ARENA Demand Response Trial: Knowledge Sharing Project performance report

Report Date: 6 March 2018

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Contract number(s)	G00917, G00920
Recipient	EnerNOC Pty Ltd ABN 49 104 710 278
Ref	Knowledge Sharing Report #1
Applicable Time Period	From program launch (Early September 2017) to program start (1 December 2017) through the end of the First Test Period (31 Jan 2018)
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1. Report summary

This report provides an overview of the Demand Response ("DR") provided by EnerNOC and its customers across New South Wales and Victoria for the ARENA Demand Response Trial, and knowledge sharing pertaining to the following periods:

- Pre-commissioning phase (prior to 1 December 2017)
- Commissioning phase (1 December 2017 to 31 January 2018).

The report describes EnerNOC's technology used to provide DR, including the software and hardware solutions used to monitor customer load and remotely initiate curtailment. The report also provides a summary of EnerNOC's DR business model and the pricing structures and incentives for recruiting customers. EnerNOC also lists the various industries where it has recruited its Commercial and Industrial customers, and provides a full list of customer types and their general locations in **Appendix A.**

EnerNOC also provides details of the tests undertaken during the Commissioning Phase (or 'First Test Period'), and summary of lessons learnt from the development and operation of the project during the pre-commissioning and first test periods. This includes EnerNOC's reflections on the functioning of the DR market, the impact of market incentive structures on performance, and EnerNOC's own DR business model design and recruitment of different customer types.

Finally, the report also provides a summary of lessons learnt from the co-optimisation and opportunity costs of participating in ARENA-funded DR compared to providing other services such as Frequency Control Ancillary Services (FCAS). The report is structured and labelled such that many section and subsection headers are verbatim prompts excerpted from the *Knowledge Sharing Agreement* ("KSA") EnerNOC and ARENA agreed to. Use of these headers helps to ensure that EnerNOC has addressed all topics and included all information specified in the KSA.

2. Overview of demand response being provided

EnerNOC has developed a 20 MW reserve in New South Wales and a 30 MW reserve in Victoria, as part of its contracts for the three-year ARENA DR Trial.

The combined 50 MW DR portfolio is comprised of commercial and industrial ("C&I") energy users who have agreed to safely reduce their electricity consumption during DR events dispatched by AEMO. These C&I energy users (EnerNOC's "customers") are capable of implementing load curtailment within 10 minutes of receiving dispatch instructions from EnerNOC indicating that a DR event is commencing.

EnerNOC has developed individual Energy Reduction Plans ("ERPs") in consultation with each of its customers. Each ERP includes the following three-step process:

1) EnerNOC will notify you that a dispatch has been called.
2) Confirm phone and e-mail notifications.
3) Commence load reduction processes (E.g. safely reduce energy usage, shut down equipment, and processing units etc. – this part of the ERP is customised to each customer's facility).

EnerNOC has installed its own metering technology at customer sites for purposes of monitoring customer facility demand and facilitating effective demand response (see below). Additionally, a portion of the sites has been equipped with controls equipment that allows EnerNOC to safely remotely initiate a load reduction. The controls are tested prior to full customer enrolment, and customer participation in events is pre-authorised – the customer simply receives notifications to inform them that a DR event is taking place.

Technology being used to provide DR

EnerNOC's reserves utilise a range of technology to provide DR, including the following solutions for continuous monitoring of customers' energy consumption in near real-time, and for remotely initiating load reduction during DR events.

1) EnerNOC Site Server

Continuous monitoring of customer demand:
The EnerNOC Site Server (ESS) is a highly secure, low latency communications gateway for energy management and demand response applications.

Accepting both KYZ pulse-based meter inputs and ModBus RTU inputs, the ESS provides reliable communications with utility meters, supervisory control and data acquisition (SCADA) systems, or existing meter networks.

These devices transmit data to the EnerNOC platform every 5 minutes, and allow EnerNOC to provide automated DR, assess demand response capability in advance of – and to monitor performance during – demand response events. Data is made available in EnerNOC's online portal for both EnerNOC's customers and staff to access and conduct ad hoc analysis.

During DR events, an "event performance dashboard" becomes available in the portal, and is used by EnerNOC's customers and staff to assess the near real-time "performance" of each facility: the instantaneous and average load reduced from its adjusted baseline – superimposed against a "reduction target".

Initiating load reduction:
EnerNOC works closely with customers that are able to automate their energy reduction plans. Automated DR capability is provided via the ESS relay control module, providing a clean contact state change both at the start and end of the dispatch period. Customers integrate this signal into their Programmable Load Control and/or Building Management Systems ("PLC/BM") to provide a safe, controlled initiation of load curtailment.

2) EnerNOC FCAS Hardware Solution

For customers that participate in both the ARENA DR Trial and EnerNOC's Frequency Control Ancillary Service (FCAS) program[1], EnerNOC utilized the existing FCAS Hardware Solution instead of an ESS. The requirements for participating in the FCAS markets operated by AEMO require special technology (far beyond the capability of the EnerNOC ESS) that includes local

[1] To participate in FCAS, EnerNOC (as an independent aggregator) interfaces directly with the NEM's wholesale markets for Contingency Raise FCAS by submitting bids for each trading interval. In order to do so, EnerNOC registered with AEMO as a Market Ancillary Services Provider ("MASP").

frequency sensing, fast relay switching, and high-speed data logging (at least 50 milliseconds granularity). To meet this specification and participate in the FCAS markets EnerNOC has procured and installed an off-the-shelf power quality metering solution, and loaded it with custom firmware we developed in partnership with a third-party vendor.

In order to also participate in the ARENA program, EnerNOC developed a new web services application, providing the ability to schedule ARENA dispatch event times and allowing secure automated load control of the FCAS metered sites. Dual enrolled sites are equipped with a dedicated relay expansion module, providing individual (and differentiated) load control signalling for both FCAS and ARENA DR.

This allows some of EnerNOC's customers to programme one "immediate" load control script for FCAS, and to program a second, slower "10 minute" script for their ARENA participation. This option gives customers added flexibility in situations where 10 minutes might allow the customer to undertake a more controlled, elegant curtailment process.

Business model and pricing structures/incentives employed to recruit capacity and activate load reduction

EnerNOC's initial approach was to target C&I customers in industries where it has prior experience developing flexible loads in other markets. This included businesses such as chemical manufacturers, metalworkers and cold storage & refrigeration facilities. EnerNOC also approached its customers who were already participating in EnerNOC's FCAS resource – EnerNOC had an intimate understanding of these customers' individual response capabilities and the amount of load able to be curtailed – this information was used to determine load reduction capabilities for the ARENA DR Trial.

However, as part of its broader risk management strategy, EnerNOC was also able to identify and contract new customers in industries in which we had less prior experience, such as product manufacturing, tertiary education, and fruit & tree nut growing. This provides EnerNOC with a more diversified DR customer portfolio across NSW and Victoria that is not impacted by particular seasonal fluctuations in energy usage (i.e. EnerNOC's portfolio is not heavily reliant on seasonal HVAC loads), and ensures EnerNOC is not reliant on any single industry to deliver its aggregated reserve.

EnerNOC presented customers with the following pricing structures/incentives:

- Availability Payments – based on customers' daily availability for responding to a DR event. The units for these payments are $/MW/year.
- Energy Payments – based on the energy delivered/reduced per interval during a DR event. The units for these payments are $/MWh.

Availability Payments cover the costs of searching for, contracting, commissioning, account managing, and ensuring continuous availability of each customer facility. Energy Payments are intended to cover the short run marginal costs associated with load curtailment during DR events.

Payment terms with customers were negotiated on a case-by-case basis, depending on their individual operational requirements, size of loads, cost of reducing load, magnitude and complexity of required on-site technology and controls work, opportunity cost of other energy management strategies, and other commercial considerations.

Customer types and geographic location

EnerNOC has recruited a range of Commercial and Industrial customers from the following industry types:

Commercial	Industrial
Agricultural Product Wholesaling	Basic Chemical Manufacturing
Building Structure Services	Basic Metal Manufacturing
Fruit and Tree Nut Growing	Fruit and Vegetable Processing
Tertiary Education	Grain Mill and Cereal Product Manufacturing
Warehousing and Storage Services	Meat and Meat Product Manufacturing
	Waste Treatment, Disposal & Remediation Services
	Wood Product Manufacturing

Overall, the percentage split (in terms of MW) is approximately 25% Commercial, and 75% Industrial. This is in line with the forecast guidance EnerNOC provided to ARENA in its application to the Demand Response Competitive Round.

In Victoria, most Commercial customers are located in the outer suburbs of Melbourne, such as Campbellfield, Clyde and Laverton, and others in regional cities such as Shepparton. Industrial customers were mainly located in the inner Melbourne suburbs such as Altona and Kensington.

In New South Wales, both Commercial and Industrial customers were mainly located in the outer western suburbs of Sydney between Parramatta and Penrith.

A more detailed table outlining each customer's general location and industry type is provided in **Appendix A.**

3. Analysis of performance based on six-monthly test data and any real activation data

AEMO undertook testing of EnerNOC's NSW and VIC portfolios during the First Test Period, as required under the RERT Panel Agreement and ARENA DR Funding Agreement.

The reserve quantities tested were:

- 20 MW in NSW
- 30 MW in VIC.

The tests, which were conducted separately and lasted for two hours each, were designed to simulate real DR Events and assess EnerNOC's performance against the contracted levels of reserve.

Following the tests, AEMO advised EnerNOC that the target reserve quantities were achieved for both portfolios. As expected from an aggregated portfolio, while some customers' load reduction

volumes were slightly lower than their expected quantities ("nominations"), other customers performed better than their nominated quantities.

There were no emergency/reliability DR events dispatched by AEMO during the First Test Period, therefore no real activation data is available.

4. Summary of most recent lessons learnt from the development and operation of the project, and participation in the competitive round

Participant reflections on the functioning of the DR market and the impact of market incentive structures on performance

The compressed timeline was the biggest challenge

EnerNOC was notified of ARENA's intention to fund EnerNOC's proposed project at the end of August 2017, and finalised a funding agreement with ARENA at the end of September 2017. With a program start date of 1 December 2017, this gave EnerNOC just two months to search for, analyse, contract, commission, test, and enrol 50 MW of greenfield DR customers. This timeframe presented EnerNOC's staff with a significant challenge of building the required 50 MW portfolio by the program commencement date.

In essence, the timeline required EnerNOC to begin building the DR resource speculatively – which is a difficult proposition for suppliers to any market or project. Following ARENA's announcement of the Competitive Round in ~May 2017, EnerNOC began undertaking preparatory work to develop and build a DR resource – approximately three months before gaining certainty that EnerNOC would be a program participant.

This preparatory work included market research, lead generation, contract development, CRM system buildout, and recruiting for the additional staff that would be required to successfully recruit 50 MW of energy users, and operationalise the program by 1 December 2017. This preparatory work required EnerNOC to make speculative investments that introduced some commercial risk (of EnerNOC's application to the Competitive Round not being successful). After thorough internal review, EnerNOC decided to accept this risk and commit resources to developing the DR resource, with the hope that at least some portion of EnerNOC's application would be accepted in the Competitive Round.

Stacking multiple value streams is what allowed EnerNOC to make a 50 MW commitment

In deciding what quantity (of MW) to bid into the Competitive Round, the key enabling factor that allowed EnerNOC to commit to (and eventually be awarded) the maximum allowable quantity (50 MW per participant, for three years) was EnerNOC's existing activity recruiting energy users to participate in EnerNOC's FCAS program. Since ~December 2016, when the AEMC announced that the *Ancillary Services Unbundling*[2] rule change would go ahead effective 1 July 2017, EnerNOC had been preparing to launch an entry into the Contingency FCAS markets in the second half of 2017.

With 6+ months to plan and prepare, EnerNOC had ample time to undertake market research, lead generation, hiring, and IT system upgrades. This 'program launch' effort in the first half of

[2] Refer http://www.aemc.gov.au/Rule-Changes/Demand-Response-Mechanism

2017 was the first substantial buildout of EnerNOC's presence and customer base in the NEM. For the first time, independent aggregators had direct access to offer load curtailments into one of the NEM's wholesale markets – and EnerNOC was determined to enter and make an impact.

By the time ARENA announced the Competitive Round in mid-2017, EnerNOC had already hired additional business development staff, and spent weeks in the field recruiting energy users to join EnerNOC's FCAS program. In this sense, EnerNOC had already 'primed the pump' of its go-to-market engine, and so was well placed to accommodate an incremental 50 MW ARENA commitment on (what would otherwise be a near impossibly) tight timeline.

In many cases, EnerNOC had already hired and trained new staff, and established open dialogue with large energy users to discuss FCAS - so adding an incremental grid service to these warm conversations was a relatively simple undertaking. EnerNOC's global experience developing greenfield DR resources is that the most time consuming and costly aspect of launching a new program/offering is searching for, establishing contact with, building trust with, and negotiating agreements with large energy users[3].

When the ARENA Competitive Round was announced, EnerNOC was in a fortunate position where it had already undertaken a good portion of that effort – on the basis of a different value stream (FCAS). If EnerNOC had not had a 'running start' in developing a new DR resource (triggered by the certainty of the AEMC announcing the opening of the FCAS market to independent aggregators from 1 July 2017), it is highly unlikely that EnerNOC would have bid 50 MW into the ARENA competitive round. Two months would simply not be enough time to build 50 MW from a cold start.

To EnerNOC, this experience illustrates the benefits of 'value stacking' multiple types of DR. Because of the AEMC's decision to allow aggregators into the FCAS markets[4], greater quantities of DR were available to ARENA (and at lower cost[5]) when it sought to invest in a Strategic Reserve[6] in time for the 2017-18 summer. Additionally, the 6+ months that EnerNOC had to plan and prepare its entry into the FCAS markets created economies of scale that ensured the MW it offered into the ARENA competitive round were made available at lowest cost.

For any future permanent Strategic Reserve mechanism, EnerNOC hopes that participants will be given the opportunity to make firm commitments at least six months in advance of the time they are required to be available. Running tenders only 2-3 months prior to program start will see participants mobilise fewer MW, at a higher per-unit cost than if six months' lead-time were

[3] As a further example of this – EnerNOC notes that all of the participants in the ARENA trial with a > 12 MW commitments in any single year are all large established retailers (besides EnerNOC). To EnerNOC, this suggests that customer acquisition is one of the primary considerations in DR resource development, and that established players with established commercial relationships with energy users are best positioned to make large commitments.
[4] i.e. 'Ancillary Services' DR
[5] Were it not for EnerNOC's FCAS participation, EnerNOC would have had to bid into ARENA's Competitive Round at a higher price than the $60k/MW/year it bid. This may have resulted in ARENA procuring fewer than the 200 MW it was able to procure with its fixed $37.5m budget. EnerNOC notes that on a per-MW basis, its bid price of $60k/MW/year was the lowest bid price of any aggregator selected to participate in the ARENA trial. EnerNOC's unique ability to value-stack multiple grid services – and leverage related economies of scale - is a key reason its DR resource proved to be lower cost than those bid by other aggregators.
[6] i.e. 'Reliability' or 'Emergency' DR.

provided. EnerNOC has further detailed its thoughts on the 'timeline problem' in a recent submission to the AEMC's Reliability Frameworks Review – Interim Report[7].

Lessons learnt from the First Test Period

EnerNOC achieved successful test results for its NSW and VIC portfolios in the First Test Period. All communications between AEMO and EnerNOC, from the initial Invitation to Tender (ITT) to the formal dispatch activations ran smoothly.

Customer feedback was positive overall, and although EnerNOC was required to provide guidance and support in preparation for the tests, this should reduce over time as customers become more familiar with dispatch communications for future tests and real DR events.

While financial incentives were a key motivator for program participation, the majority of EnerNOC's customers also appeared to place value on the context of their DR participation – that is, being part of an industry-wide solution for easing demand on grid infrastructure and helping to ensure system reliability during peak demand periods.

Participant lessons learnt on hardware and software technology requirements to support firm delivery of DR

EnerNOC also experienced several challenges relating to ensuring DR-enabling hardware and software was installed and completed with setup and testing by the 1 December 2017 start date. These included:

- Installing utility meter pulse connections – these are a critical part of EnerNOC's enablement process, as they allow EnerNOC to collect real-time utility meter data and monitor customer performance. However, the utility meter pulse enablement can only be undertaken by the Meter Provider (MP), some customers' pulse connections were enabled slower than others. Further, it was sometimes difficult to identify and connect with the right person in each MP to arrange the installation; this at times added several weeks to the hardware deployment process.

- Timeframes – overall the general timing of program commencement (1 December 2017) proved challenging given the run-up to Christmas is a typically busy time for energy users and contractors in general. This made the enablement process even more difficult as EnerNOC had to compete with customers' other on-site priorities.

On a positive note, most customers appreciated the importance of having EnerNOC's hardware installed in order to be able to monitor their load during DR events and tests, and were willing to make staff available to coordinate installs. Customers were also pleased to learn that EnerNOC staff did not need to interrupt site power in order to install an ESS.

Participant lessons learnt on DR business model design

Diversification is critical to building the required scale to operate a reliable and robust DR portfolio. Instead of being reliant on specific industry sectors where EnerNOC had prior experience and customers from other markets, it was advantageous to broaden EnerNOC's scope

[7] Refer https://www.aemc.gov.au/sites/default/files/2018-02/EnerNOC.pdf

to other industries such as fruit & tree nut growing, tertiary education and product manufacturing.

During the recruitment process, EnerNOC received several customer and internal staff questions about the current ARENA DR Program design. There was some confusion about whether customers could participate in the ARENA program if they were also participating in some kind of DR or demand management scheme facilitated by their DNSP, and if customers could participate if they are (or have been previously) exposed to spot market prices.

To EnerNOC, the philosophy underpinning the RERT framework[8] is clear and well intentioned: resources are only eligible for RERT if they are not already providing wholesale (supply or demand) response by actively managing generation/load in response to energy spot prices[9]. In this way, RERT resources (which are paid outside the wholesale market) can be thought of as truly "additional" resources.

However, the way this philosophy is implemented and enforced by AEMO would benefit from clearer definition. During the Competitive Round application and program launch phase, EnerNOC had to ask many clarifying questions to AEMO regarding what types of multiple-service value stacking were and were not eligible. From the FAQs ARENA published over the course of administering the Competitive Round, it seemed that many other participants had similar questions. An AEMO-administered guideline would serve well to set out clear guidance, and ensure all participants are on the same page and playing by the same rules.

Interactions with "Ancillary Services DR"

In the early days of programme recruitment, EnerNOC had to decide which FCAS customers it would target for ARENA recruitment, and what percentage of its portfolio would be comprised by "dual participating" customers. In theory, EnerNOC could have pursued 100% dual participation in an attempt to maximise economies of scale in the recruitment/contracting/commissioning process.

However, a decision made by AEMO caused EnerNOC to take a different tack and to focus instead on recruiting "greenfield" DR customers to its ARENA portfolio, rather than dual-enrolling its FCAS customers. The decision related stemmed from the below provision in the NER, and AEMO's interpretation of it[10]:

> **NER 3.20.3 (j)**: *AEMO* may only enter into a *reserve contract* if the contract contains a provision that the other party to the contract has not and will not otherwise offer the *reserve* the subject of the contract in the *market* for the *trading intervals* to which the contract with *AEMO* relates except in accordance with the contract.

In preparation for its bid to the Competitive Round, EnerNOC put a query in to AEMO – asking AEMO to confirm that offering a load into the FCAS market(s) posed no conflict with the above

[8] As codified in the NER.
[9] i.e. curtailing load in response to a high spot price.
[10] AEMO's interpretation of this NER clause, as excerpted from AEMO's RERT Panel RFEOI document (bold emphasis EnerNOC's): *Reserve that is required or might be required or available to be provided under any other agreement or arrangement, including any electricity supply agreement or arrangement,* ***any demand side management agreement or arrangement*** *or any other similar agreement or arrangement in the trading intervals during which the reserve is required.*

NER provision, and the way AEMO planned to interpret the provision[11]. EnerNOC's interpretation of the NER, the RERT Guidelines, and the RERT Procedures indicated that such a dual-participating customer should be eligible for RERT, on the basis that that, though the load is technically subject to a "demand side management agreement or arrangement" (with EnerNOC), the arrangement is for the provision of Contingency FCAS, and not "reserve". Said otherwise, the load is only available to help control frequency, and is not (nor has previously been) available for reserve (i.e. providing peaking capacity in any way, or is price responsive in the energy market in any way). In EnerNOC's view, "frequency control" and "reserve" are distinct and separable grid services.

In reply, AEMO informed EnerNOC was of the view that any load "contracted under a reserve contract[12]" is ineligible to simultaneously bid into any of the FCAS markets while the reserve contract is in place. This meant that any time AEMO issued an Invitation to Tender ("ITT") under the RERT Panel Agreement, EnerNOC would have to bid dual-participating customers out of the FCAS markets. This is problematic because FCAS payments are accrued on a trading interval basis, and only when bid and cleared. This is further problematic because AEMO's ITTs can last up to seven days, and there is no limit on the number of ITTs AEMO can issue over the duration of the ARENA trial. For example:

- A seven day ITT window would require EnerNOC to bid out of the FCAS markets for 60 hours (10am-10pm * 5 business days), and forgo 60 hours of FCAS payments. At the time, the Contingency Raise FCAS markets were returning historically high payments, and so the opportunity cost of each foregone hour was calculable, and material. As a result, EnerNOC was wary of any determination that would require EnerNOC's customers to bid out of the FCAS markets in order to participate in the ARENA trial.

At the time, EnerNOC had no certainty as to how AEMO planned to administer the ITT process to facilitate the ARENA trial. One viable option would be to leave a "standing" ITT in place year round, renewed every seven days, to ensure the ARENA trial resources were always available for dispatch[13]. Such a process would have entirely eroded the business case upon which EnerNOC's FCAS program is premised, and gave EnerNOC pause in deciding how much dual-participation to pursue.

After calculating the potential opportunity costs of forgoing FCAS participation for potentially many hours over the course of a year, EnerNOC decided not to focus heavily on dual-enrolling its new FCAS customers in ARENA, but rather to focus on recruiting greenfield DR sites for ARENA.

EnerNOC does not agree with AEMO's interpretation of the NER 3.20.3 (j), and the requirement that RERT-enrolled loads must not bid into the FCAS markets during any trading interval applicable to the RERT Contract. In EnerNOC's view, willingness to assist in the restoration of system frequency (by curtailing load for a short period of time) is not the same as providing

[11] Specifically, AEMO's administration of the RERT Panel Agreements required to participate in the Competitive Round.
[12] i.e. a RERT contract with AEMO
[13] We note that today, AEMO has landed on an approach where ITTs are kept a short as possible, and only issued in the minutes/hours leading up to anticipated RERT contract activation. This is an ideal process, in terms of facilitating continued dual-participation. However, this process was not decided or advised until just prior to the 1 December 2017 programme start, well after EnerNOC had set its recruitment strategy and completed the recruitment process.

"reserve" (by curtailing load in response to either high spot prices, or a reliability signal from AEMO) and participation in the former should not preclude the latter. This may be a policy area that ARENA wishes to explore further with AEMO as it contemplates the design of a future Reliability DR market.

Interactions with "Network DR"

During the recruitment process, EnerNOC spoke to some *prospective* customers who noted that while the ARENA DR program would work for them, there are certain days where they would not be able to participate. This was due to these prospective customers having network demand management commitments (as a result of network tariff structures), that might preclude their participation in the ARENA trial. This was on the basis that the benefits (payments) from the ARENA DR trial would not sufficiently offset the increased costs the customer might incur from being required to forgo participation in a network DR/DM event.

In particular, many C&I energy users in AusNet Services' distribution network face either:

1) A "critical peak pricing (CPP)" tariff incentive, or
2) Have bilateral network support agreements with AusNet services.

Customers in category #1 face an opportunity cost trade-off such that if they were forced to "miss" just one or two of the (five annual) AusNet critical peak days as a result of their ARENA trial participation, the customer would be financially worse off. EnerNOC has included a mathematical representation of this trade-off in Appendix B. There are two key considerations here:

A) The timing of the ARENA baseline adjustment (4-1 hours before event start), relative to the AusNet CPP window (always 14:00-18:00 AEST): On a hot, high demand day where overlapping ARENA and AusNet events are likely, a customer risks not performing in AusNet's CPP event in order to preserve their ARENA baseline adjustment window, and ensure they're able to meet their ARENA commitment. For instance, if an ARENA dispatch were called to start at 17:00 AEST, and the customer had curtailed fully at 14:00 AEST for AusNet, the customer would have wiped out their ARENA baseline adjustment and adversely affected their ARENA performance.

B) The second consideration is how AEMO might treat network tariff DR in light of its interpretation of NER 3.20.3 (j). In the early days of programme recruitment, EnerNOC had difficulty obtaining a firm view from AEMO as to the eligibility of this type of dual-participation. Absent firm guidance to the contrary, EnerNOC's risk-averse presumption was that any curtailment for AusNet tariffs would be prohibited during any trading interval in which an ITT had been offered and accepted.

On this basis, EnerNOC did not enrol any AusNet CPP exposed customers into its ARENA portfolio, on the basis that EnerNOC could not guarantee such customers that they would be better off. The interaction between Reliability DR and Network DR options may be something ARENA wants to explore further in considering the design of a future Reliability DR market.

Customers in category #2 – EnerNOC was informed by AEMO that customers in this category are ineligible for RERT, on the basis of them having a demand management agreement, and

AEMO's interpretation of NER 3.20.3 (j). Accordingly, EnerNOC did not pursue any such customers for ARENA participation.

Other considerations

Other customers noted during certain times of year, particularly in the lead up to Christmas, they may not be able to provide any or as much DR due to other commercial considerations, such as fulfilling customer orders and avoiding financial or contractual penalties.

Overall, the business model is effective for customers with a predictable load that can be safely and quickly reduced, with customers provided with an incentive to be available (Availability Payments) and to deliver energy during a DR event (Energy Payments).

Participant lessons learnt from the recruitment of different customer types

As noted above, EnerNOC has recruited customers from various industries, including some which EnerNOC has not had substantial prior experience in other markets. The diversification into new industries such as tertiary education has helped EnerNOC with achieving the 50 MW portfolio target for its ARENA contract.

Having more time available to recruit customers would have allowed EnerNOC to overcome some of the technical barriers (speed of response, testing, automation etc.) and allowed EnerNOC to target industries and larger customers where the acquisition process was slower.

Some industries had customers that were more difficult to recruit due to seasonal fluctuations in demand, such as fruit growing and fruit packing businesses. Other customers, such as those in product manufacturing, had higher opportunity costs for production delays particularly in the period prior to Christmas.

EnerNOC also found that a common issue was having enough staff numbers on site to confirm dispatch and enable load reduction. As a result of its communications testing process, EnerNOC has mandated that all customers must have at least three contacts registered to receive and confirm dispatch instructions.

Overall EnerNOC found some program parameters, such as the 4-hour curtailment duration, 10 min response time, along with the dynamic baseline and adjustment rules restricted the pool of available industries and specific customers. It became apparent during testing that a small percentage of EnerNOC's customers, despite providing load reduction during the DR test intervals, were not credited with the full amount of curtailment following measurement and verification against baseline and adjustment rules. This was due to the customer load being below baseline levels during the adjustment window on the day of testing.

Fortunately, through the benefits of portfolio aggregation, other customers within the EnerNOC portfolio with more stable loads were able to absorb any negative adjustments, and overall the portfolio performed well and achieved EnerNOC's DR test targets.

5. Details of other commercial or wholesale DR activity that the Recipient (pertaining to the DR funded under this Agreement) is participating in

EnerNOC is registered as a Market Ancillary Services Participant (MASP), which is special category that enables independent aggregators to provide market Ancillary Services (including Contingency FCAS).

The primary purpose of Contingency FCAS participation is to restore grid stability following a contingent loss of generation – Contingency FCAS is used to correct major drops and rises in frequency (when the frequency is outside of the Normal Operating Frequency Band). EnerNOC has several customers in Victoria and NSW who are registered to provide FCAS and are also participating in the ARENA DR Trial.

Number of instances and duration the DR was activated for these other activities

EnerNOC's FCAS customers have responded to six distinct low-frequency excursions since October 2017, with an average duration of 6 and a half minutes each. Based on the various availabilities and operating profiles of EnerNOC's constituent customers, this does not necessarily mean all EnerNOC customers have responded six times.

Period the DR was activated for these other activities

These FCAS excursions occurred between October 2017 and February 2018.

6. Participant lessons learnt from co-optimisation of ARENA-funded DR and other services provided by individual customers, including FCAS

EnerNOC has several customers registered to provide both Frequency Control Ancillary Service (FCAS) and ARENA DR. These customers already understand load flexibility from their FCAS participation so are well educated to consider and evaluate incremental DR opportunities.

For some of EnerNOC's FCAS customers, signing up for the ARENA DR trial seemed like a logical next step. Customers also appeared to appreciate that EnerNOC could not always make them available for both FCAS and ARENA dispatch at the same time. However, despite the potential impact on FCAS earnings during the forming of ARENA DR reserve contracts[14], customers have all trusted EnerNOC to optimise their overall earnings across both programs.

The FCAS events are infrequent and only require load curtailment for a short time period of 10 minutes or less. EnerNOC is able to opt customers out of the FCAS market when needed, to ensure that loads are fully available for the ARENA program.

The trigger for bidding dual-enrolled customers out of the FCAS market is an AEMO invitation to tender (ITT) for reserve notice. EnerNOC will bid dual-enrolled customers out of FCAS markets during specified ITT and/or activation periods, in accordance with guidance EnerNOC received from AEMO. From a risk management point of view, EnerNOC will bid customers out as early as possible to ensure any potential FCAS trip does not affect customer baselines for measurement and verification of performance during an ARENA DR event.

[14] i.e. following the issuance and acceptance of an AEMO ITT

Following receipt of an ITT from AEMO, EnerNOC plans to immediately begin processing a rebid to remove all dual-enrolled customers from the FCAS market for the time period specified in the ITT, plus an additional four hours prior to the commencement of the ITT window (if possible) to minimise the possibility of an untimely frequency excursion causing adverse impact to the ARENA baseline.

7. Participant lessons learnt from "value stacking" ARENA funded DR with other services provided by individual customers, including opportunity costs

FCAS events are short in duration, so generally limited impact to customer operations. The ARENA program provides more certain availability payments and an energy payment (which EnerNOC's FCAS program does not). However, the ARENA program causes a much more significant disruption to site operations due to the length of time involved.

As stipulated in the RERT Panel Agreement for the ARENA DR Trial and detailed previously, the reserve provided by EnerNOC's customers cannot be offered to the market through any other means during the period of a reserve contract. This means if EnerNOC accepts an AEMO Request for Tender for provision of short notice reserve during a specified period, then those dual-enrolled customers cannot be bid into the FCAS markets or other programs for that period.

Accordingly, customers incur an opportunity cost of not receiving FCAS revenue when EnerNOC accepts and forms a short notice reserve contract with AEMO, however in general EnerNOC expects the opportunity costs will be small compared to the annual value of ARENA Availability payments.

Therefore, while there are opportunity costs for being removed from FCAS, customers are positively aware they will also earn Availability Payments and Energy Payments based on their dispatch performance, as per their contracts with EnerNOC for the ARENA program.

EnerNOC's customers also understand the ARENA DR Trial is a three-year program funded by the Commonwealth and state governments, as part of initiatives to improve overall system reliability. Therefore as noted, in addition to financial incentives on offer, EnerNOC's customers seem to place some value on being part of an industry-wide solution for easing demand on grid infrastructure and helping to ensure system reliability during peak demand periods.

Appendix A – Customer types and geographic location

Key:
CC City Centre
IS Inner Suburbs
OS Outer Suburbs
RC Regional City
RA Rural Area

NSW Portfolio (20 MW)

Customer	Type	Geographic location
NSW1	Grain Mill Product Manufacturing	OS, south west
NSW2	Other Warehousing and Storage Services	OS, west
NSW3	Other Warehousing and Storage Services	OS, west
NSW4	Basic Chemical Manufacturing	OS, south west
NSW5	Building Structure Services	IS, west
NSW6	Basic Non-Ferrous Metal Manufacturing	OS, west
NSW7	Grain Mill and Cereal Product Manufacturing	IS, west
NSW8	Waste Treatment, Disposal and Remediation Services	IS, south
NSW9	Basic Ferrous Metal Manufacturing	OS, west
NSW10	Waste Treatment, Disposal and Remediation Services	OS, west
NSW11	Waste Treatment, Disposal and Remediation Services	IS, north
NSW12	Waste Treatment, Disposal and Remediation Services	RC, south
NSW13	Meat and Meat Product Manufacturing	OS, west

VIC Portfolio (30 MW)

Customer	Type	Geographic location
VIC1	Agricultural Product Wholesaling	IS, north
VIC2	Building Structure Services	OS, east
VIC3	Building Structure Services	IS, west
VIC4	Fruit and Tree Nut Growing	RA, north
VIC5	Fruit and Tree Nut Growing	RC, north
VIC6	Fruit and Tree Nut Growing	RC, north
VIC7	Fruit and Tree Nut Growing	RA, north
VIC8	Other Warehousing and Storage Services	OS, west
VIC9	Other Warehousing and Storage Services	OS, west
VIC10	Other Warehousing and Storage Services	OS, north west
VIC11	Other Warehousing and Storage Services	RA, west
VIC12	Other Warehousing and Storage Services	OS, west

VIC13	Other Warehousing and Storage Services	OS, south east
VIC14	Other Warehousing and Storage Services	IS, west
VIC15	Other Warehousing and Storage Services	RA, north
VIC16	Other Warehousing and Storage Services	OS, north
VIC17	Other Warehousing and Storage Services	OS, north
VIC18	Grain Mill Product Manufacturing	OS, south east
VIC19	Tertiary Education	IS, north
VIC20	Tertiary Education	IS, east
VIC21	Tertiary Education	IS, north
VIC22	Tertiary Education	IS, north east
VIC23	Tertiary Education	IS, north east
VIC24	Tertiary Education	IS, south east
VIC25	Basic Chemical Manufacturing	OS, south west
VIC26	Basic Ferrous Metal Manufacturing	OS, west
VIC27	Fruit and Vegetable Processing	RC, north
VIC28	Grain Mill Product Manufacturing	RC, north west
VIC29	Grain Mill Product Manufacturing	IS, north
VIC30	Grain Mill Product Manufacturing	IS, north
VIC31	Other Wood Product Manufacturing	RC, north east
VIC32	Waste Treatment, Disposal and Remediation Services	OS, west
VIC33	Waste Treatment, Disposal and Remediation Services	OS, south west
VIC34	Water Supply, Sewerage and Drainage Services	RC, north

Appendix B – Tables Illustrating AusNet Critical Peak Opportunity Costs

Tariff Code	Tariff Code Description	Network charge name
NSP81	Critical Peak Two rate 5 Day demand supplied at > 1kV	Demand Critical Peak
NSP78	Critical Peak Demand multi-rate > 850kVa & < 4 GWh	Demand Critical Peak
NSP77	Critical Peak Demand multi-rate > 550kVa & < 2 GWh	Demand Critical Peak
NSP76	Critical Peak Demand multi-rate > 280kVa & < 750 MWh	Demand Critical Peak
NSP75	Critical Peak Demand multi-rate > 150kVa & < 750 MWh	Demand Critical Peak

Table 1		# AusNet days curtailed for, resulting value capture (per 1 MW curtailed), ($)					
Code	**Cal Year 2018 DCP Rate ($/MVA/Yr)**	5	4	3	2	1	0
NSP81	65,391	65,391	52,313	39,234	26,156	13,078	-
NSP78	100,850	100,850	80,680	60,510	40,340	20,170	-
NSP77	91,980	91,980	73,584	55,188	36,792	18,396	-
NSP76	85,606	85,606	68,485	51,364	34,242	17,121	-
NSP75	82,512	82,512	66,010	49,507	33,005	16,502	-

Table 2		Opportunity Cost of only participating in X AusNet Days ($)					
Code	Cal Year 2018 DCP Rate ($/MVA/Yr)	5	4	3	2	1	0
NSP81		-	13,078	26,156	39,234	52,313	65,391
NSP78		-	20,170	40,340	60,510	80,680	100,850
NSP77		-	18,396	36,792	55,188	73,584	91,980
NSP76		-	17,121	34,242	51,364	68,485	85,606
NSP75		-	16,502	33,005	49,507	66,010	82,512