fast-response capability.

Batteries as part of broader portfolios

One approach for battery storage projects is for the project owner to lease the dispatch rights to a third party, such as a retailer or integrated generator-retailer. While ARENA has no knowledge of the third parties' trading strategy, we envisage battery storage can be used to complement a broader generation or contract portfolio. For example, an older gas generator with a 15 minute start time could be complemented with battery storage able to cover a contract position while the gas generator ramps up. A battery to serve this need would only require a small energy storage volume relative to its maximum power output. Such an approach would allow an existing physical portfolio of slower-response generators to continue underwriting cap contracts, with relatively little new capital investment.

Aggregation could increase contribution to reliability from distributed energy resources

Many analysts project strong consumer-led growth in small-scale, distributed battery storage installations. ARENA has funded several projects demonstrating commercial models for delivering electricity system services from distributed battery storage. Examples include the AGL Virtual Power Plant project in Adelaide, Reposit Power GridCredits trial, and GreenSync's distributed energy exchange (deX). Five minute settlement would increase the incentive that could be offered for the owners of distributed batteries to sign up to these types of approaches. This would increase the contribution to reliability and security from distributed battery storage.

Demand response as a physical alternative to financial hedges

One approach used by retailers to take advantage of demand response capability is to use it as a replacement for hedge contracts. Retailers' contracts with their customers for demand response allow them to reduce expected exposure to high-priced periods in the spot market, thus reducing the volume of cap contracts they need to cover their position. A five minute settlement timeframe would increase the value of faster, automated responses, but would not fundamentally change the approach. An aggregated portfolio would allow a retailer to offset not only short-term high-price periods but also longer periods. Aggregation helps with this because it increases the certainty or firmness of a response from the portfolio as a whole. Aggregation is a critical element of projects funded under the ARENA-AEMO demand response round.

In other countries, up to 15 per cent of peak demand is met with demand response. This can be seen as a proxy for its potential to reduce the demand for cap contracts in the longer term.

Approach to transition

The AEMC's approach to transition is prudent in allowing a long lead time for market participants to develop new systems, install or reconfigure technology, and negotiate or re-negotiate contracts. However the lead time does have an opportunity cost in failing to provide a more efficient operational incentive (and corresponding investment incentive) in the interim period.

The AEMC could bring forward some of the benefits while managing transitional costs for existing participants by providing for voluntary settlement on a five minute basis ahead of the compulsory start date. This would encourage new investment to take account of the enhanced incentives sooner, and allow existing participants to gradually transition internal systems, contracts and trading approaches. Some of the necessary transitional measures for such an approach will be required in the long term, such as net system load profiling to allocate settlement costs to participants with half-hourly or accumulation metering.

Demand response projects

| Funding Recipient | Max Capacity | Capacity in 2017-18 | Total ARENA Funding (\$) | Type of Project |
|-------------------|------------------|--------------------------|--------------------------|--|
| EnergyAustralia | 30 MW | 11 MW (Vic) 9 MW (SA) | \$6.9 million | EnergyAustralia will sign up commercial and industrial businesses and residential customers. EnergyAustralia will use WattWatchers' remote monitoring and load curtailment devices and GreenSync's VPP technology for aggregation along with Redback Technology's smart battery storage systems. |
| EnerNOC | 30 MW (Vic Only) | 30 MW | \$5.4 million | EnerNOC, one of the world's leading demand response aggregators, will install its own hardware to automatically and remotely control and curtail energy use in 30 large commercial and industrial businesses, with 1 MW available per site. These businesses will include cold storage facilities, manufacturing plants, metalworkers, water pumps, gas production facilities, commercial buildings, mills, paper/timber/forest mills and glass manufacturers. The demand response will be 100 per cent generated by curtailment of loads. EnerNOC will also provide FCAS services demonstrating how customers can receive multiple revenue streams from their reserves. |
| Zen Ecosystems | 15 MW | 5 MW | \$2 million | Zen Ecosystems is a Victorian smart thermostat developer which has previously exported its innovative technology in the United States. Zen Ecosystems will deploy its smart, connected and controllable network of Zen thermostats. The demand response capacity will be delivered by controlling air conditioning, heating and ventilation. Zen Ecosystems will roll this out at business customers, and through a combination of voluntary and load control programs aimed at residential customers run in partnership with insurers and retailers. |
| Powershop | 5 MW (Vic Only) | 5 MW | \$1 million | Powershop plans to run a behavioural demand response program called Curb Your Power using a mobile notification system for its Victorian retail customers. It will invite customers to reduce energy consumption in exchange for a financial incentive. By reducing energy usage for 1-4 hours, customers may receive the equivalent of a weekend of free electricity. Powershop will also be able to draw on 1 MW of Reposit enabled batteries installed in Powershop customers' homes and on a 1 MW co-generation facility at Monash University as a backup. |

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|-------------------|---------------------|-------|---------------|--|
| United Energy | 30 MW (Vic Only) | 12 MW | \$5.8 million | United Energy intend to use voltage control devices installed at substations across its entire distribution network in Melbourne and Mornington Peninsula to deliver demand response. During a peak event, United Energy will slightly lower the voltage across its whole network of 600,000 households and businesses, and will use smart meters to ensure the voltage remains at a safe allowable limit. |
| Intercast & Forge | 10 MW (SA Only) | 10 MW | \$323,654 | Intercast & Forge is a South Australian metal foundry which manufactures metal castings. This local business has installed sophisticated energy systems that allows it to provide dispatchable demand response by powering down furnaces during peak events. |

Demand Response Projects - NSW

| Funding Recipient | Max Capacity | Capacity in 2017-18 | NSW Government ARENA Funding | Type of Project |
|-------------------|--------------|---------------------|------------------------------|--|
| AGL | 20 MW | 18 MW | \$5.2 million | AGL will provide 17 MW of capacity from large commercial and industry customers, and 3 MW from 10,000 NSW residential households with smart meters using a combination of behavioural demand response and controllable load/storage. |
| EnergyAustralia | 20 MW | 18 MW | \$2.9 million | EnergyAustralia will sign up commercial and industrial businesses and residential customers. EnergyAustralia will use WattWatchers' remote monitoring and load curtailment devices and GreenSync's VPP technology for aggregation along with Redback Technology's smart battery storage systems. |
| EnerNOC | 20 MW | 20 MW | \$3.6 million | EnerNOC will install their own hardware to automatically and remotely control and curtail energy use in 20 large commercial and industrial businesses, with approximately 1 MW available per site. The demand response will be 100 per cent generated by curtailment of loads. EnerNOC will also provide FCAS services demonstrating how customers can receive multiple revenue streams from their reserves. |
| Flow Power | 20 MW | 5 MW | \$2.6 million | Flow Power will create a program called Energy Under Control which involves roll out of their own kWatch Intelligent Controller (designed and manufactured in Victoria) to 100 commercial and industrial energy customers across NSW. This will target manufacturing, agricultural businesses and cool storage. |

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

Yours sincerely

A handwritten signature in black ink, appearing to read 'O. Story', written in a cursive style.

Oliver Story

Manager Strategy, ARENA