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Australian Renewable
Energy Agency

ARENA



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Demand Response Project Performance Report

ARENA Knowledge Share Report
June 2019

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GLOSSARY

AEMO	Australian Energy Market Operator
APP	Administered Pricing Period
ARENA	Australian Renewable Energy Agency
AT1	Activation Test 1
AT2	Activation Test 2
AT3	Activation Test 3
BDR	Behavioural Demand Response
BI	Business Intelligence
C&I	Commercial & Industrial
DER	Distributed Energy Resources
DR	Demand Response
eDM	Electronic Direct Marketing
ITT	Invitation to Tender
kW	Kilowatt
LCD	Load Control Device
MM	Mass Market
MVP	Minimum Viable Product
MW	Megawatt
NEM	Nationale Electricity Market
NMI	National Metering Identifier
NSW	New South Wales
PV	Photovoltaics
RERT	Reliability and Emergency Reserve Trader
SA	South Australia
SMS	Short Message Service
VIC	Victoria
VPP	Virtual Power Plant

EXECUTIVE SUMMARY

The Energy sector is undergoing unprecedented change with a wave of disruption that will re-invent the industry. Significant investment is required across the supply chain to deliver a reliable, secure, affordable and sustainable energy network.

Distributed energy resources (DER) like solar, energy storage, smart homes and electric vehicles will have a material impact on the investment trajectory for the energy sector. Given the strong focus on energy costs in Australia, decentralised, behind the meter activity, including self-generation and load control, is seen as a potential way to reduce system wide costs for all market participants.

The Australian market has some of the highest uptakes of DER globally, and a key challenge for the Australian energy sector is to integrate the rapidly growing share of behind the meter DER and large-scale renewable energy sources across the National Electricity Market (NEM), while preserving or improving the reliability, security, affordability and sustainability of energy.

EnergyAustralia's Demand Response (DR) project seeks to deliver DR capability as agreed under the ARENA Advancing Renewables Programme – Demand Response, and is underpinned by EnergyAustralia's Purpose, **'to lead and accelerate the clean energy transformation for all'**.

The programme objective is to provide up to 50 megawatts (MW) of DR capacity per year over the next three years, which can be called upon by AEMO if operating reserves in the NEM fall to critically low levels, derived as follows:

- 18 MW of DR in NSW in the first year of the trial, increasing to 20 MW in years two and three
- 20 MW of DR in VIC/SA in year one, increasing to 30 MW in years two and three

This programme also provides an opportunity to further develop and test EnergyAustralia's innovative solutions for a future energy grid which include but are not limited to;

- capability and capacity to deliver reserves,
- financial viability and co-funding,
- customer engagement with DR, and
- innovation and knowledge sharing.

The programme, which began in December 2017, will help to provide insight into consumer engagement in DR activities, and whether DR can assist in maintaining a stable electricity grid in the NEM.

1. CONTEXT

This knowledge share report represents the evolution of the EnergyAustralia DR journey since beginning this programme and performance outcomes of the past three ARENA Activation Tests (AT1, AT2 and AT3).

2. OVERVIEW OF CUSTOMER SEGMENTS AND ACTIVITIES

The portfolio draws on initiatives across all customer segments using a complex and highly diversified portfolio and leverages several existing and new activities and technologies. EnergyAustralia aggregated the various distributed elements and offered these as a diversified reserve capacity as part of the trials.

The portfolio employs the following DR approaches:

- **Mass Market (MM) Behavioural Demand Response (BDR)** - Residential customers are invited to participate in DR campaign/s and receive incentives if they reduce their consumption in response to an SMS notification.
- **MM Circuit Level Control Device campaign** - where residential customers install innovative, high quality circuit-level monitoring and remote-control capable devices at their premises; consumers can receive incentives if they allow EnergyAustralia to switch off their appliances such as air-conditioners, pool pumps or other loads at the circuit level, and after a series of notifications.
- **Battery storage group control** - this activity involved developing group control capability to aggregate a large proportion of battery storage devices. For a financial incentive, customers allow EnergyAustralia to remotely charge and/or discharge their battery into the grid after a series of notification steps.
- **Biofuel conversions** - EnergyAustralia has enabled existing or new diesel generators to qualify as being operated as a 100% renewable generation source. This can be achieved through using a biofuel, which is derived from products such as recycled cooking oils.
- **On site generation** - a group of customers have linked their assets to a Virtual Power Plant (VPP) platform to allow for remote control and orchestration of their DER assets. The VPP includes a range of generators which can be called upon when needed and business activities can be curtailed or shifted when advance notice is given.
- **Commercial and Industrial Customers** - EnergyAustralia has collaborated closely with a number of major customers and our VPP provider for some time, trialling an innovative approach to DR. In certain sites, a range of capabilities are managed simultaneously to provide load reduction during events. This includes pre-cooling/heating at large sites, and curtailing low temperature freezers under managed conditions. To date, key successes, include the ability to control numerous sites, each with different capabilities and strict operational limitations under one platform.

This is a cornerstone to developing a cost effective and comprehensive demand management strategy that can be rolled out nationally to all sites and businesses across the EnergyAustralia retail portfolio.

- **Large scale industrial load curtailment** – several of EnergyAustralia’s largest customers have seen significant value in participating in and providing DR reserve through curtailment of core business activity. Each has gone through a process of change management to ensure their availability fits within requirements of notification and activation times while still being able to manage core business activities.

3. METHODOLOGY

EnergyAustralia decided to approach building DR capability over two stages.

3.1. Stage 1

The first stage focussed on delivering 38MW of reserve capacity split between Victoria, New South Wales and South Australia, using a Minimal Viable Product (MVP) philosophy to ensure speed to market and to minimise development times. Stage 1 included entering into commercial arrangements with vendors and initial customers, which enabled EnergyAustralia to establish initial MVP offerings for the market. This approach ensured that systems, processes, technology and value propositions were suitable when called for test and dispatch events.

3.2. Stage 2

To support the subsequent tests and to scale the initial MVP offerings, EnergyAustralia scaled the technology platforms and supporting processes established during Stage 1; improvements include:

- Expanded use of the BDR engagement portal to deliver event management capabilities for all in market Mass Market solutions.
- Uplifted and refined the event management process.
- Executed Mass Market surveys post-test events.
- Formalised C&I customer performance debrief approach and supporting collateral.
- Commissioning of the first biodiesel site in our portfolio.
- Gained insights from residential participants that will assist with designing future program including incentive structures and engagement approaches.
- Electronic Direct Marketing campaigns targeting EnergyAustralia residential customers which directed customers to a webpage that enables digital sign up and self-enrolment in BDR programs.
- Increased BDR participation in both VIC/SA and NSW.
- Increased C&I participation in VIC and the first-time participation of C&I in South Australia.
- Trialled an alternative event messaging platform for Mass Market customers.
- Built new Business Intelligence data modelling tools for C&I customer analytics.

4. TECHNOLOGY

EnergyAustralia is using the ARENA trial as an opportunity to test multiple control devices and software platforms at customers' premises as well as application platforms for customer registrations.

5. TEST PERFORMANCE

An activation test involves the following:

1. A formal request to AEMO by EnergyAustralia of the preferred three-day test window.
2. Confirmation by AEMO that request has been received.
3. Subsequent notification to the EnergyAustralia trading desk via an SMS with a formal invitation to tender from AEMO to progress the test between the hours nominated.
4. On acceptance of the notification, EnergyAustralia arms the Demand Response portfolio and responds to AEMO confirming availability.
5. On receiving formal notification from AEMO to activate the reserve capacity, capacity is dispatched by EnergyAustralia at the nominated time.

5.1. Summary of Test Results

DATE	STATE	TIME	DR Target (MW)	Delivered Reserve (MW)
16 January 2018	NSW	12-2pm	18	23.2
2 March 2018	VIC/SA	2-4pm	20	19.8
17 May 2018	NSW	5-7pm	18	23.8
29 May 2018	VIC/SA	4-6pm	20	24.2
29 October 2018	VIC/SA	1-2pm	30	30.7
28 November 2018	NSW	2-4pm	20	26.5

By the end of March 2018, EnergyAustralia had conducted two successful DR tests (43MW to a target of 38MW, 113% of target MW achieved during test windows), across both regions (NSW, VIC/SA)..

The May 2018 ARENA AT2 was successfully concluded with target reserve capacity objectives met. Overall 48MW of reserve capacity was achieved against a target of 38MW (126%)

The October and November 2018 ARENA AT3 was successfully concluded with target reserve capacities met. Overall 57.2 MW of reserve capacity was achieved against a target of 50MW.

AT3 Key Achievements:

- This was an improvement of 11.7% from the tests conducted in May 2018
- 30.7 MW compliant reserve capacity achieved for VIC/SA against a targeted capacity of 30MW
- VIC/SA improved by 22% from the March 2018 test

- 26.5 MW compliant reserve capacity achieved for NSW against a targeted capacity of 20MW

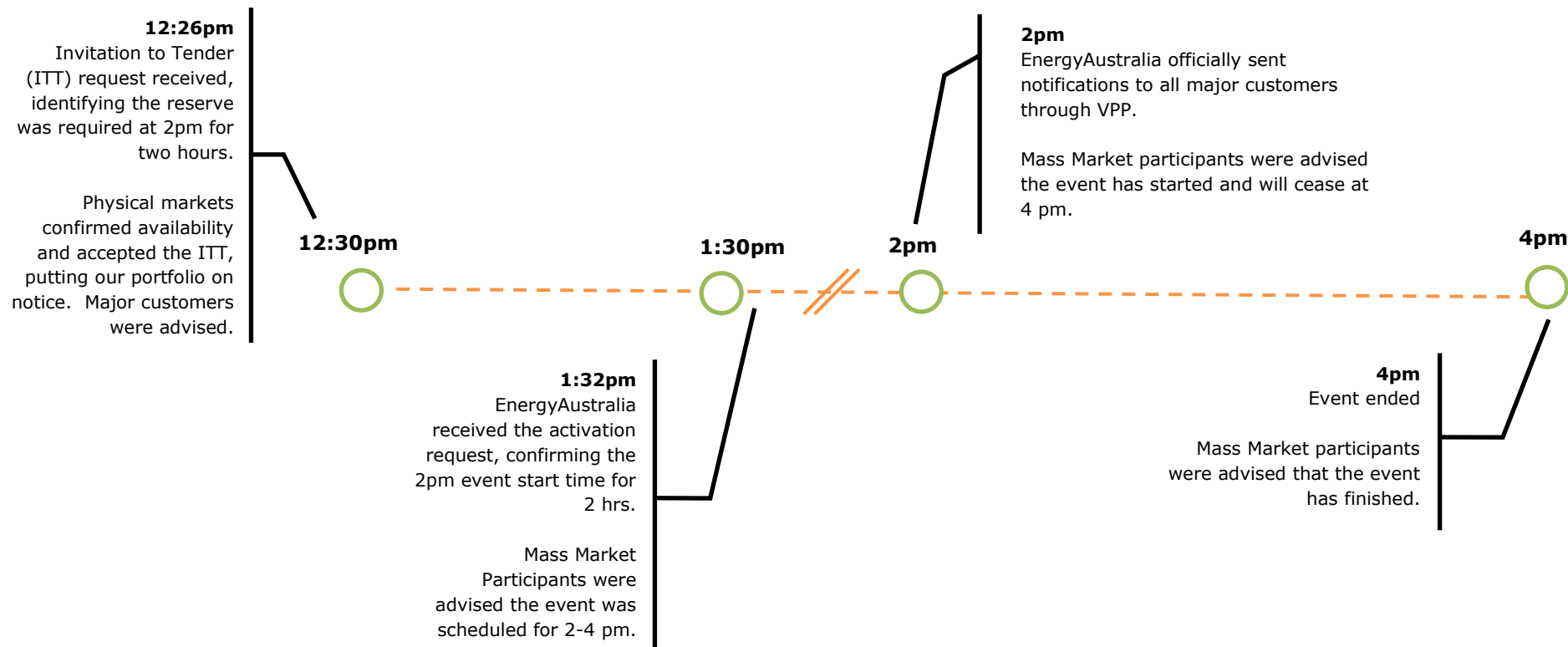
EnergyAustralia's calculations have been validated and verified independently by AEMO.

Measurement indicators used include:

- **Actual Usage**
- **Baseline Usage**, which is the average usage of an individual or portfolio over 10-days.
- **Adjusted Baseline**, which is the individual or portfolio's expected usage during a demand response event. The Adjusted Baseline is calculated using the Actual Usage and Baseline Usage prior to the event.

5.2. Anatomy of an event

The following illustrates how a real test was experienced by EnergyAustralia, our vendors, and MM participants.



5.3. Materialising a Diverse Portfolio

It is EnergyAustralia's aim to draw together a complex and highly diversified DR portfolio that provides the contracted reserve capacity.

Reserve capacity targets were established by EnergyAustralia per NEM region, year of programme, technology, and customer segmentation. These targets were established with no prior knowledge or experience in formulating and materialising a diverse DR portfolio.

Note that a number of the learnings are captured in SECTION 6 – LESSONS LEARNED.

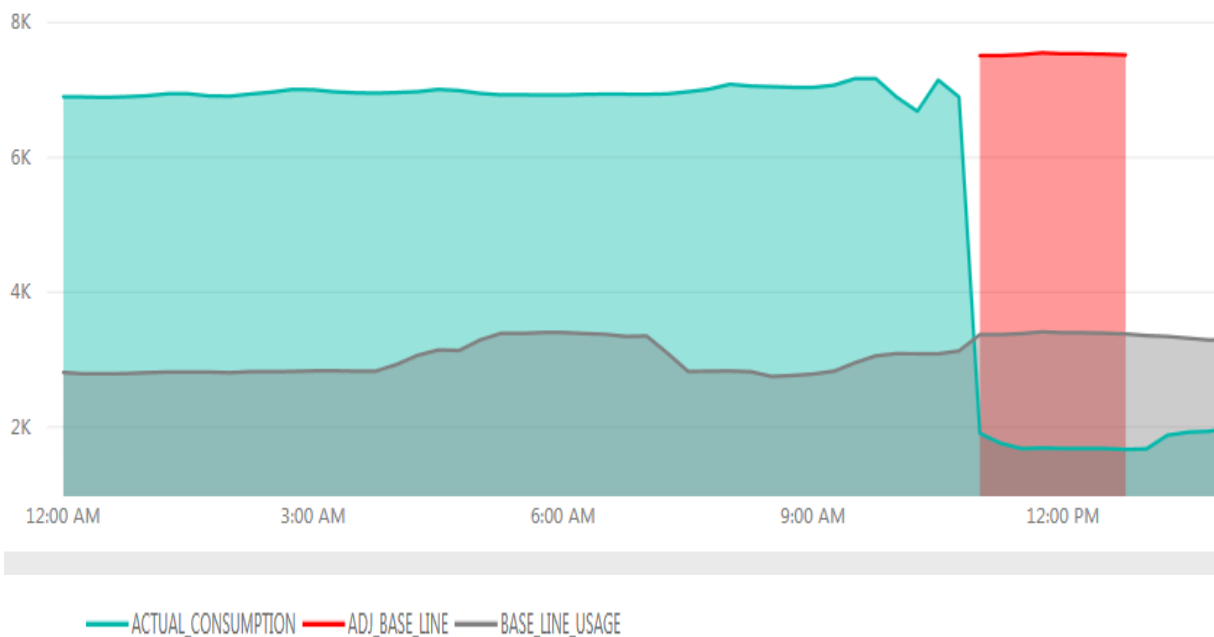
5.4. NSW Tests

Our initial test was conducted on 16th January 2018 between 12-2pm. This resulted in the successful curtailment of participating C&I sites and residential customers, totalling approximately 23.2MW of capacity.

Note: For all graphs following, the Adjusted Baseline is the portfolio's expected usage during the test period.

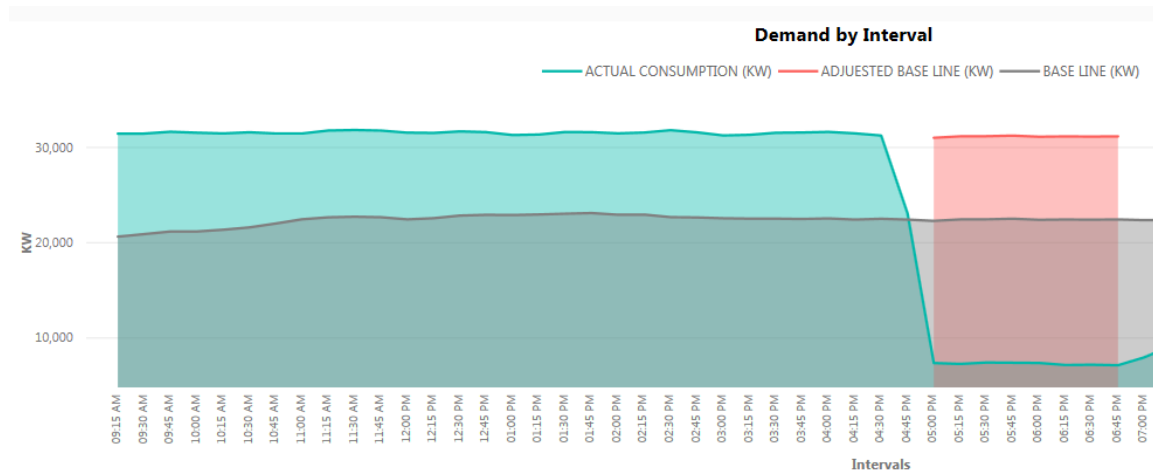
Test 1 – NSW Tuesday 16 January 2018, 12-2pm

Delivered Reserve: 23.2MW

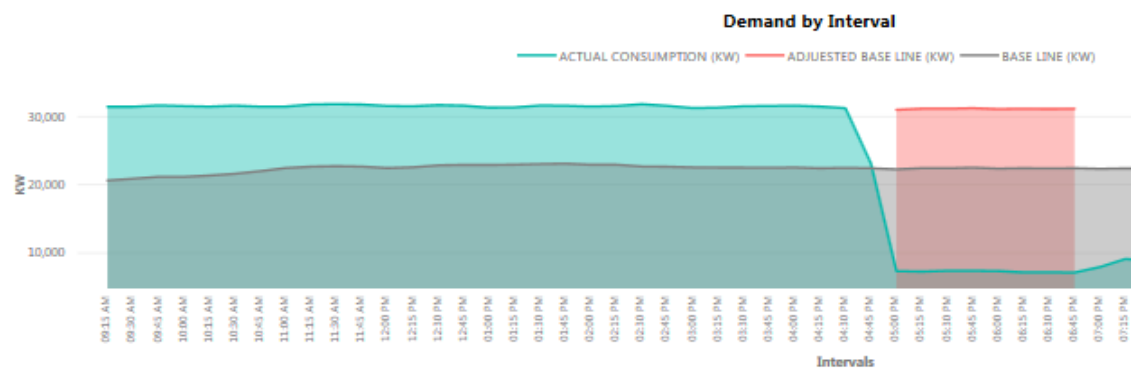


Test 2 – NSW Thursday 17 May 2018, 5-7pm Delivered Reserve: 23.8MW

The second NSW test was conducted on 17 May 2018 between 5-7 pm. This resulted in the successful curtailment of participating C&I sites and residential customers. 23.8MW compliant reserve capacity achieved against a contracted target of 18MW.



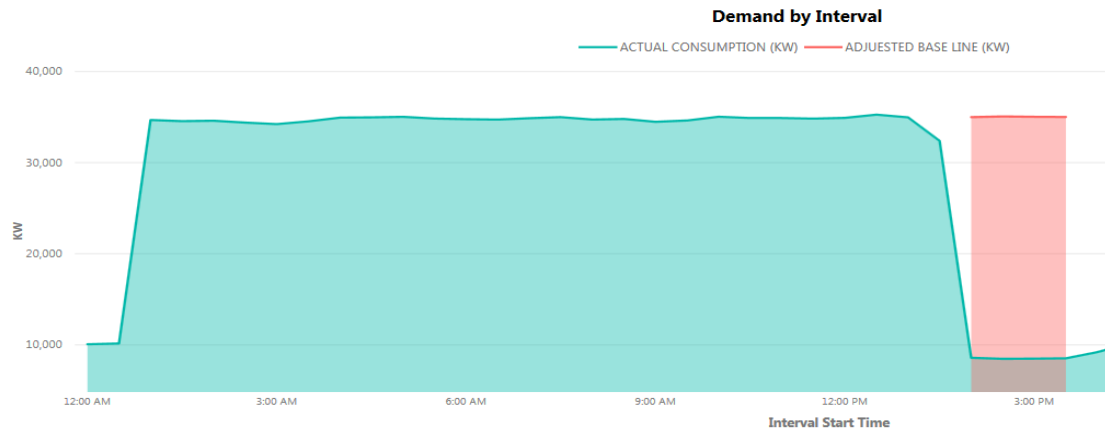
NSW Commercial & Industrial Test Performance



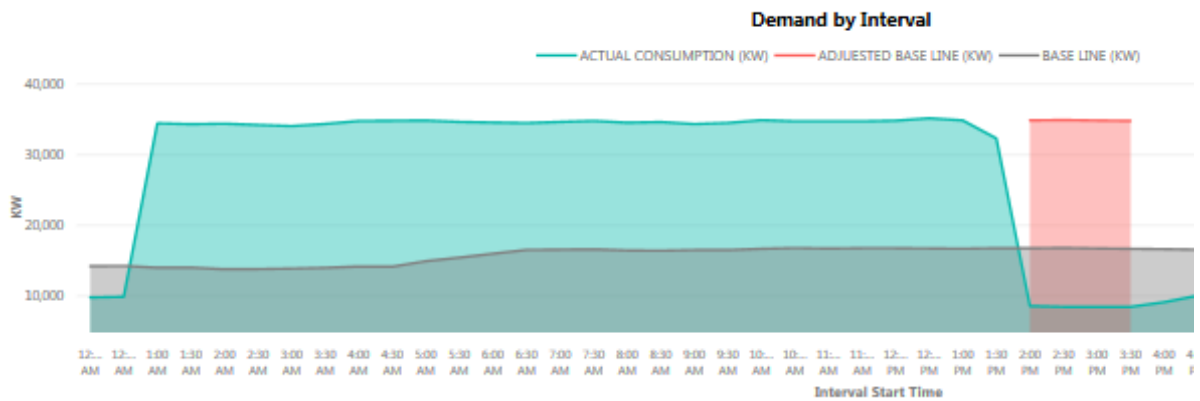
Test 3 – NSW Wednesday 28 November 2018, 2-4pm

Delivered Reserve: 26.5MW

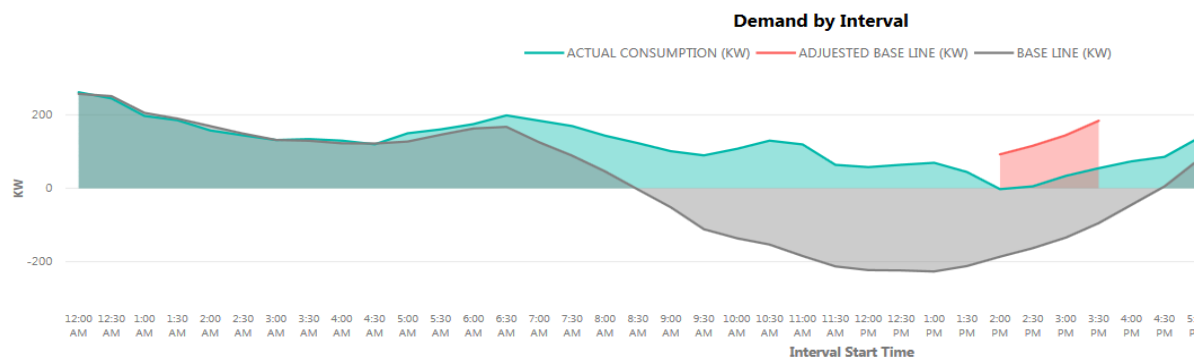
The test was conducted on 28 November 2018 between 2-4 pm. This resulted in the successful curtailment of the participating C&I sites and residential customers. 26.5MW compliant reserve capacity achieved against a contracted target of 20MW. The delivered reserve saw a 11% improvement over the May 2018 test, and a 14% improvement over the March 2018 test.



NSW Commercial & Industrial Test Performance



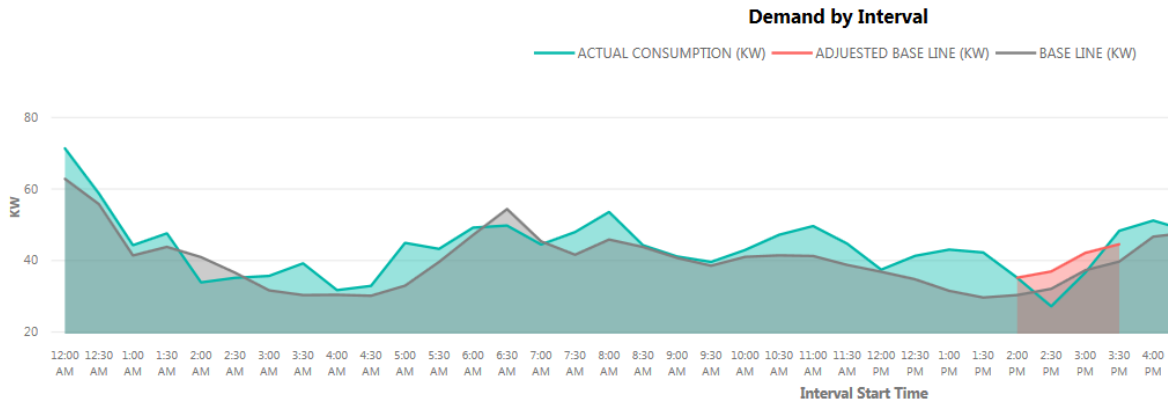
NSW Mass Market Test Performance



NSW Mass Market Solar vs Non-Solar Test Performance

- Non-Solar**

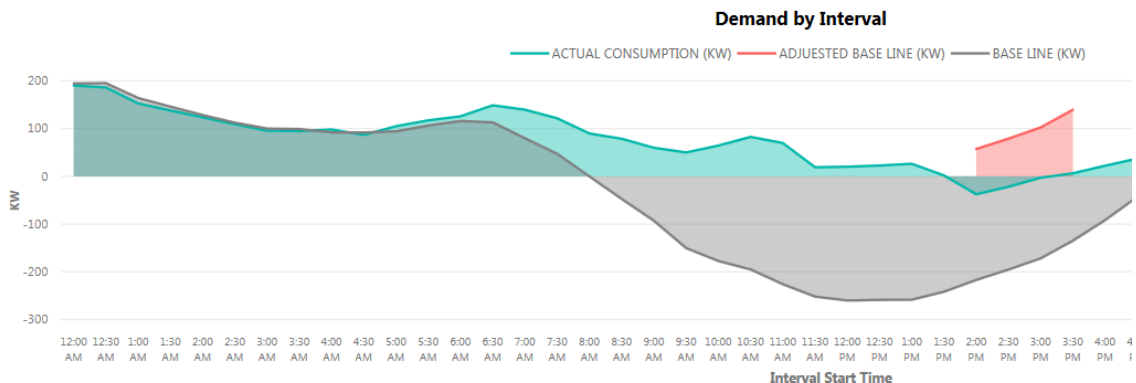
A number of non-solar customers provided 3.5 KW during the test. The accuracy of the baseline methodology may have been impacted by the weather that day. With Sydney experiencing torrential rain, customers may have been more inclined to stay home resulting in higher energy consumption.



- Solar**

97.5 % (110 KW) of the total MM load was derived from solar customers (~66% of total MM participants) due to unusual weather conditions on the day of test. Given solar customers were more dependent on the grid on event day than previous days, this resulted in higher than usual adjusted baseline leading to a larger calculated load curtailment.

~82 % of Solar customers curtailed their usage by 20% and over.

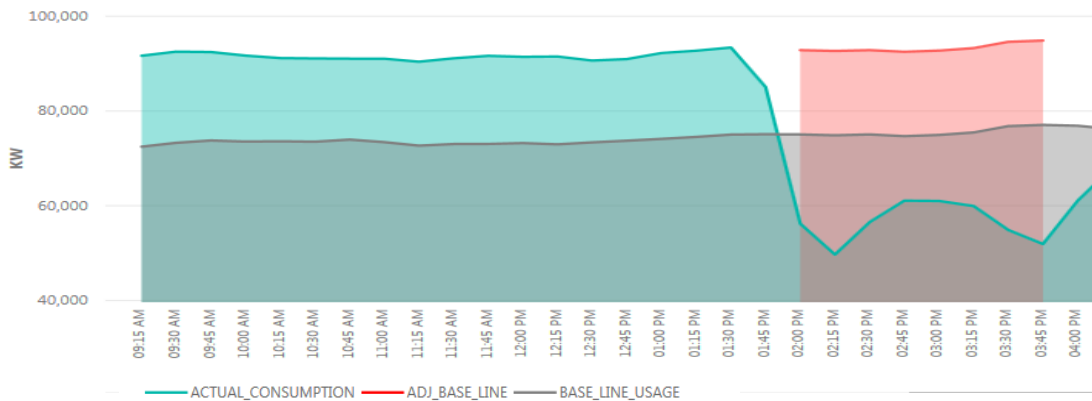


5.5. VIC/SA Tests

Our initial VIC/SA test was a complex portfolio of a few hundred MM customers and minimal participating C&I sites all responding in unison to AEMO's activation test event over the nominated three-day test window period. The test was conducted on 2nd March 2018 between 2-4pm and EnergyAustralia was successful in curtailing 19.8MW towards a contracted target of 20MW.

Note: For all graphs following, the Adjusted Baseline is the portfolio's expected usage during the test period.

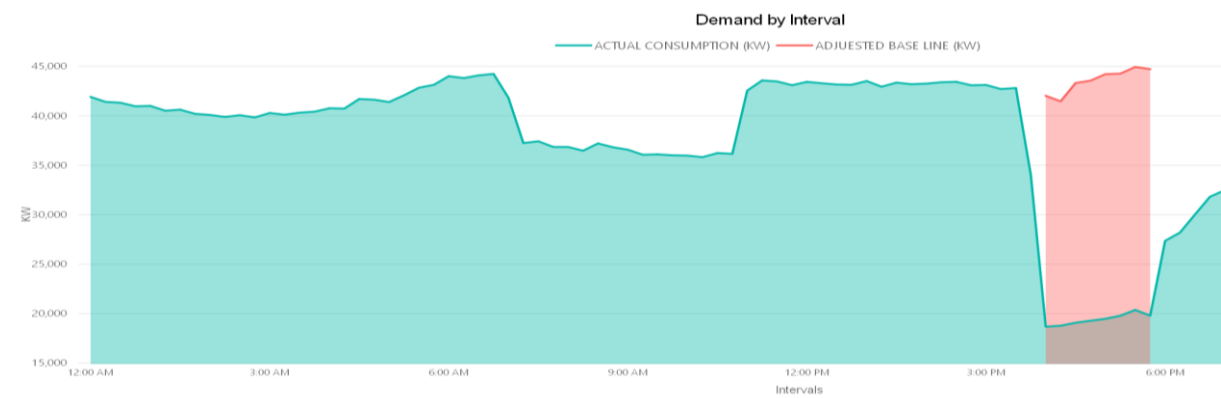
Test 1 – VIC/SA Friday 2 March 2018, 2-4pm Delivered Reserve: 19.8MW



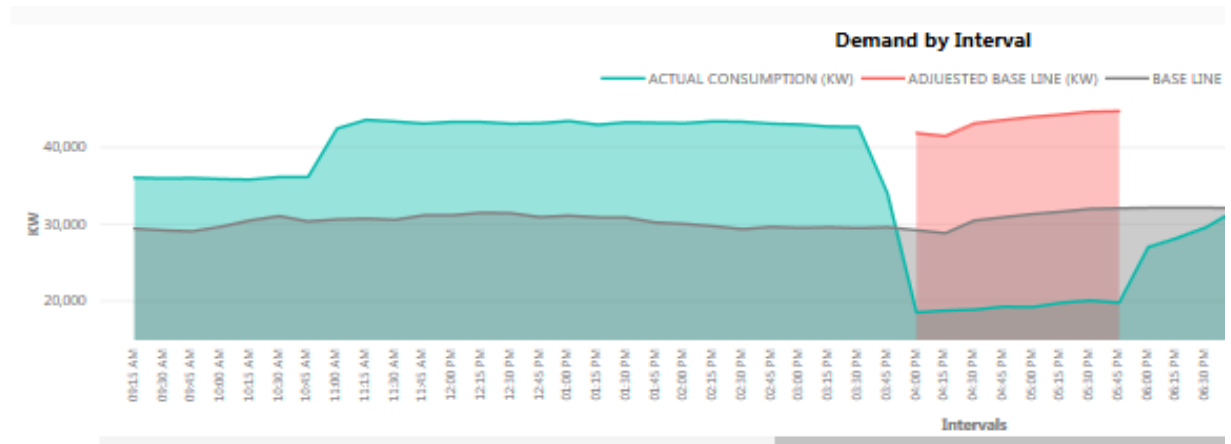
Test 2 – VIC/SA Friday 29 May 2018, 4-6pm Delivered Reserve: 24.2MW

The second VIC/SA test was a more complex portfolio with a similar number of MM customers and a larger group of participating C&I sites, again all responding in unison to AEMO activation test event in the nominated three-day test window period.

The test was conducted on 29 May 2018 between 4-6pm and EnergyAustralia was successful in curtailing 24.2 MW compliant reserve capacity against a contracted target of 20MW. The delivered reserve saw an 22% improvement over the March 2018 test.



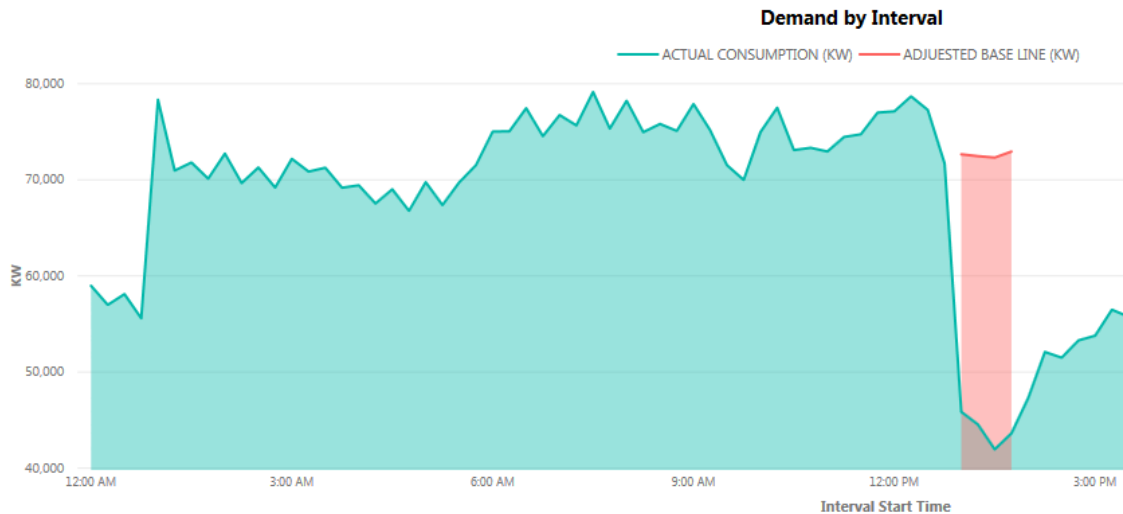
VIC/SA Commercial & Industrial Test Performance



Test 3 – VIC/SA Monday 29 October 2018, 1-2pm Delivered Reserve: 30.7MW

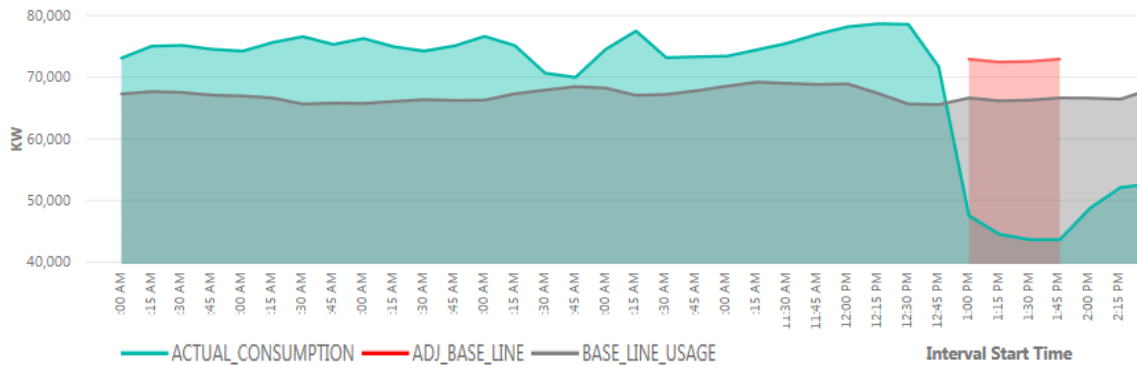
The portfolio in this test had increased complexity and included thousands of MM customers and a larger number of participating C&I sites.

The test was conducted on 29th October 2018 between 1-2pm and EnergyAustralia was successful in curtailing 30.7 MW compliant reserve capacity against a contracted target of 30MW. The delivered reserve saw a 21% improvement over the May 2018 test, and a 40% improvement over the March 2018 test.

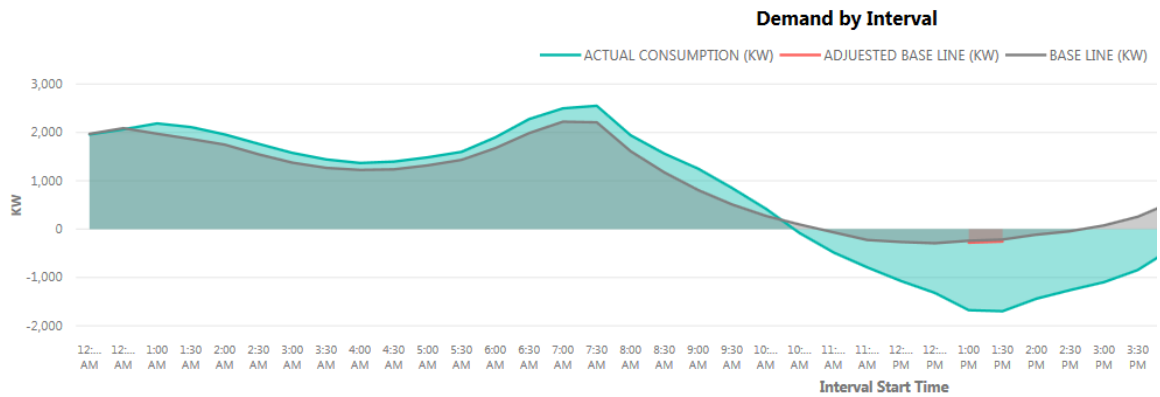


In order to be consistent with NMI Declaration (AEMO), the report includes NMIs, for MassMarket, that performed (delivered reserve over 0 KWh) during the test.

VIC/SA Commercial & Industrial Test Performance



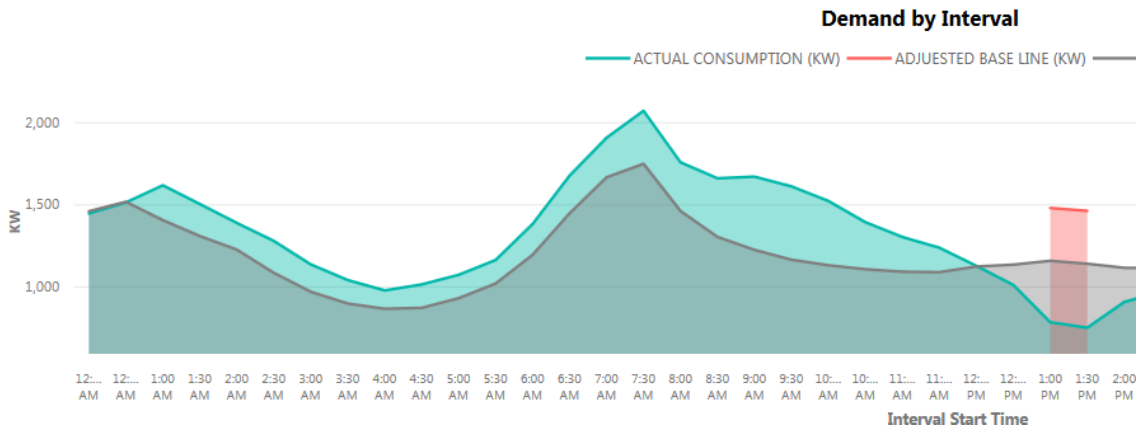
VIC/SA Mass Market Test Performance



VIC/SA Mass Market Solar vs Non-Solar Test Performance

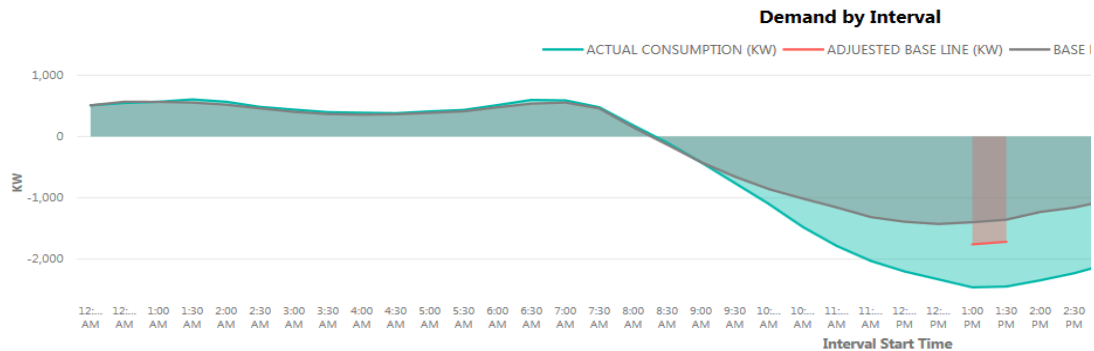
- **Non-Solar**

A number of non-solar customers responded to the test notification by reducing their consumption and provided reserve of 695.8 KW.



- **Solar**

Solar customers (24% of Mass Market participants) provided half of the Mass Market load (716.5 KW) because of suitable weather conditions during the test window – the adjusted baseline took into account a period of time where solar was not exporting the grid.



Demand Response Event – VIC/SA Thursday 24 January 2019, 5:30-7:30pm

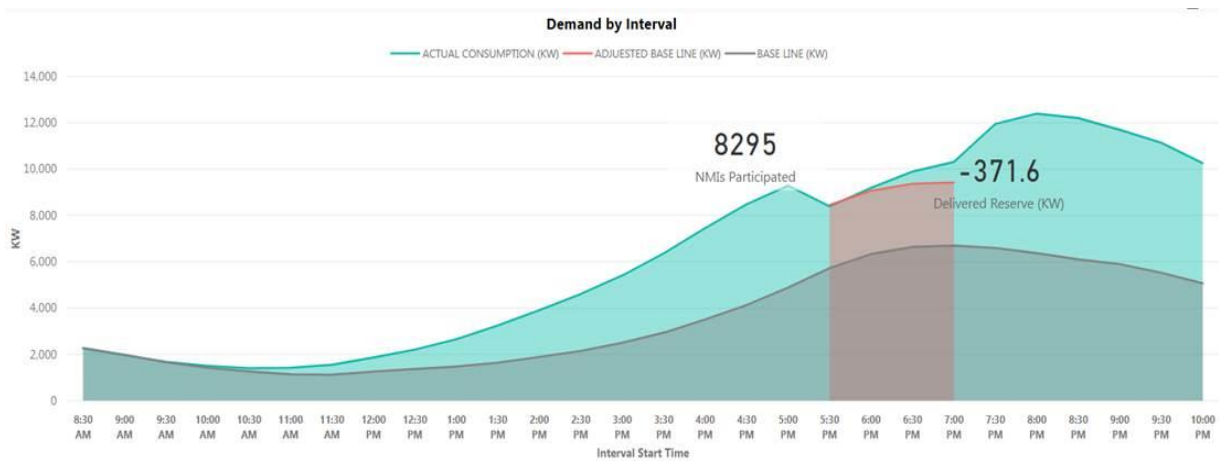
Delivered Reserve: 21.5MW (inclusive of loads already offline)

On Thursday the 24th of January, the temperature in Melbourne reached 40.8 degrees celcius putting an immense amount of strain on the grid in Victoria. EnergyAustralia was able to use its demand response portfolio as follows:

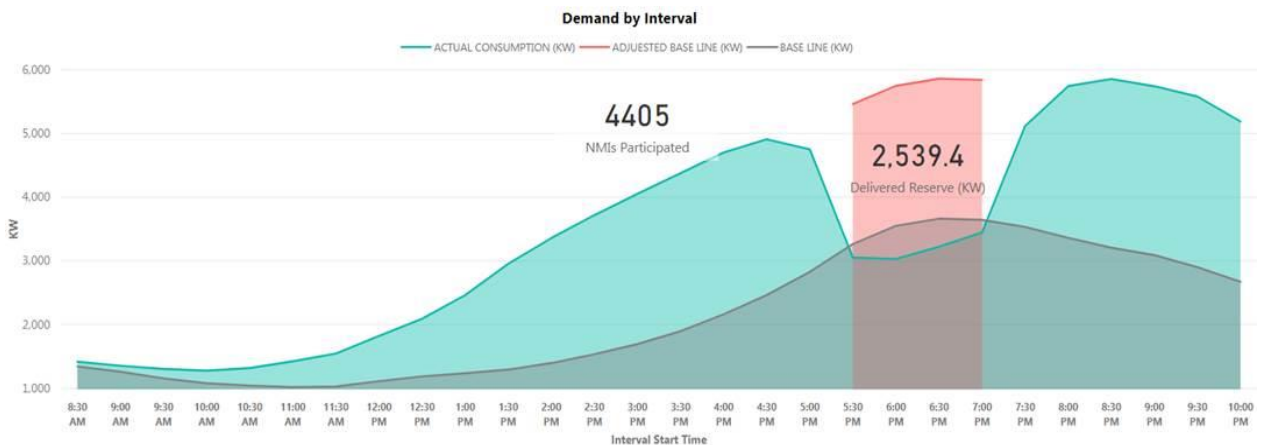
- Overall EnergyAustralia activated ~9MW of C&I DR
- A major commercial customer (10MW) was already offline
- Activated 2.5MW of Mass Market DR (further learnings and information on this below)

For Mass Market, 8,295 residential customers received DR notifications to reduce their consumption but not as many customers, as per the meter data, could support during the test and consumed more than the previous days due to hot weather conditions.

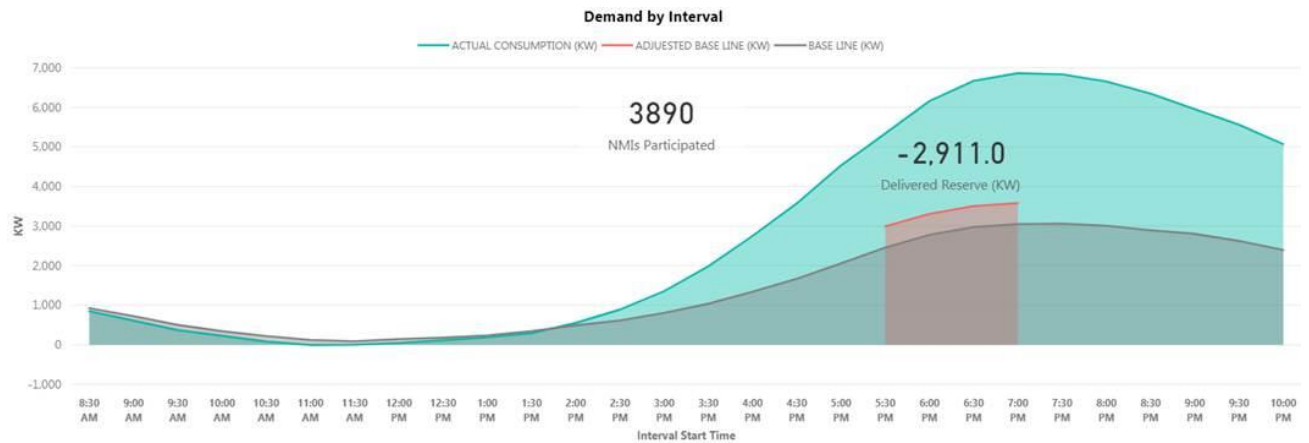
The overall demand was 371.6 kW more than the adjusted base line.



There were 4,405 customers (53% of participants) whose delivered reserve was positive which means they provided some sort of reserve during the DR event. Their combined delivered reserve is 2.5 MW. It is clear from the green actual consumption graph that these customers did indeed respond to the call to action.



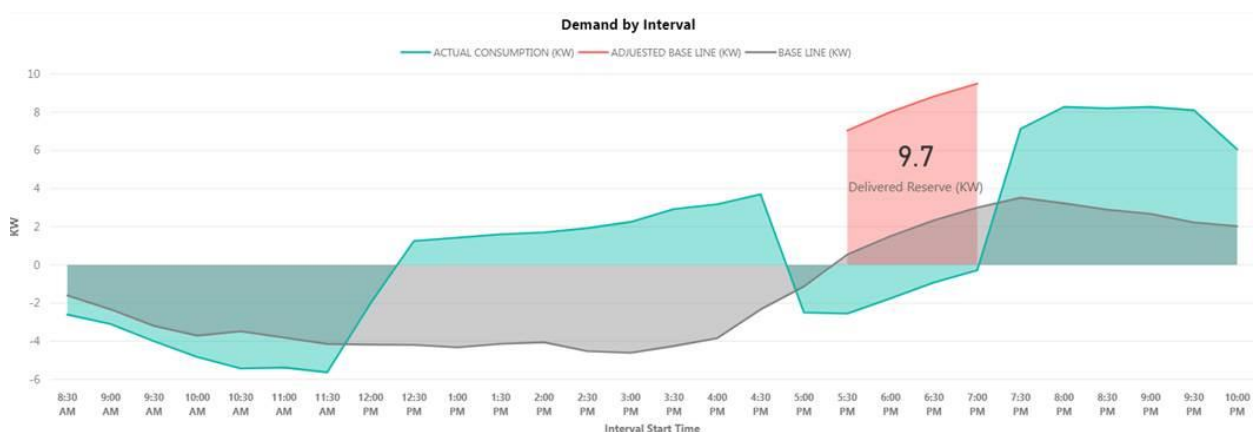
However, this was offset by 3,890 customers who didn't respond and consumed 2.9 MW over than they normally would have.



From these 3 graphs of the event of the 24th of Jan for Mass Market it is clear that even though the net consumption was 371.6kW over the adjusted baseline, this would have been much higher had a DR event not have been called by EnergyAustralia.

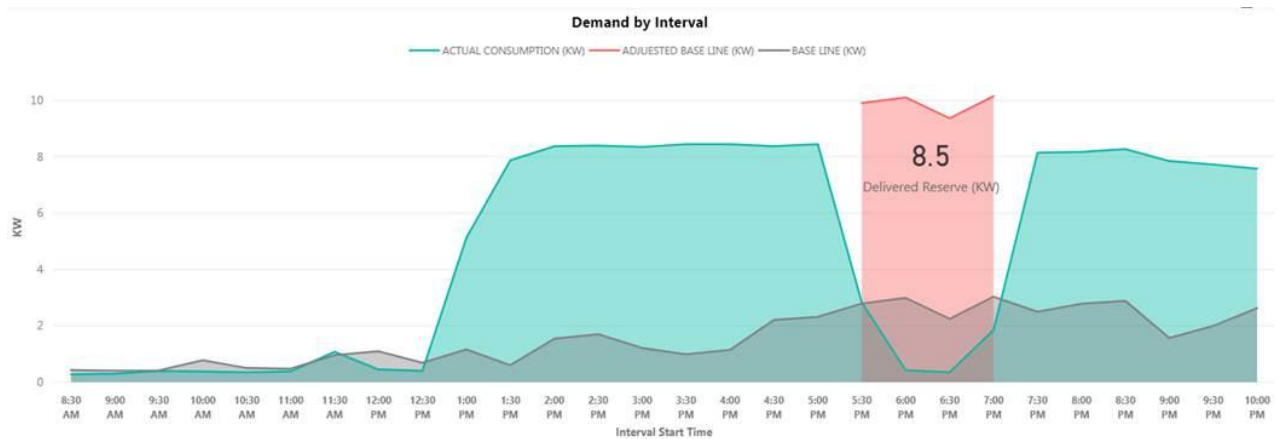
Below are further deep dives into two customers who curtailed during the event, one has solar, the other does not.

Looking at the solar customer's usage, their solar generally fed-in to grid during afternoon but on the event day their house was exporting from the grid, assuming it may have been the air conditioner in play due to hot temperature. As soon as the test notification was received, the customer responded by curtailing which helped solar to feed in to grid. Straight after the test, the customer started consuming energy normally.



Example 2: This is a highest curtailment from a non-solar customer during the event. This customer might have pre-cooled the house and switched during the event to support the grid.

The customer consumed 17 KWh (8.5 KW) less during 2-hours than what they would have otherwise used.



Demand Response Event – VIC/SA Thursday 25 January 2019, 12:00-3:00pm

Delivered Reserve: 21.5MW (inclusive of loads already offline)

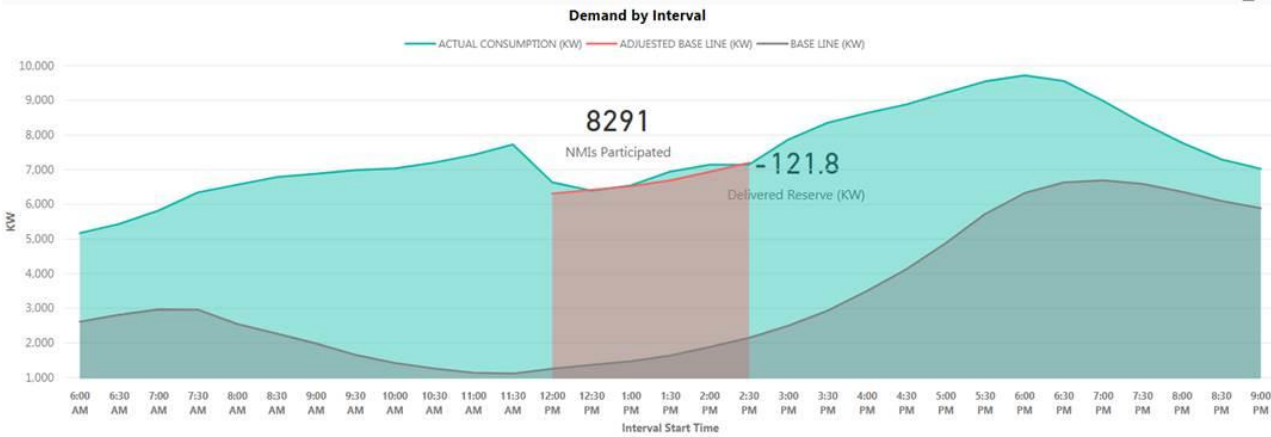
On Friday the 25th of January, the temperature in Melbourne reached 42.8 degrees celcius, continuing a streak of exceptionally hot days. EnergyAustralia was able to use its demand response portfolio as follows:

- Overall, we activated ~13.6MW of C&I DR
 - One site was due to start their 10MW plant at 10am. EA requested they delay their start to 3pm instead. This customer obliged.
 - One customer ran their generators until the administered pricing period (APP) began then turned them off due to cost.
 - One customer ran their generators through APP despite it not being cost effective.
 - Another industrial customer curtailed from 10am to 2pm. They remained offline for 4 hours despite it not being commercially viable due to APP. This customer earned 8% of what they did on Thursday the 24th January.
- Mass Market (MM) provided 2.3MW as explained below

The MM VIC/SA event was conducted between 12:00 PM and 3:00 PM. This was when the supply/demand was tightest and APP had been administered. An event notification was sent to customers at 11:00 AM with the intention of providing as much notice as possible for pre-cooling etc.

Overall, 8,291 customers received notifications to reduce their consumption. The overall demand was 121.8 kW more than the adjusted base line.

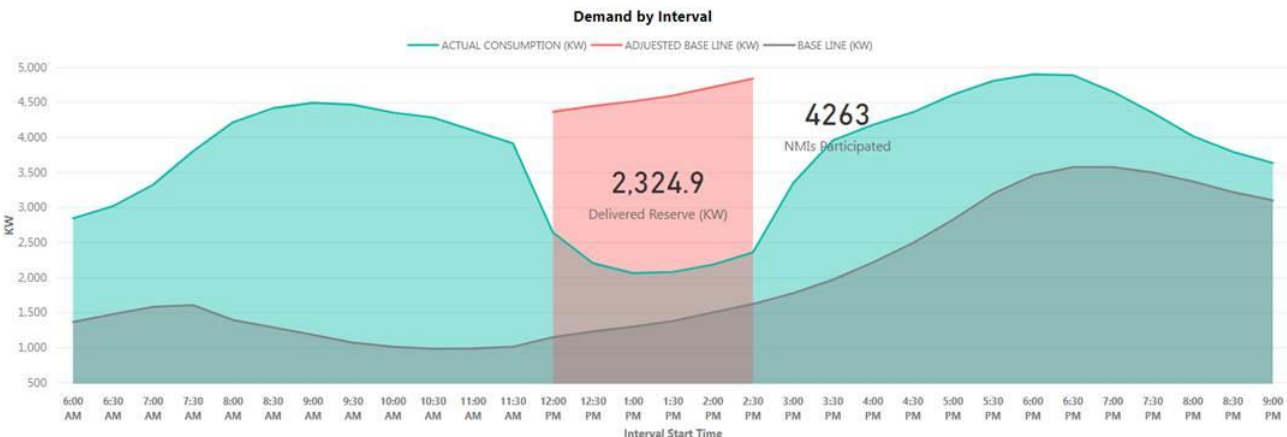
Having a hot start to the day and temperature peaking during the event window, greater number of customers were consuming higher than normal to keep their house cool.



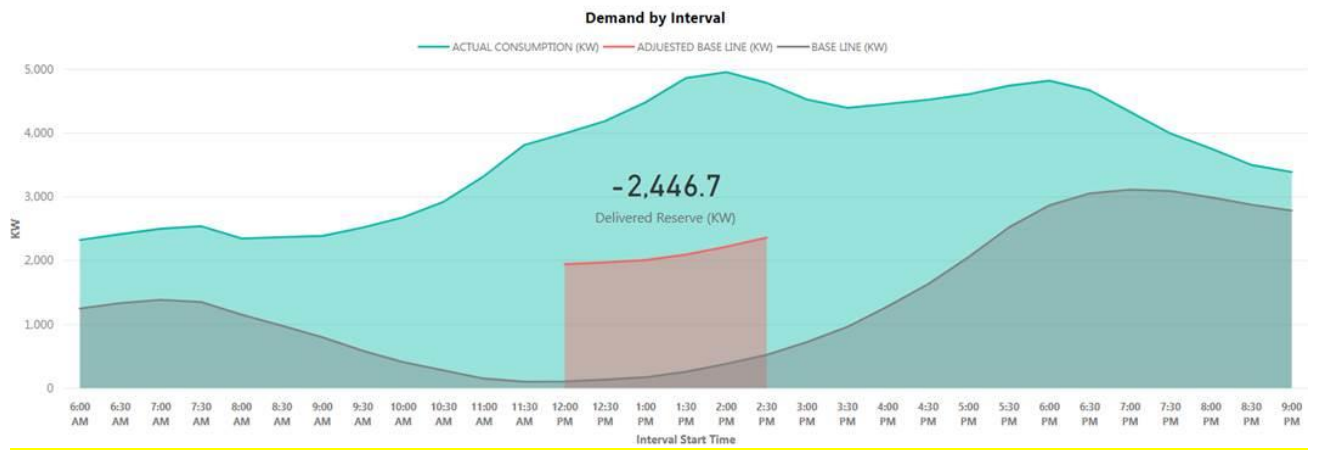
As result 8,291 customers consumed 365.3 kWh (121.8 KW) more than the adjusted baseline.

Focusing on the customers who provided curtailment during the event, there are 4,263 customers who curtailed and contributed 2.3 MW.

As shown below, their usage was significantly higher than their baseline from start of the day but as soon as they received the test notification after 11:00 AM, their usage went downwards and remained lower throughout the test window.



On the other end, 4,028 customers could not lend their support during the test and consumed 2.4 MW more than their adjusted baseline.



6. LESSONS LEARNED

The following outlines the lessons learned by EnergyAustralia during the successful tests.

6.1. Customer / Portfolio / Execution

At a high level our key learnings are:

1. Longer lead time is required to accommodate C&I customers in establishment of new contracts between all entities (EnergyAustralia and ARENA, EnergyAustralia and customers) due to the complexity of the commercial arrangements and liabilities regarding non-performance.
2. Participants may have conflicting commercial interests when considering core business objectives and DR incentives. Customers may also face technical challenges to provide the desired load reductions when sites have complex processes and safety considerations.
3. Commercial pressures relating to greenfield biodiesel investment and deployment time challenges, especially when considering that generator connections and switchboard upgrades can outlive the trial period.
4. Asset failure risks; EnergyAustralia will work towards integrating these insights into a demand response asset risk management strategy.
5. 10-day average may not represent baseline for all periods (i.e. Friday pm) which may not adequately account for the increase activity during those periods and so the delivered curtailment may be misrepresented (e.g. retail shopping centres).
6. Effective customer engagement is paramount and ongoing – education, branding, style, safety and voluntary nature are important; particularly from a Mass Market perspective.
7. Deep customer understanding - establishing a deep understanding of the baseline methodology and site operations of C&I customers enables identification and tailoring of the correct DR solutions for specific customers. This also helps to assess customer suitability for different programs as well as being able to better structure commercial incentive structure. Strong internal stakeholder engagement meant great collaboration and support was achieved despite pressures of short timeframes.
8. There is low smart meter penetration in NSW presenting a challenge in MM segment; there is an opportunity to increase DR participants as the uptake of smart meters progresses.
9. Survey results: Residential customers were asked to respond to a survey about their participation in one of the events. Approximately 50% completed it. Responses revealed:
 - a. 80% of respondents' actively changed their usage during the event
 - b. 64% of those that were at home, changed their usage behaviour
 - c. Participants scored 90% for their likelihood of recommending the program.


10. Load Control Device customer proposition needed refinement and a more focused message on the energy use case (ie Pool Pumps, low lifestyle impact narrative) and a contrast with the call to action associated with BDR; uplift in aggregation / fleet management software & capability required in order to onboard and operate at the scale planned.
11. Mass Market uptake in VPP segments is lower than expected, likely due to cost of entry of emerging technologies such as batteries.
12. Financial rewards were more appealing than altruistic rewards for MM customers.
13. Customer communication – pre and post event: Research indicates customers prefer to be communicated via email or SMS, and want to be advised of how they performed personally and what rewards they earned.
14. The CAISO 10 of 10 baseline may not be suitable for all types of BDR: unusual weather conditions can impact the artificially impact the adjusted baseline. In addition, a key learning is its lack of suitability when measuring curtailment from households with solar.
15. C&I customers were keen to come offline as a result of higher spot prices therefore provided MW capacity into the grid without necessarily being officially called for RERT.
16. On the 25th of January, most C&I customers remained either switched off or remained offline almost solely to provide capacity into the grid and not necessarily for the financial gain.

6.2. Technology

The technology to support DR was assessed during the tests conducted. The tests highlighted areas in technology that worked well and those that are cumbersome and prone to error. These have the potential to impact the desired outcome of the test.

At a high level our key technical learnings were:

1. Our ability to monitor operational technology allowed early identification of issues and understand the 'health' of assets in the field
2. Interval meter data versioning and preliminary vs final results – timing can materially affect the DR performance calculations
3. Mass Market DR software platform experienced localisation challenges regarding time zones and daylight savings – our provider did not adjust for these.
4. Mass Market DR software platform localisation challenges regarding negative baseline and uncapped Morning of Adjustments.
5. Uncapped baselining calculations required system changes to cater for customer loads with Photovoltaic (PV) capacity, which can be net negative. The platform had hitherto only been used in jurisdictions with positive values. The software also had a cap and floor on the adjustment factor,



which needed to be removed to align with the symmetric additive adjustment methodology defined in the ARENA DR specification

6. Mass Market customers appear to be reluctant in purchasing battery storage based on current technology costs and marginal commercial outcomes.
7. Expected level of dispatchable battery energy is impacted by customer load and solar generation during an event.
8. Under some circumstances, using biofuel requires pre-heating due to viscosity requirements for engine combustion (for example, 2 hrs notice) Whilst the generator can still operate on standard diesel with short notice, the complication impacts on the intent of converting to biofuel in the first place and therefore reduces the value of using biofuel generators as emergency back-up or for demand response user cases.

7. CONCLUSION

DR and optimisation of DER plays a critical role in delivering EnergyAustralia's purpose and strategy. EnergyAustralia's DR initiative is leading the industry and accelerating the transition to a cleaner energy future through a combination of aggregating distributed energy sources and changing customer behaviours.

Whilst there were no dramatic changes in the methodology and technology used between the tests conducted, a substantial increase in energy curtailment has been achieved over the course of the programme.

The outcomes of these tests have demonstrated:

- The existing portfolio of customers are becoming familiar with the process as our Commercial & Industrial participants have provided more reserve compared to tests conducted earlier in 2018;
- EnergyAustralia has the processes in place to manage and learn from unforeseen events;
- Minor improvements to internal processes are required;
- Commercial & Industrial customers contributed all or most of the reserves, highlighting a need to further engage, educate, and develop effective incentives for Mass Market customers so that they too contribute large amounts of reserve capacity on a regular basis.

In preparation for future tests, EnergyAustralia is actively looking for avenues to unlock more DR curtailment out of the existing Mass Market portfolio. Particular focus will be on leveraging what will then be the newly built Mass Market technical solution, in addition to developing customer value propositions that assist with Load Control Device and battery adoption.