Restoring the balance: startup opportunities in Demand Side Participation

Demand Side Participation (DSP) in the electricity grid has received increasing attention in recent years. Historically, the most important question relating to electricity has been how to generate and transport enough of it to meet our ever-rising needs. However, the focus has increasingly turned to how demand-side resources, such as rooftop solar, household batteries and smart appliances, can be utilised to better manage the grid.

The business opportunity in providing DSP solutions is in the hundreds of millions, if not billions of dollars. The market for frequency control ancillary services (FCAS), which help balance the grid, has grown by an average of 54% per year for the last five years to be worth more than $200 million. In addition, new government incentives could unlock a similarly-sized market for Demand Management (DSP that reduces network constraints). However, the real prize could be in using demand-side approaches to innovate in the $50bn retail electricity market.

These opportunities are becoming accessible as a consequence of changing legislation and market rules. The Australian energy policy landscape is presently characterised by a high rate of change, with regulatory adjustments occurring across the system in response to recent events and reviews. Three changes of note are:

1. **Ancillary Services Unbundling:** On 1 July 2017 a new way of participating in the electricity market – as a Market Ancillary Services Provider – was created, lowering the barriers to providing FCAS.
2. **Demand Management Incentive Scheme and Innovation Allowance Mechanism:** On 14 December 2017 this scheme and accompanying mechanism were published to incentivise electricity distributors to explore demand-side approaches as alternatives to infrastructure spending. This could potentially create a $200 million market for Demand Management services.
3. **The 5-Minute Rule:** On 1 July 2021 the settlement period for the National Electricity Market will reduce from thirty minutes to five, significantly increasing the opportunity for demand-side resources to generate value.

(Energy)Lab

28 January 2018

James Tilbury
james@energylab.org.au

About EnergyLab
We are Australia's leading platform for launching new energy businesses. Our Acceleration Program was the first in Australia to focus on energy startups and is currently available in four different cities. To find out more visit energylab.org.au.

About EnergyLab's research
EnergyLab prepares discussion papers such as this to help facilitate productive conversation around clean energy innovation, and to promote and support clean energy entrepreneurship.

Suggested citation
Tilbury, James. *Restoring the balance: startup opportunities in Demand Side Participation*. EnergyLab, January 2018. <<app.energylab.org.au/research/demand-side-participation>>

Entrepreneurs can leverage emerging technologies to take advantage of these new opportunities. Household batteries are becoming cheaper and more ubiquitous, creating new opportunities to support the grid and arbitrage the volatile electricity market. Household appliances are also becoming smarter, creating new opportunities for Demand Response programs. Coordinating all household appliances in Australia could create something in the range of a 7.5 GW Demand Response resource, 100 times the capacity of Tesla's 'big battery' in South Australia.

We believe there are untapped business opportunities in DSP, and residential Demand Response in particular. By taking advantage of these trends startups may be able to reduce electricity bills, increase the ability of our grid handle renewable energy resources, and grow valuable businesses.

Contents

Introduction

At EnergyLab we're fortunate to see a lot of what entrepreneurs in Australia are working on as it relates to clean energy. We're about to close applications to the third intake of our acceleration program and have run dozens of workshops, hackathons and other events with energy entrepreneurs and other interested parties. Through this work, we have had exposure to hundreds of clean energy ideas and businesses, and we are starting to see trends in what entrepreneurs in this sector are working on.

Most of the startups we see could be broadly categorised as improving the sustainability of either energy production or energy consumption. On the production side, we received a lot of proposals from people working on better ways to generate electricity (including a few perpetual motion machines) as well those facilitating the uptake of existing renewable energy technology. On the consumption side, many entrepreneurs are attempting to overcome barriers to energy efficiency, and an increasing number are working on improving transport sustainability such as by facilitating a transition to electric vehicles.

Within the category of consumption, this discussion paper will focus on the sub-category of Demand Side Participation (DSP). This catchy piece of industry jargon is defined differently by different parties. We will take it to mean any interaction between consumers and the grid that results in an increase in the reliability or affordability of electricity. This could mean reducing energy consumption when there is stress on the grid or increasing consumption when too much energy is being generated. It also includes charging or discharging a household battery for similar reasons. For the entrepreneur, it means shifting attention from the person or company consuming the energy, and towards the electricity grid as a whole.

We think there is an opportunity for startups in DSP due to four different trends, which are nonetheless related and reinforcing:

- **Increasing variability of generation**: The first trend is the increasing need for measures to counteract the intermittency of renewable energy. The declining cost of renewable electricity (such as solar and wind) has resulted in a large proportion of electricity generation coming from intermittent sources, increasing the challenge of matching generation and consumption. DSP can help the grid adapt to this variability in a more dynamic way, by adapting the load on the grid to better match supply.
- **Increasing cost pressure**: The second trend is increasing electricity costs, with residential electricity prices rising by 47% in eight years in real terms.[1] This rise in costs has increased pressure to find cheaper ways to meet the energy needs of consumers.
- **Decreasing cost of technology**: The third trend is the increasing affordability of technology that enables DSP, such as rooftop solar, household batteries, smart meters and smart appliances. This increasing affordability is creating new options for controlling and managing electricity consumption and is also making existing options increasingly viable.
- **New regulatory space**: Finally, the fourth trend is a progression of regulatory changes that are lowering barriers and incentivising DSP. As we will see in a later section, these changes are making spaces for business models which could not have existed otherwise.

These four trends effectively present two problems, a technological solution, and freedom to use it.

[1] ACCC 2017 Retail Electricity Pricing Inquiry: Preliminary report

In our opinion, there are fewer entrepreneurs working on DSP than the opportunity justifies. There are a good number of fantastic startups in this area, some of which EnergyLab has had the privilege to work with. However, we think there is untapped potential for businesses to make money and facilitate an increase in renewable energy penetration by enabling consumers to play a more active role in managing the grid.

This discussion paper is intended to help entrepreneurs understand and take advantage of the opportunity DSP presents. To understand this opportunity, it is first necessary to grasp how Australia's electricity markets work, so this is where we start, followed by a discussion on how DSP fits into the picture. The next section contains the heart of the paper, estimating the size of the opportunity and summarising the recent legislative changes that have delivered it. We finish with a discussion of the potential for residential Demand Response and some concluding thoughts on related opportunities. The paper is structured so that any section the reader feels comfortable with can be safely skipped.

Understanding electricity markets

A proper appreciation of the DSP opportunity requires at least a high-level understanding of electricity markets. This section provides a quick (and rather simplistic) overview of how Australia's electricity markets work. More specifically, we'll talk about the National Electricity Market (NEM), which covers most of Australia, namely New South Wales, Victoria, Queensland, South Australia, Tasmania and the Australian Capital Territory.

A lot needs to happen for the lights to turn on every time someone flicks a switch. Generation and consumption of electricity needs to be constantly balanced, with unexpected deviations on either side of the equation adjusted for in real time. In addition, said electricity needs to be transported from wherever it was generated to wherever it's needed, and the wires between those two locations need to be able to handle the load.

Matching supply and demand is a lot more complicated in electricity markets than in other commodity markets. With commodities like grain and oil, any surplus production can be stored at relatively low cost, and then sold when demand picks up again. This makes matching variable supply and demand easier. However, we don't presently have a cheap way to store electricity in sufficient quantities, and so supply and demand need to be equal at all times. If they aren't the frequency of electricity starts to move off the sweet spot of 50Hz, which is undesirable for the stability of the grid and the safety of whatever is plugged into it. The Australian Energy Market Operator (AEMO) is responsible for balancing supply and demand, and therefore maintaining the grid at this frequency.

The wholesale electricity market is our primary tool for matching supply and demand. First AEMO asks electricity generators to tell them how much they would be willing to produce at different prices. For example, a coal plant might be willing to produce 1,000 MW at $50/MWh but would be happy to increase that to 2,000 MW if they could be paid $100/MWh. AEMO then go through their list of generators – from cheapest to most expensive – and deploy or 'dispatch' each one until enough electricity is being generated. The last generator to be chosen sets the 'dispatch price'. Therefore, if the coal plant just mentioned was needed to produce the last 2,000 MW required to match demand, then the dispatch price would be $100/MWh. AEMO match supply and demand as such for every 5-minute interval in the year. However, not everything always goes to plan.

The snappily titled 'frequency control ancillary services' (FCAS) is our secondary tool for matching supply and demand. During any 5-minute interval, something unexpected might disturb the balance between supply and demand. For example, the wind might start blowing harder than forecast, generating more wind power than needed, or a factory might have an unexpected failure, significantly reducing demand. At this point the FCAS markets step in by incentivising 'market participants' to increase or decrease their generation or consumption of electricity by just the right amount, thus restoring balance to the force. I mean the grid.

There are two types of FCAS: regulation and contingency. Regulation services correct minor deviations in load or generation while contingency services correct larger deviations following the loss of a generator, major load, or part of the transmission network. Regulation services are directly controlled by AEMO, and therefore loads providing such services need to have telemetry or other communications and control technology incorporated into them. By contrast, contingency services are activated automatically. This is

accomplished by monitoring the local grid frequency and then, if it is off the mark, adjusting the net load of a given facility to help correct it.[2]

Altogether there are eight ancillary markets, depending on the type of service, direction of change, and response time. Two are regulation markets, which trade in services that can raise or lower frequency. Six contingency markets trade in services capable of raising or lowering frequency in six seconds, sixty seconds or five minutes. These are summarised in Table 1.

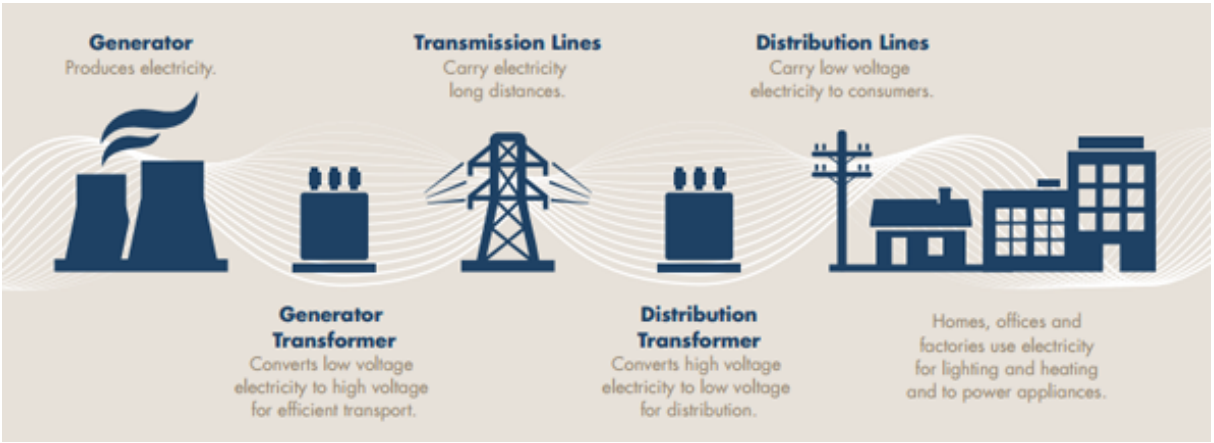
Table 1: Types of FCAS

Type	Direction	Response time	Bid code
Regulation	Raise	NA	Raisereg
	Lower		Lowerreg
Contingency	Raise	6 seconds	Raise6sec
		60 seconds	Raise60sec
		5 minutes	Raise5min
	Lower	6 seconds	Lower6sec
		60 seconds	Lower60sec
		5 minutes	Lower5min

There are also other services in play that help manage the grid. In addition to FCAS, there are Network Support and Control Ancillary Services (NSCAS) and System Restart Ancillary Services (SRAS). SRAS helps get the grid up and running after a blackout, while NSCAS encompasses a range of services, such as voltage control.[3]

Finally, after all this balancing has been done the grid needs to transport electricity from where it was generated to where we need it. This is done by transmission network service providers (TNSPs) and distribution network service providers (DNSPs or distributors). The transmission lines transport electricity from large generators to the distribution lines, which then transports the electricity to the businesses and households that consume it, as illustrated in the following figure from AEMO.

Figure 1: Transport of electricity[4]



[2] AEMO 2015 Guide to Ancillary Services in the National Electricity Market
[3] Ibid
[4] AEMO 2018 National Electricity Market

Network service providers must ensure the grid itself can handle the largest load we put on it during the year. Because we live in Australia this load occurs in summer. If the grid can transmit and distribute sufficient electricity to satisfy consumers on the hottest day of the year (when we all have our air conditioners at full blast), then it can handle anything else we throw at it. This load is called peak demand. To make sure the grid can handle peak demand, network service providers are constantly building and maintaining the network. The cost of doing so is eventually passed on to electricity consumers.

Electricity retailers deal with all these details so you don't have to. They are responsible for measuring how much electricity you use, paying generators to generate that amount, and effectively paying network service providers for getting it from A to B. Retailers also protect customers from price volatility, which we'll go into more later.

The role of Demand Side Participation

Historically, the national energy conversation has been dominated by the supply side and network considerations, with little room left for DSP. The topic hasn't been completely ignored; the initial design of the NEM included a strong statement about DSP and various schemes have encouraged it. But in general electricity consumption has been taken as a given, with the emphasis squarely on ensuring sufficient supply and network capacity to meet demand.[5]

Increasingly, it is being acknowledged that the demand side should play a more significant role in managing different aspects of the electricity system. As far as balancing the grid is concerned, reducing energy consumption is the same as increasing generation, and increasing consumption is the same as reducing generation. Therefore, focussing only on supply and infrastructure unnecessarily neglects one of the most important tools we possess to manage the grid. While in the past the cost of doing so may not have been worth the effort, the increasing affordability of solar, household storage, and communication technology makes it an opportunity worth paying attention to.

DSP can reduce the volatility of electricity prices. Instead of dispatching additional generation at a high price, consumption can be reduced instead. Whoever reduces their load will not only be charged for less consumption, but the price that they and everyone else in that settlement period pays will be reduced (assuming they're purchasing from the wholesale market).

DSP can also help match supply and demand within each 5-minute interval. Currently, FCAS are mostly provided by large-scale generators – energy generation is increased or decreased to counteract unexpected changes in supply or demand. [6] The same service can also be provided from the demand side, by increasing or decreasing consumption as needed.

Other ancillary services can be provided from the demand side too. As discussed previously, AEMO and network service providers acquire a range of grid services to keep everything running smoothly, many of which could technically be provided by demand side resources. Australian start-up Reposit claims that if configured properly, a network of household batteries controlled by their software could help restart the grid after a blackout.[7] While these possibilities are interesting, we will focus on FCAS in this paper as we believe that to be a more attractive opportunity due to a combination of revenue potential and accessibility.

Finally, and importantly, DSP can reduce the need to build additional grid infrastructure. Instead of upgrading the grid to meet rising peak consumption, demand can instead be reduced during those peak periods. It may be necessary to pay people to reduce their consumption, but if they're paid less than it would cost to build the infrastructure everyone will benefit. When DSP is used as an alternative to building grid infrastructure this way, it is usually referred to as Demand Management.

Given that DSP can provide these functions, how exactly is it done? There are several methods of implementing DSP, depending on the goal in mind. The simplest measure is permanently reducing electricity consumption i.e. increasing energy efficiency. A slightly more nuanced approach has been

[5] AEMC 2009 Review of Demand-Side Participation in the National Electricity Market; RAP 2011 Demand-Side Participation in the Australian National Electricity Market: A Brief Annotated History
[6] AEMC 2017 More options for Demand Response in providing frequency control services
[7] Solar Choice 2017 Could distributed battery systems 'blackstart' the grid?

taken with a large proportion of Australia's hot water systems, which are programmed or controlled to run outside peak times. More sophisticated yet is an approach that has received increasing attention in recent years: Demand Response.

Demand Response is a form of DSP which involves dynamically changing net demand on the grid according to an external signal. Demand Response can come in the form of increasing or decreasing net energy consumption. These changes can come from household appliances, from altering how much electricity is being exported from rooftop solar panels, or from instructing a battery to charge from or discharge to the grid. The signals to take these actions can come in various forms. The signal might be a locally detected frequency variation, as in the case of contingency FCAS, a direct signal from an external party like AEMO, or a response to variations in the wholesale price of electricity (Price-Responsive Demand). This differs from the previous off-peak hot water system example in that it happens in real time – with appliances or batteries listening and responding to *live* signals, rather than just following a preordained schedule. When we think about smart DSP options, it's usually Demand Response we are thinking about.

Capturing the value of Demand Side Participation

We have identified three main areas of opportunity for entrepreneurs to generate revenue from facilitating DSP. While the physical mechanism for capturing each of these opportunities are similar, we have treated them separately as each requires entrepreneurs to take a different approach to capturing a share of the value they generate. These opportunities are:

1. **Participating in the FCAS markets** discussed previously
2. **Providing Demand Management services** to distributors seeking to address network constraints
3. Competing in the **retail electricity market** or providing services to existing retailers by using Price-Responsive Demand to reduce the cost of electricity

This isn't a comprehensive list. There are other opportunities in DSP and more will be created in the future. For example, other ancillary services could be provided, such as helping AEMO restart the grid after a blackout. With the right incentives, DSP could also reduce the need to build additional transmission or generation infrastructure. However, based on our analysis we think the above three opportunities are currently the largest and most accessible to entrepreneurs.

At this point, it is worth noting the $35.7 million Demand Response trial conducted by AEMO and the Australian Renewable Energy Agency (ARENA). The companies who will receive this funding were announced in October 2017 and included startups such as Powershop.[8] As there currently aren't any further funding rounds announced this paper won't dwell on this initiative. However, it is worth keeping an eye on – if this trial is successful it could lead to similar opportunities in the future.

Participating in the FCAS markets

The FCAS markets discussed previously have grown by over 50% per year for the last five years and are now worth over $200 million (Figure 2). A high penetration of intermittent wind and solar power increases the demand for regulation services,[9] so as the penetration of these sources continues to increase the market for regulation FCAS is likely to continue to grow.

As evident in Figure 3, more than a third of FCAS payments are made in NSW. South Australia is the runner-up, with almost a quarter of the FCAS market in 2017. Tasmania and Queensland follow and have similarly sized markets and Victoria ranked last in 2017.

[8] ARENA 2017 AEMO and ARENA Demand Response trial to provide 200 megawatts of emergency reserves for extreme peaks
[9] Riesz & MacGill 2013 Frequency Control Ancillary Services: Is Australia a Model Market for Renewable Integration?

Figure 2: Annual FCAS payments by AEMO[10]

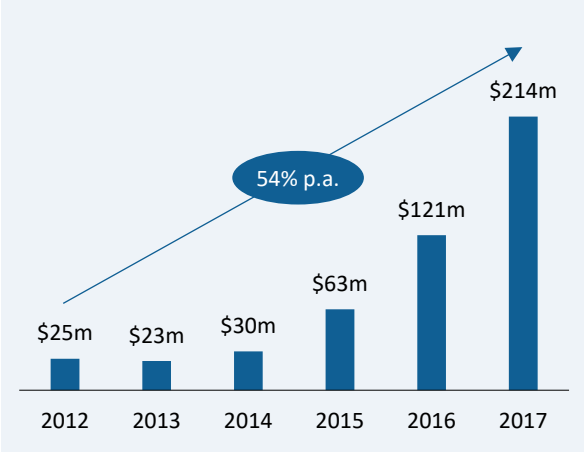
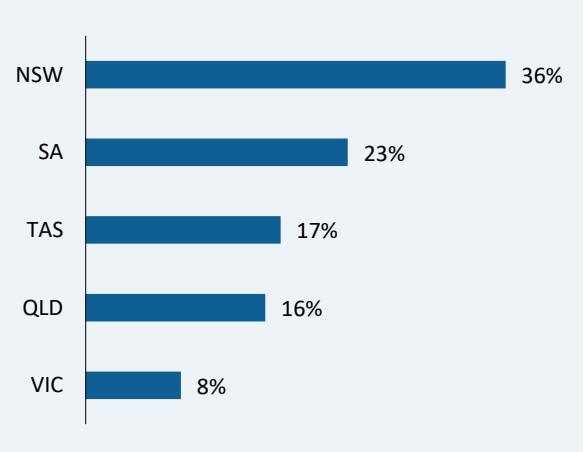


Figure 3: Proportion of 2017 FCAS payments[11]



Until recently, it was difficult to participate in the FCAS markets. Only those registered to buy or sell electricity in the wholesale electricity market were able to provide FCAS.[12] This created a high hurdle for new entrants – in many cases higher than the opportunity would justify. However, recently the Australian Energy Regulator (AER) acknowledge this shortcoming and has changed the rules to address it.

As of 1 July 2017, it is possible to participate in FCAS markets by registering as a 'Market Ancillary Service Provider'.[13] In 2016 the Australian Energy Market Commission (AEMC – the body responsible for making the electricity market rules) decided to create this new type of market participant. In AEMC's words, this participant can "do deals with energy users to offer demand response as a tool to help maintain power system security".[14] The purpose of the rule change was to foster greater competition in the ancillary services markets by lowering barriers to entry.

Registering as a Market Ancillary Service Provider is relatively straight-forward. To do so an applicant must demonstrate to AEMO that it has sufficient load under its control to provide ancillary services and that it can measure the services provided.[15] This is no easy feat, but the new designation does at least mean that the barriers for new entrants in the ancillary services markets are now technical rather than regulatory.

So far, this opportunity appears to be largely untapped. At the time of writing, seven months after the rule change, there was only one registered Market Ancillary Service Provider.[16] This solitary company is EnerNOC, who have aggregated 70 MW of demand to bid into the FCAS markets.[17] Hopefully, others will join EnerNOC, to take advantage of this opportunity and help maintain grid stability in a cost-effective manner.

[10] AEMO 2018 Ancillary Services Payments and Recovery
[11] Ibid
[12] COAG Energy Council 2015 Demand Response Mechanism Rule Change Request
[13] AEMC 2016 Final determination on the Demand Response Mechanism and Ancillary Services Unbundling rule change
[14] Ibid
[15] AEMC 2017 National Electricity Rules Version 104
[16] AEMO 2018 Current Registration and Exemption Lists
[17] EnerNOC 2017 EnerNOC Enters Frequency Control Market in Australia

Providing Demand Management services to distributors

Historically, there has been little incentive for network service providers to apply demand side responses to network constraints. Due to the incentive structure they operate in, networks service providers have traditionally preferred to invest in network infrastructure. Demand Management initiatives have still taken place, with Jemena's Power Changers trial[18] and Energex's PeakSmart scheme[19] just two examples. However, as the Power of Choice Review noted, "the potential for DSP to provide a credible, efficient alternative to network investment remains largely untapped." The recognition of this opportunity has led to an effort to help balance the incentives for distribution businesses.[20]

New legislation will encourage distributors to spend more on Demand Management. On 14 December 2017, the Australian Energy Regulator (AER) published the Demand Management Incentive Scheme (DMIS) and the Demand Management Innovation Allowance Mechanism (DMIAM).[21] The DMIS provides distributors with an incentive to invest in Demand Management projects, while the DMIAM encourages them to test new Demand Management approaches. Combined, they form a set of incentives for actively seeking out Demand Management solutions to network constraints where it would be cheaper than investing in network infrastructure.

The new incentives could result in distributors spending up to $200m per year on Demand Management. Under the DMIS, each distributor can spend up to 2% of their regulated revenue on Demand Management measures and receive half of that (1% of their regulated revenue) as an incentive.[22] The full amount (Demand Management spend plus the incentive amount) is recovered from customers. In addition, the DMIAM allows distributors to spend $200,000 plus 0.075% of revenue each and recover the full amount from their customers.[23] As distributors have a combined annual revenue of about $10 billion, they could end up spending around $200m on Demand Management.

Energy Queensland could become the largest customer of Demand Management services (Figure 4). After being formed from the merger of Energex and Ergon Energy, Energy Queensland has a higher level of regulated revenue than any other distributor. As the Demand Management incentive is tied to revenue, that means they could also become the largest potential customer of Demand Management.

NSW could be the state that spends the most on Demand Management services (Figure 5). While Energy Queensland is the distributor that has the highest regulated revenue, distributors in NSW collectively generate more regulated revenue than any other state. As a result, up to $75m p.a. could be spent on Demand Management in NSW.

[18] Jemena 2017 Power Changers – new electricity trial in Victoria encourages small changes for big impacts
[19] Energex 2018 Air-conditioning rewards
[20] AEMC 2015 Demand Management Incentive Scheme
[21] AER 2017 Demand management incentive scheme and innovation allowance mechanism
[22] AER 2017 Explanatory statement: Demand management incentive scheme: Electricity distribution network service providers
[23] AER 2017 Explanatory statement: Demand management innovation allowance mechanism: Electricity distribution network service providers

Figure 4: Annual eligible spend under DMIS and DMIAM by distributor

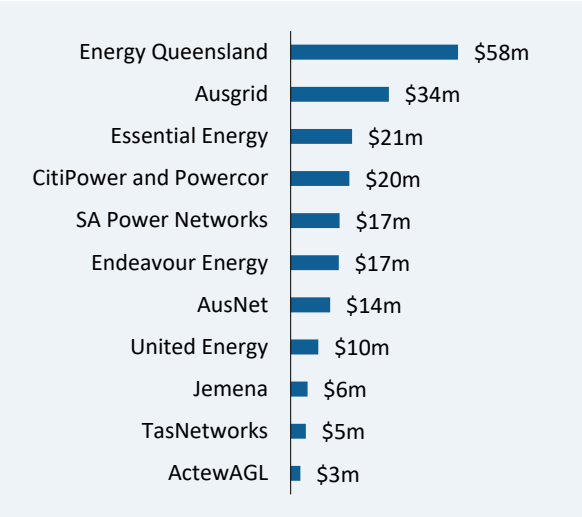
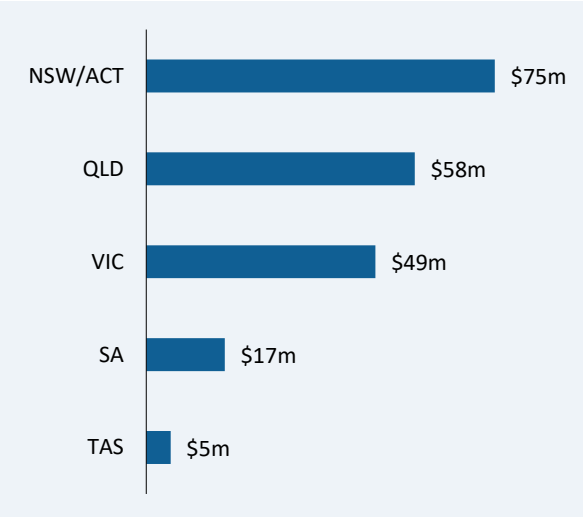


Figure 5: Annual eligible spend under DMIS and DMIAM by state



While distributors can conduct Demand Management in-house, it is possible they will outsource the task to third parties. When considering a Demand Management approach to a network constraint, a distributor must request solutions from companies on its demand side engagement register.[24] They aren't obligated to engage any of those companies, but this obligation does provide startups with an opportunity to develop innovative solutions and demonstrate their value. For entrepreneurs interested in getting on those demand side engagement registers, we have compiled the necessary email addresses and URLs in Appendix A.

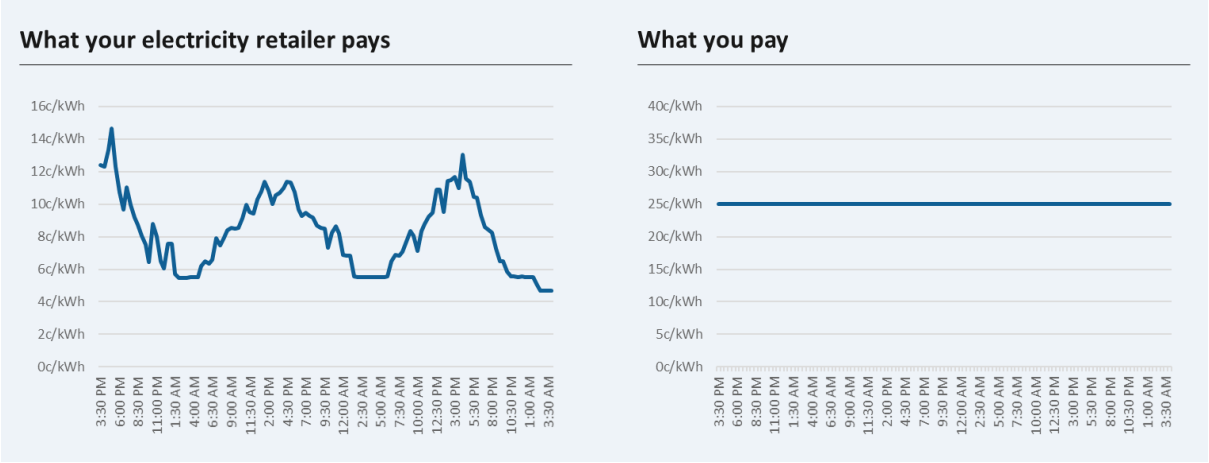
Accessing the retail electricity market

Perhaps the biggest opportunity for entrepreneurs could be found in the retail electricity market. According to IBISWorld, electricity retailing in Australia generates $50 billion in revenue each year,[25] dwarfing the collective $400 million of opportunities discussed so far in this paper. DSP provides opportunities to reduce the cost of electricity consumption, which could be sold as a service to existing electricity retailers or used as a competitive advantage in capturing a larger share of this market.

One of the services electricity retailers provide their customers is protection from wholesale price fluctuations. The amount electricity retailers pay for electricity in the spot market is highly volatile and can currently reach as high as $14,200/MWh,[26] or 1,420c/kWh. By contrast, the price paid by households is largely fixed (as illustrated in Figure 6), exposing retailers to significant financial risk. Retailers hedge this risk in several ways, such as by purchasing derivatives that effectively lock in the prices of electricity in the future.[27] The cost of such hedging has been estimated to cost retailers about $15/MWh.[28] DSP could provide cheaper alternatives to managing wholesale price risk.

[24] AER 2017 Explanatory statement: Demand management incentive scheme: Electricity distribution network service providers
[25] IBISWorld 2017 Electricity Retailing in Australia: Market Research Report
[26] AEMC 2017 AEMC publishes the Schedule of Reliability Settings for 2017-2018
[27] AER 2017 State of the Energy Market
[28] Grattan Institute 2017 Price Shock: Is the retail electricity market failing consumers?

Figure 6: Illustration of wholesale versus retail prices for electricity



Price-Responsive Demand is one approach that could help manage this exposure to wholesale price volatility, and even take advantage of it. Price-Responsive Demand is a form of Demand Response that varies electricity consumption in response to wholesale prices.[29] When prices spike, consumption could be temporarily reduced until prices fall again. Conversely, consumption that is not time-sensitive could wait until prices are low. Not only could such an approach reduce the cost of hedging, it could also reduce the average price of all electricity consumed.

Unfortunately, the value of Price-Responsive Demand is currently diluted by the market rules. As discussed previously, a 'dispatch price' is calculated every 5 minutes based on supply and demand. However, consumers are charged the average price over a half hour period, which is called the spot price.[30] Figure 7 illustrates the difference between these prices and the impact on the cost of consumption. You can see that the dispatch price spikes in the sixth 5-minute interval. In Case A consumption is flat across the whole period and in Case B, consumption is dropped to zero during the high price event. However, because the average price is charged across the half-hour period, the consumer in Case B is still affected by the high price event. As a result, the value of any action taken to respond to the dispatch price is both uncertain and significantly diluted.

Figure 7: Example of Demand Response savings under current rules

Case A

Time	Dispatch price ($/MWh)	Spot price ($/MWh)	Usage (MWh)	Cost ($)
16:30-16:35	107	735	1	735
16:35-16:40	104	735	1	735
16:40-16:45	228	735	1	735
16:45-16:50	252	735	1	735
16:50-16:55	218	735	1	735
16:55-17:00	3,501	735	1	735
Total			***6***	***4,410***

Case B

Time	Dispatch price ($/MWh)	Spot price ($/MWh)	Usage (MWh)	Cost ($)
16:30-16:35	107	735	1	735
16:35-16:40	104	735	1	735
16:40-16:45	228	735	1	735
16:45-16:50	252	735	1	735
16:50-16:55	218	735	1	735
16:55-17:00	3,501	735	0	0
Total			***5***	***3,675***

[29] Chao 2010 Price-Responsive Demand Management for a Smart Grid World
[30] AEMC 2017 Fact sheet: How the spot market works

A new rule-change will address the dilution problem, eventually. On 28 November 2017, the AEMC made a rule to change the settlement period from 30 minutes to 5 minutes, removing the mismatch between dispatch and spot prices. However, that rule change won't come into effect on 1 July 2021.[31]

This rule change will significantly increase the value of Price-Responsive Demand services. Figure 8 illustrates the impact of this change. Now that the consumer is charged for every 5-minute price, rather than the half-hour average price, they can save a lot more money by reducing consumption during high-price events. Before the rule change, the consumer in this example only saved $735 by reducing their consumption (the difference between the two totals of $4,410 and $3,675 in Figure 7). After the rule change, the same action would have saved them $3,501 ($4,410 minus $909), an increased saving of $2,766.

Figure 8: Example of Demand Response savings after rule change

Case A

Time	Dispatch price ($/MWh)	Spot price ($/MWh)	Usage (MWh)	Cost ($)
16:30-16:35	107	107	1	107
16:35-16:40	104	104	1	104
16:40-16:45	228	228	1	228
16:45-16:50	252	252	1	252
16:50-16:55	218	218	1	218
16:55-17:00	3,501	3,501	1	3,501
Total			***6***	***4,410***

Case B

Time	Dispatch price ($/MWh)	Spot price ($/MWh)	Usage (MWh)	Cost ($)
16:30-16:35	107	107	1	107
16:35-16:40	104	104	1	104
16:40-16:45	228	228	1	228
16:45-16:50	252	252	1	252
16:50-16:55	218	218	1	218
16:55-17:00	3,501	3,501	0	0
Total			***5***	***909***

Setting up an electricity retailer and competing with incumbents is one way to take advantage of this opportunity, but it is challenging. The barriers to registering an electricity retailer are quite high – one must demonstrate they have the organisational and technical capacity, and the financial resources to do so.[32] Incumbents argue this doesn't pose a barrier to entry [33] but, in EnergyLab's experience, this burden of proof is a showstopper for entrepreneurs without significant industry knowledge and financial capital.

However, there are quicker ways for entrepreneurs to provide value to the retail market. One option is to partner with an existing retailer. This is the route taken by Reposit, who partner with retailers like Diamond Energy, who use Reposit's battery control technology to purchase electricity from households when wholesale prices are high.[34] Another option is to acquire a 'white-labelled' retail license, which his essentially what Energy Locals offer. As their website says, "Want to be an energy retailer? Now you can, without the complexity."[35] These options presently provide a faster route to market for energy entrepreneurs interested in retail innovation.

[31] AEMC 2017 New deal for fast energy – five minute settlement
[32] AER 2014 Retailer Authorisation Guideline; RDANI 2012 Becoming an Electricity Retailer; Compliance Corner 2017 How To Become An Electricity Retailer
[33] ACCC 2017 Retail Electricity Pricing Inquiry: Preliminary report
[34] Canstar Blue 2017 How to get a 100 cents per kWh solar feed-in tariff
[35] Energy Locals 2018 Create your own retailer...

The potential of residential Demand Response

Currently, commercial and industrial energy users dominate DSP. This makes sense because electricity can be a large part of their cost base, and DSP offers a way of reducing it. From the grid's perspective, this is also the low hanging fruit, as a large amount of energy can be controlled in a relatively straight-forward manner.

We believe the greatest opportunity is currently in residential DSP, and residential Demand Response in particular. This is because as far as we can tell, the potential for residential DSP is less tapped, more accessible to the typical entrepreneur, and better able to be combined with other value streams. Likewise, compared to other approaches like energy efficiency, the options for Demand Response are evolving more quickly due to several complementary technological trends.

Residential Demand Response can be provided by behind-the-metre resources such as batteries and household appliances. Batteries can draw down from the grid on command and release that energy when needed, either back to the grid or to the household it is connected to. Likewise, appliances can be turned down or off when needed, and sometimes turned up as well. The combination of these capabilities provides a flexible demand base that can interact with the grid in various ways.

AGL's virtual power plant is an example of utilising household batteries for Demand Response. In March 2017 AGL launched an initiative to install internet-connected batteries in 1,000 South Australian homes, with backing from ARENA. This is called a virtual power plant because despite being a group of separate units, the batteries will operate as one coordinated plant. As such, they will be able to sell electricity back into the grid (just like a traditional power plant) as well as modulate load from these individual houses to support grid stability. AGL claim this will be the largest project of its kind in the world, and it has attracted significant media attention.[36] (But this might have more to do with the political fisticuffs it unintentionally triggered – search YouTube for "Watch SA Premier Jay Weatherill shirtfront Josh Frydenberg" for some light entertainment.)

Connected household appliances could serve a similar function. Each connected household appliance is basically a small load. If these loads can be coordinated they may add up to a meaningful amount of energy consumption, therefore becoming worth managing. Appliances such as fridges, freezers, dishwashers, washing machines, dryers and air conditioners could be paused, turned down and (for some appliances) turned up for short periods of time to relieve stress on the grid.

By our rough estimate, about 7.5 GW of the load on the grid could be controlled by coordinating household appliances. To arrive at this figure, we have taken a list of common household appliances and the numbers of these appliances currently in use in Australia, the average power consumption of each appliance, and the proportion of time each appliance is used. Appliance numbers were easy to estimate thanks to ABS data on household appliance penetration and population,[37] but average power consumption and usage for each device are less certain, and accordingly should be consumed with an appropriate amount of salt. These estimates are based on information provided by energy companies,

[36] ARENA 2017 AGL Virtual Power Plant; AGL 2018 Our energy future; ABC 2017 AGL suspends household battery installations for Adelaide's cutting-edge Virtual Power Plant; RenewEconomy 2017 AGL hits pause on virtual power plant in technology "rethink"
[37] ABS 2014 4602.0.55.001 - Environmental Issues: Energy Use and Conservation; ABS 2007 4602.0 - Environmental Issues: People's Views and Practices; ABS 2018 Population clock; ABS 2015 3236.0 - Household and Family Projections, Australia, 2011 to 2036

government data, and analysis by BZE.[38] Of course, not everyone will let someone else control all their appliances at all times, so the full potential of Demand Response won't be captured. Conversely, 7.5 GW is only an average figure and is likely to be higher when Demand Response is needed e.g. during peak demand events when people are using more energy than usual. Overall, the 7.5 GW estimate is accurate enough to illustrate the size of the opportunity, and readers can modify the assumptions in Table 2 to suit their needs.

Table 2: Estimate of Demand Response potential of household appliances

Appliance	Proportion of households possessing appliance	Average power consumption per appliance (kW)	Proportion of time appliance is used on average	Indicative average national electricity consumption (MW)
Electric space heating	38%	3.6	4%	527
Electric space cooling	74%	2.0	4%	586
Electrical water heating	56%	3.6	8%	1,546
Pool pump	12%	1.2	18%	235
Refrigerator	100%	0.3	100%	2,477
Separate freezer	34%	0.2	100%	519
Dishwasher	55%	2.4	4%	504
Washing machine	98%	1.3	7%	841
Clothes dryer	55%	3.2	1%	228
Total				***7,463***

To put 7.5 GW in perspective, it is equivalent to installing 75 Tesla 'big batteries'. The energy storage facility recently installed by Tesla in South Australia was heralded as one of the largest such installations in the world, with a capacity of 100 MW.[39] This is just 1.3% of the 7.5 GW that may be available by controlling household appliances.

[38] Origin Energy 2015 Understanding Your Energy Usage: Household Appliances; Essential Energy 2011 "How much energy do your appliances use?"; Woolcott 2016 Pool Pumps: An Investigation of Swimming Pool Pumps in Australian and New Zealand; BZE 2013 Buildings Plan

[39] RenewEconomy 2017 Tesla big battery officially switched on in South Australia

Conclusion

For the sake of clarity, this discussion paper has talked about three opportunities in DSP separately. Firstly, the barriers to utilise DSP to provide ancillary services, and be rewarded for it, have been lowered. Secondly, new incentives for distributors could expand the market for Demand Management services. Finally, facilitating Price-Responsive Demand could create innovative retail opportunities. Furthermore, we have noted that residential Demand Response appears to be a particularly prospective area for entrepreneurs interested in the space. We think covering each topic separately will help entrepreneurs better understand how to capture some of the value they create.

However, the real value will probably come from stacking multiple benefits together. You will have noticed that many of the actions taken to access each of the three opportunities are the same. It's all just a matter of increasing or decreasing the net load on the grid at different times. However, there is no reason why the same technology and business model couldn't be used to enable Price-Responsive Demand at certain times, provide Demand Management solutions at others, while also participating in the FCAS markets. One study examined various value streams that batteries could provide, including frequency regulation and arbitraging the market, and found that many could be provided simultaneously.[40] Extrapolating these findings to demand-side resources in general (including household appliances) suggests that it would be possible to capture more than one of the value streams discussed in this paper.

Entrepreneurs may want to pay particular attention to opportunities to combine energy services with smart home benefits. Many smart home solutions aim to improve the quality of life for occupants which, combined with the financial benefits of providing energy services, could provide a compelling value proposition. For example, most people purchase a Nest thermostat because it's better at achieving their desired household temperature and is more enjoyable to use than old thermostats. But once such a device is in someone's home, the provider can extract additional value by managing that energy consumption for the benefit of the grid. Not all consumers will allow this but, with the right incentives, many are likely to. We think entrepreneurs who can combine value streams in this way to create compelling customer value propositions will have a greater chance of success.

There will also be other DSP opportunities available. This paper has attempted to cover the low hanging fruit, but a creative entrepreneur will be able to find other value streams to capture with DSP initiatives. In addition, other opportunities for DSP will likely appear as the industry evolves, and possibly eclipse or replace the opportunities discussed in this paper. We have only just begun to transition our electricity grid from a centralised system with predictable generation to a decentralised one dominated by intermittent renewables, augmented by storage and responsive demand. Whether due to regulatory changes, tenders, or technological innovation, new opportunities for DSP are likely to emerge.

Changing regulations and technology are making it possible to manage our grid and reduce the cost of energy in creative new ways. It's now up to entrepreneurs to take advantage of this opportunity to serve their customers, help modernise Australia's electricity system, and grow valuable businesses.

[40] The Brattle Group 2017 Stacked Benefits: Comprehensively Valuing Battery Storage in California

Glossary

AEMC Australian Energy Market Commission

AEMO Australian Energy Market Operator

AER Australian Energy Regulator

ARENA Australian Renewable Energy Agency

DMIAM Demand Management Innovation Allowance Mechanism

DMIS Demand Management Incentive Scheme

DNSP Distribution Network Service Provider

DSP Demand Side Participation

FCAS Frequency Control Ancillary Services

NCAS Network Control Ancillary Services

NEM National Electricity Market

SRAS System Restart Ancillary Services

TNSP Transmission Network Service Provider

Appendices

Appendix A: Distributors and how to get on their demand side engagement register

Distributor	Email/link
Ausgrid	https://www.ausgrid.com.au/Common/Industry/Demand-management/Demand-Side-Engagement-Register.aspx
AusNet	jacqueline.bridge@ausnetservices.com.au or justin.harding@ausnetservices.com.au
CitiPower and Powercor	DMInterestedParties@powercor.com.au
Endeavour Energy	consultation@endeavourenergy.com.au (providing your name, company name, type of service provided and a contact number)
Energex	https://www.energex.com.au/about-us/contact-us/forms/general-forms/demand-side-engagement-facility
Ergon Energy	https://www.ergon.com.au/network/network-management/network-infrastructure/regulatory-test-consultations/rit-d-portal-registration
Essential Energy	https://www.essentialenergy.com.au/f_demand-management-register.aspx
Evoenergy	https://www.evoenergy.com.au/en/emerging-technology/demand-management
Jemena	https://jemena.com.au/industry/electricity/demand-management
SA Power Networks	https://www.sapowernetworks.com.au/centric/industry/our_network/annual_network_plans/register_on_the_demand_side_engagement_register.jsp
TasNetworks	SystemStudies@auroraenergy.com.au (providing the name, description, and postal address of your company and the name, position, phone number and email address of a contact person)
United Energy	https://www.unitedenergy.com.au/contact-us/demand-side-engagement-registration/