# Tullamore Community Battery Study

*Beyond Peer to Peer - An open system for Community Energy Trading and Orchestration*

# Neighbourhood Battery Feasibility Study Report

DELWP Schedule no: OPP-50911

Manningham City Council

Neighbourhood Battery Initiative - Stream 1 - Feasibility Study – Ver 1.6

Beyond Peer to Peer - An open system for Community Energy Trading and Orchestration

# 1 Acknowledgements

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We thank our partners and advisory board on this project: United Energy, Monash University, Mirvac, RedEnergy, and Yarra Energy Foundation.

Manningham Council and Redgrid acknowledge the Wurundjeri Woi-wurrung and Boonwurrung peoples as the Traditional custodians of the lands upon which we work. We pay respect to Elders past, present and emerging.

## 1.1 Use of materials in this report



Images Cover https://tullamore.mirvac.com/explore-tullamore/tullamore-community.

## 1.2 Disclaimer

# 2 Executive Summary

*"The double whammy of transformation coming from digitisation and decarbonisation amounts to one thing, empowerment of the customer"*
*Norbert Schwieters Global Power & Utilities Leader*

This report details findings of behavioural studies, battery, and community energy simulations, and extrapolates how the findings can inform future policy in local peer-to-peer energy trading.

**Not all kilowatt-hours are equal.** Policy and behavioural studies need to differentiate between renewable vs fossil fuel energy, and energy used during peak vs off peak hours. Current frameworks measure energy monochromatically; energy needs to be seen in technicolour. It is time for the market to reflect nuance in energy consumption habits.

Automation through monitoring grid signals can provide the most significant savings. 19% load shifting is predicted by the model.

Resident behaviours can be shifted towards greener times on the grid, through education and reward incentives. 8% load shifting is predicted by the model. We confirmed that the load shifting can occur through behaviour change. The study used the Redgrid Powers App to investigate how improved information feedback and various incentives impacted behaviour. A combination of behavioural shifts and solar photovoltaic (PV) system installations can lead to a reduction in the required battery size or alternatively, lead to a larger community being serviced.

The most attractive rewards were cash rebates. Other incentives included cryptocurrency, which the authors believe will become prominent in a few years, and community coupons (e.g., free coffee at a local cafe).

The community needs to be taken on the journey from remote coal-fired energy to local assets. Trust needs to be built that community-centred energy is more reliable and cost-effective.

A community battery with intelligent devices using agent-based software can lead to improved coordination of home battery inverters and smart heat pump hot water systems which in turn improves voltage management across the neighbourhood.

# 3 Introduction

## 3.1 DELWP NBI Objectives

The objective of this report is to assist DELWP to address the objectives of the Neighbourhood Battery Initiative (NBI):

- To support the understanding of the full range of benefits that neighbourhood scale batteries can provide;
- Help overcome barriers to the deployment of neighbourhood scale batteries;
- Inform regulatory reform;
- Determine which methods of neighbourhood scale battery deployment provide the most benefits for the Victorian electricity system; and
- Support the decarbonisation of Victoria's electricity system to tackle climate change.

## 3.2 Project Description

The Tullamore Community Battery Study (project) ran from October 2021 until delivery of this report in August 2022. The project aimed to test and evaluate opportunities for innovative energy trading based on an open accounting and user engagement system.

Thirty houses in the Mirvac Tullamore estate were recruited to participate in our study. They were provided two smart plug devices and the mobile Powers Application. A smart plug is an inexpensive device that is inserted between the wall point and an appliance, that provides energy data and ability to turn the smart plug on and off via logic or a mobile application. See section 14.2 in Appendix B for more information.

Each participant gave their consent to access National Metering Identifier (NMI) meter data.

With the data collected from each household belonging to the neighbourhood energy community, various shared battery, demand management and optimisation strategies were tested through the Neighbourhood Energy Simulator tool. See section 14.1 Appendix B for more information.

## 3.3 Project Objectives

The focus of this study is to investigate the use of an agent-based architecture within a neighbourhood battery environment and to determine and evaluate the innovative energy trading opportunities (and barriers) as they relate to automation, behaviour, and policy. Agent-based architectures resemble natural behaviour, where an agent has autonomy to act based on a few simple rules reacting to external stimuli. Examples would include bees in a hive, ants in a colony, or the way birds flock and fish school. The benefit is simplicity without bottlenecks to a central server for commands.

The project sought answers to the following key questions to showcase the benefits an open energy system for energy trading can provide in the context of neighbourhood batteries.

- What reduction in battery capacity can be achieved through automating major household loads?
- What reduction in battery capacity can be achieved through behavioural changes to household loads?
- What are the policy opportunities that would lower the barriers to community energy trading?
- Is an open system for community energy trading a scalable and repeatable solution?

## 3.4 Project Governance

Prominent voices in the emerging new energy landscape in Victoria participated in our project and together provided a very good overlap of expertise looking across technical, policy, and behavioural perspectives.

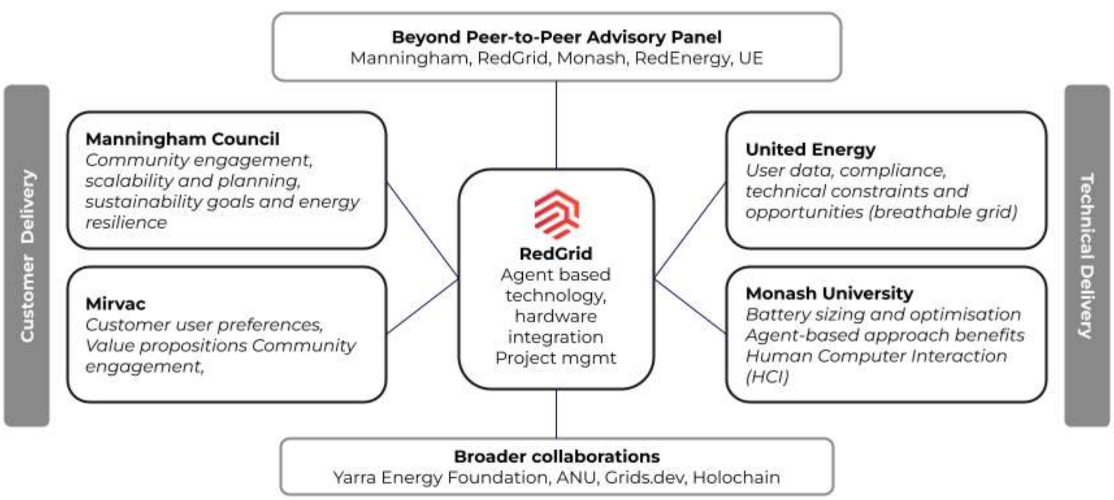


***Fig.1. Project governance model***

# 4 Data Gathering Through Tools

Existing Redgrid and bespoke new products were applied to gather data used for results in this Study. See Appendix B for a fuller description of each of the tools.

| Tool Name | Used By | Purpose |
|---|---|---|
| Neighbourhood Energy Simulator | Redgrid | What-if scenarios applying a number of inputs |
| Redgrid Powers App | Study participants | Mobile application providing times in the grid using the most renewables, plus notifications on the past 24 hours usage, and the next day forecast. |
| Redgrid Home App | Study participants | Mobile application to register and assign smart plugs provided in the study. |
| Smart Plugs | Study participants | Off-the-shelf devices inserted between the wall point and an appliance, to monitor energy usage. They can also be used to remotely or programmatically turn appliances on and off. |
| Energy Data Platform | Redgrid | This web application provided Redgrid with aggregated information, plus allowed administrative functions such as asset management, and ability to send custom notifications to assist a particular test. |

***Table.1. Tools Used in this Project***

# 5 The Neighbourhood Energy Simulation

In this chapter we explain how we set up the simulator. The findings are explored in the next chapter.

To add real life context to the modelling, we used the community at Tullamore estate, Doncaster as the neighbourhood for the simulation. At the moment, there are no plans to install a neighbourhood battery. Tullamore is part of Mirvac's progressive vision for energy efficient housing; it also provides a useful cross section sample of a middle-class estate. Tullamore currently has approximately 400 residential 'free-standing' properties built and tenanted with more being developed. These are a mixture of separate houses and townhouses that are all built to a 6-star energy rating.

One third of the houses have rooftop solar. The size of solar installed per household is generally 5kW.

At Tullamore we fed various data points into our model including:

- Number of properties
- Type of properties
- Number of properties with solar
- Meter level energy consumption
- Community demographics and persona of residents

Data collection was through:

- Energy monitoring smart plugs
- Household meter data from United Energy
- Industry appliance data
- AEMO and OpenNEM data of grid conditions and carbon intensity
- Participant and community interviews
- Powers app user engagement analytics and reporting

## 5.1 Operating Conditions for the Simulator

We created a representation of a community with different personas to understand their energy usage. One persona represents households with big families that have high energy usage and limited ability to shift when they use that energy. Another persona represents retirees who have more options for when they use some of their energy. These personas were derived from interviews with tenants to categorise energy usage, plus consultation with Mirvac on the estate demographics.
Based on lessons learned with the 30 households recruited from the Tullamore estate, we modelled a week of energy usage in the summer and a week in winter.

The model of energy usage for each household was statistical. Statements from participant interviews like "this household does their washing in the mornings three times a week" were converted into a tangible outcome such as "the washing runs at 8am on Monday, 7am on Thursday, and 9am on Sunday".

Once all energy usage from appliances, Reverse Cycle Air Conditioners (RCAC), and hot water systems (HWS) were assigned, as well as underlying energy usage and solar production, we could see the energy usage of the community.

We then ran another simulation where we shifted the time-of-use, and therefore when energy was consumed, into more cost-effective parts of the day. For example, shifting time-of-use to the middle of the day to soak up more solar electricity, or in the early morning for cheap electricity tariffs.

For appliances that have a behavioural response element to them (such as washing machines, dishwashers, etc), each persona had their own likelihood of making this behaviour change, as well as certain times they could shift this appliance usage to (for instance, a household which works in an office will not be able to shift the appliance usage into the middle of the day).

For appliances that have an automated response, such as RCAC for space heating and cooling, and hot water heaters, we make small adjustments to when these appliances run to lead to better energy outcomes.

This approach produced outcomes that compare Redgrid's agent-based software intervention with business-as-usual:

- Automated shifts in energy usage with Redgrid intervention;
- Behavioural shifts in energy usage through incentives and training using the Redgrid software; and
- Behavioural shifts in energy usage by demonstrating Redgrid intervention.

## 5.2 Battery size

We elected to simulate an 800kW/1600kWh community battery for this analysis, which is 4kWh/resident. The battery size is achievable within the current market, and the per resident figure is a generous usage to avoid using the grid.

The hypothesis as formulated in section 6.4.1 is that behaviour changes can reduce the capacity of the battery by 20% or 320kWh, and automated device control can reduce the capacity by a further 20% or 320kWh, yet still provide each resident their expected daily energy requirements.

## 5.3 Solar

In the Neighbourhood Energy Simulator, a key input that greatly affects the results of the modelling is the percentage of households that have rooftop solar. If there is too little solar in the community the battery will not charge as all solar is soaked up through the demands from households in the community.

As of December 2021,[1] there were:

- 409 completed houses (including townhouses).
- 131 of those houses have rooftop solar.

So approximately 32% of houses at Tullamore have a 5kW solar system on their rooftop.

Australia has had 30% year on year growth of solar rooftop installations from 2017 to 2020[2], representing more than 1 in 4 residences. The objective of this project is to study the *opportunities* for energy trading within community batteries. We have based our modelling on the expected solar uptake at Tullamore in 2030 (8 years from now).

In Doncaster (Tullamore is in this suburb), there are 5,829 separate houses[3]. Of these, there are 1,402 houses with solar (24%)[4]. In the year from May 2021 to 2022, 192 Doncaster houses installed solar. This is a 3.29% increase in rooftop solar in a single year. We expect falling solar PV costs and increasing grid energy pricing will continue to attract residents to install on their rooftop.

If we make the conservative assumption, that over the next eight years to 2030, the percentage of the 409 houses in the Tullamore Estate that install solar will, at a minimum, continue to increase at the same rate (3.29% year on year), then each year 13.5 houses will install solar. If these assumptions prove correct, then by 2030 an additional 108 houses will have rooftop solar which equates to 58% of existing Tullamore houses.

To provide an accurate prediction of the value of automation and behavioural load shifting, we will show results in this report for both current state (2022, 32% solar uptake) and future state (2030, 58% solar uptake) in Tullamore.

The modelling sized solar PV systems at 5kW, except for the households in the 'Big Family' persona, whom we modelled with a 7kW system to account for increased energy requirements for a larger household.

## 5.4 Tariff and Objective Inputs

In our Neighbourhood Energy Simulator, there are two tariffs to choose from, either the Victorian default market offering (United Energy TOU[5]) or the wholesale price. The wholesale price tariff is the VIC1 wholesale price for these periods, with an 8c/kWh network charge being applied to imports.

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[1] Tullamore Mirvac

[2] https://www.energy.gov.au/news-media/news/australia-achieves-3-million-rooftop-solar-pv-installations

[3] Figures as reported in 2016.

[4] https://www.cleanenergyregulator.gov.au/RET/Forms-and-resources/Postcode-data-for-small-scale-installations

[5] https://www.esc.vic.gov.au/electricity-and-gas/prices-tariffs-and-benchmarks/victorian-default-offer

The wholesale price, emissions, and solar data is taken from reference days in 2021/22 that give a range of temperature and other weather conditions to reflect the range of days you can seasonally expect. These dates are:

| Day | Summer | Winter |
|---|---|---|
| Monday | 21.01.2022 | 01.06.2021 |
| Tuesday | 28.01.2022 | 02.06.2021 |
| Wednesday | 29.12.2021 | 05.06.2021 |
| Thursday | 30.01.2022 | 13.06.2021 |
| Friday | 21.02.2022 | 23.07.2021 |
| Saturday | 28.02.2022 | 12.08.2021 |
| Sunday | 26.12.2021 | 13.08.2021 |

***Table.2. Seasonal reference days***

**Setting Objectives for Households**

The simulation model allows households to optimise their energy use for a particular objective. Typically, the objectives are to reduce emissions or to reduce energy costs. As these two values are somewhat correlated (energy tends to cost less during low emission periods), the simulation will tend to reduce both costs and emissions regardless of which objective you choose – but this is a way of favouring one over the other.

## 5.5 Appliance data

For the modelling exercise we included high energy consuming appliances and categorised them into either controllable (appliances with a load that can be automated and controlled through remote smart technology) or non-controllable (appliances with a load that can be shifted through behavioural changes by the resident). When selecting the appliances, we considered our previous studies/projects data to choose the highest energy consuming appliances that can be remotely controlled or the resident can change when they use their load.

By considering the above factors, we categorised the following appliances:

- Controllable: Hot water system[6], RCAC
- Non-controllable: Washing Machine, Clothes Dryer[7], Dishwasher

Most of the data front loaded into the modelling is from research institutes[8]. In addition, we have taken data, like CO2 emissions, from an Application Programmable Interface (API) provided by the

[6] https://www.solarquotes.com.au/good-solar-guide/heating-water-choices/

[7] https://assets.sustainability.vic.gov.au/susvic/Report-Energy-Clothes-Dryer-Retrofit-Trial-PDF-December-2016.pdf

[8] https://ahd.csiro.au/other-data/typical-house-energy-use/

OpenNEM[9] and considered both wholesale price tariff and the Victorian default market offering. To reflect the seasonal variations we have selected days with different temperature and weather conditions and aligned the tariff, emission, and solar data accordingly.

[9] https://opennem.org.au/energy/nem/?range=7d&interval=30m

## 5.6 Personas

When gathering the data, we created several user personas based on the lifestyle and work style of each household and mapped the data according to the personas. To build the personas we analysed the NMI meter data of 19 people at Tullamore and segregated each according to the energy consumption in summer and winter seasons. Based on the members of the household we have assumed the WFH (Work From Home) status for the adults in each family. The below table shows the summary of Personas we used in the modelling exercise.  Note that "WFO" means "work from the office or worksite".

| Persona | Lifestyle | Work style | No of Household Members | Energy Usage per Month |
|---|---|---|---|---|
| Young Couple WFH | Young Couple | Work from Home | 2 adults, 0 kids | Medium |
| Small Family WFH | Small Family | Work from home | 2 adults, 1 kid | Medium |
| Lives Alone WFO | Lives Alone | Full time work | 1 adult, 0 kids | Low |
| Big Family WFO | Big Family | Full time work | 2 adults, 3 kids | High |
| Retired | Retired | Retired | 2 adult, 0 kids | Low |

***Table.3. Personas modelled in this study***

## 5.7 Assumptions

- We can reduce RCAC daily usage up to a cumulative hour without disturbance to the resident. This will be seasonally adjusted.  This assumption is based on subjective tests Redgrid has previously done using controllers programmed to reduce usage and the effect on resident comfort levels.
- For hot water systems, we included all capacity as shiftable, although it would only be able to shift a few hours earlier or later.  This was to avoid 'busy' hours at the start and end of a workday, and assuming laundry and dishwashers operated during the day.
- All solar on households will be 5kW, with exception of the "Big Family" persona.  See Appendix A for more details.
- From 2022 to 2030, 3.29% of houses at Tullamore will install solar each year.

# 6 Findings from Neighbourhood Energy Modelling

In this chapter we explain the results of modelling neighbourhood energy in Redgrid's simulator, which models various scenarios to see the effect on household and community battery usage. See Appendix B for more information about the Neighbourhood Energy Simulator.

## 6.1 Benefits of reducing battery capacity

There are several advantages to reducing battery size including:

- Reduced capital expenditure when smaller batteries are commissioned;
- Reduced ongoing operating expenditure: lithium batteries charge and discharge cycles cause ions to be lost as they interact with the electrolyte, plus natural oxidation and ageing. Using a smaller battery means less material to protect it from environmental factors such as humidity[10];
- Reduced cost to households.

The net result is a lower Total Cost of Ownership (TCO) over the lifetime of the battery.

## 6.2 Reducing battery capacity via automated load shifting

- *Hypothesis: We believe that...* automated device control under an agent-based system will enable a battery to require 20% less capacity.
- *Test and Methodology: To verify that...* We will model how much energy from major appliances in a community we can automatically shift without affecting the comfort of household members.
- *Metric and results: And we will measure...* The % reduction in battery capacity achieved.
- *Criterion: We are right if...* Capacity can be reduced by at least 20% through automating loads.

### 6.2.1 Method

To verify how much battery capacity we can save, through automation within an agent-based battery system, we researched the consumption loads of controllable appliances (RCAC & hot water systems) then modelled how much shiftable capacity there was each day.

### 6.2.2 Result

For RCAC, cooling and heating, we counted one hour of each use as shiftable capacity. So, if the RCAC was going to consume 5kWh each hour, and run for 4 hours, we have 5kWh of shifted capacity, due to the limited ability to shift RCAC usage (e.g., A shift 6-9pm of usage to 3-6pm would be a noticeable,

[10] https://www.manlybatteries.com/info/why-does-lithium-battery-wear-out-can-lithium-61588658.html

and possibly uncomfortable[11], change in ambient temperature.  A shift to 5-8pm in this example through precooling may still be acceptable).

For hot water we included all capacity as shiftable; although it would only be able to shift a few hours earlier or later to avoid peak usage periods.

Automated load shifting represented a 19% energy savings as predicted by the model.

## 6.3 Reducing battery capacity through behavioural load shifting

- *Hypothesis: We believe that...* behavioural changes in the use of major appliances under an agent-based system will enable a battery to require 20% less capacity through.
- *Test and Methodology: To verify that...* We will model how much energy from major appliances in a community we can shift to other times of the day and verify those results in field trials through smart plugs and the Redgrid Powers app.
- *Metric and results: And we will measure...* The % reduction in battery capacity achieved.
- *Criterion: We are right if…* Capacity can be reduced by at least 20% through behavioural changes.

### 6.3.1 Method

Study participants were provided with the Redgrid Powers App.  The Redgrid Energy Data Platform allowed Redgrid to conduct different tests with custom notifications and to observe the results.

### 6.3.2 Result

We found that by reminding participants of times when the grid is greenest and providing feedback through the Redgrid Powers App, an 8% reduction in energy usage was observed.

## 6.4 Reducing battery capacity combining automation and behavioural load shifting

- *Hypothesis: We believe that...* behavioural changes in the use of major appliances under an agent-based system will enable a battery to require 20% less capacity through.
- *Test and Methodology: To verify that...* We will model how much energy from major appliances in a community we can shift to other times of the day and verify those results in field trials through smart plugs and the Redgrid Powers app.

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[11] https://www.euronews.com/2022/08/08/europes-energy-crisis-spain-lowers-the-temperature-on-strict-air-conditioning-rules

- *Metric and results: And we will measure...* The % reduction in battery capacity achieved.
- *Criterion: We are right if…* Capacity can be reduced by at least 20% through behavioural changes.

### 6.4.1 Method

We elected to simulate an 800kW/1600kWh community battery for this analysis, which is 4kWh/resident. This means the hypothesis is that behaviour changes can reduce the capacity of the battery by 320kWh (20%), and automated device control can reduce the capacity by a further 320kWh (20%), yet still provide each resident their expected daily energy requirements.

### 6.4.2 Result

This model demonstrates using behavioural and automated demand response that less community battery capacity needs to go towards achieving a community's objective of consuming more of their locally generated solar energy and being less reliant on the grid. This means:

1. A smaller community battery can be installed to achieve equivalent outcomes in respect to solar self-consumption and grid reliance objectives, saving the community money; or
2. The excess capacity can be directed to the energy markets to increase revenues for the battery.

# 7 Community Engagement Trials

In this chapter we provide the findings from study participants using the mobile Powers App and providing feedback through interviews and surveys.

## 7.1 What did this involve?

In our interaction with residents in the Tullamore community, our focus was on behavioural load shifting with a roadmap towards automation.

We spent four months of technology development on the Redgrid Powers App and Energy Data Platform (refer Appendix B). A key focus was on onboarding to make it easy to understand and to take part in the trials.

We tested different incentives and metrics by offering a choice of reviews, and then monitoring the metric - 'Time to value'. We also tracked in-app metrics and KPIs and captured user interviews and their feedback (refer Appendix A).

## 7.2 Findings from Community Engagement

- The most engaged participants were those working from home, or retired
- 73% earned a reward through shifting their behaviour
- Incentives listed by popularity:
    - Cashback (50%)
    - Donation towards a community battery (30%)
    - Local cafe voucher (2%)
    - Crypto (2%)
    - Not yet selected (16%)
- In app metrics:
    - Average Frequency of Use (FoU) was 6 days
    - Average time to value: 30 days (target was 15)
    - Frequency of reward: Average of 2, with some users earning up to 7 ($35).

*"it's nice to do something for the environment and know when energy is clean every day, and if you can get rewarded for it "why not?!".*

*"I get value from the daily notifications more than checking the app"*

*"I pre-set my devices every day for the rewards"*

# 8 Community Energy Trading

In this section we explore opportunities and barriers for community energy trading.

## 8.1 Social and Behavioural opportunities

In this study we utilised the major appliances in the home that are high energy consuming and that residents have a degree of freedom to change when they use them. We included washing machines, clothes dryers, and dishwashers.

The incentive of study participants changing behaviour towards greener energy during the day was through rewards against levels of energy saved. The records of these behaviours can be honoured by rewards providers, like a loyalty programme scheme.

The theme of trust can extend to the community, establishing community social media networks to compare goals met, and perhaps provide friendly competition with other communities to do better. All of this requires energy trusted at a human level of measurement.

## 8.2 Tariff Opportunities

There are opportunities in the emerging energy landscape for policy makers at the local and state levels to assist the adoption of distributed energy. Coordination across jurisdictions could ultimately exist at the federal level, but the authors believe a 'grassroots' effort will be the most effective initially.

The existing tariff structure considers usage charges in a few scenarios and adds a Distribution Use of System (DUoS) fee[12] which is biased toward centralised generation. However, if energy generation is local, consisting of Distributed Energy Resources (DER), then there is less or even zero use of the distribution network. What if local electricity meant there was a reduced DUoS, that reflected Local Use of System(LUoS)? A new framework that supports local generation, distribution, and storage should support energy storage of all kinds, and improved functioning of a DER electricity grid. The current "peak" and "off-peak" designation can be refined based not just on consumption, but "contribution" in the form of intelligent energy use.

After gathering information from this and other NBI reports, a series of policy workshops from DELWP with stakeholders and NBI participants would help set the course for the next few years in Victorian energy, with the objective of equitable, resilient, and responsive energy supply for consumers. We also need to consider additional markets, to supplement existing feed-in tariffs, that would allow the one in four rooftop solar installations a quicker payback. A community battery is a very good 'energy bank' for its local sources of behind-the-meter energy generation and storage and can provide other

[12] https://www.finder.com.au/energy/tariffs-and-fees

value to the smooth functioning of the distribution grid e.g., voltage management, peak demand response, and solar soaking.

Incentives should encourage battery operation and its usage. Figure 2 below depicts one proposal for innovative battery tariffs.

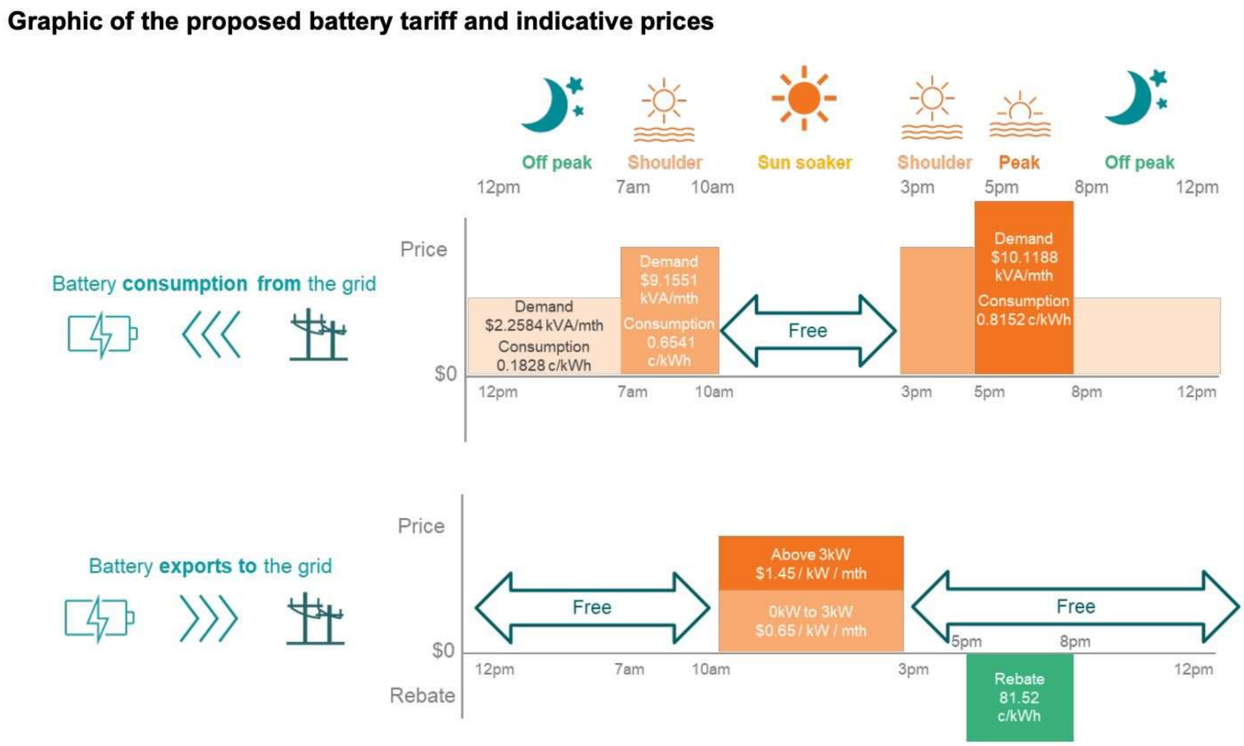


***Fig.2. Example of battery tariffs, source: Essential Energy, NSW's largest DNSP***

There is some hidden complexity with blocked/scaling demand charges, but 81c/kWh 'sell rate' from 5pm to 8pm provides an incentive for battery operators, particularly with free network charging from 10am to 3pm.

## 8.3 Financial Opportunities for a Peer-to-Peer Market

The current regulatory framework gives no voice to emerging energy producers at the community level. Future policy needs to nurture trust for residents, that the new technologies can augment, match, and ultimately replace the existing grid in greater periods throughout the day.

Feasibility Studies across the NBI program are showing that some neighbourhood batteries in certain scenarios have a negative return on investment. This is partly due to initial high capital expenditure costs, which will eventually lower with scaling. These studies also showed that a reduced DUoS that reflected the Local Use of System (LUoS), was necessary to achieve a positive return on investment.

As peer-to-peer trading is established in a community, the associated value can be couched in financial terms. Many community batteries together represent a significant shift away from the current infrastructure. Communities together formed in co-op style buyer's groups means a new energy economy seeking investment capital. Financial advisers versed in this area will be required[13], and with adequate, accurate accounting that comes with an agent-based community, the community battery can participate in a carbon credits scheme, which may appear on the Australian Security Exchange (ASX)[14].

Community rewards as provided through the Redgrid Powers App at redemption have value which may have consideration from the Australian Taxation Office (ATO), as ruled by the Australian Competition and Consumer Commission (ACCC) on loyalty programmes[15].

Policy should encourage these new services and think of a community as its own economy, trading within its boundaries and working toward less reliance on the grid.

## 8.4 Battery-Focussed Energy Trading

Redgrid is creating transactive energy software that could be offered by community battery operators. The immutable records generated can determine the performance of these micro contracts, contributing to reputation ratings as buyers or sellers, similar to eBay or Amazon shopfronts.

The community battery can act as the focus, or the waypoint of energy. It represents an identified landmark on the road to completely distributing the energy market, with the ultimate goal of true peer-to-peer (household-to-household, or even DER-to-DER) trading.

Assuming the battery operator is also a retailer, there are no policies preventing this; the inertia is in market acceptance and viability which could be assisted with an incentivising tariff structure (see section 8.2).

## 8.5 Automation and Optimisation opportunities

Given this constraint, what are the opportunities to move forward with neighbourhood electricity trading, through the intermediary of an Electricity Retailer?

An agent-based architecture can be fine-grained down to the appliance consuming energy, and aggregated up to provide visibility at the building, street, and suburb levels. Redgrid had done tests prior to this project using the programmable on/off capability of smart plugs to react to grid signals; when the spot price exceeded a threshold, performing load shifting at a device level, in this case, a

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[13] Financial advisers are required to hold an Australian Financial Services Licence (AFSL).

[14] This means CHESS (Clearing House Electronic Subregister System).

[15] https://www.accc.gov.au/focus-areas/market-studies/customer-loyalty-schemes-review

reverse-cycle air conditioner. This is similar to 'cycle stealing'[16] on computer systems; turning off the device periodically and for short periods of time, which does not affect comfort levels or add additional wear on the device.

Automation and optimisation can provide micro control and visibility. Neighbourhood Batteries can also address the 'end of the line' where voltage variation tends to be greatest.

All agent activity, and the corresponding interaction with other agents, can be recorded in a local ledger that can be shared with others with algorithms to confirm data integrity and establish a trustworthy record.

[16] https://en.wikipedia.org/wiki/Cycle_stealing

# 9 New Approaches for a New Market Reality

In this chapter we look at some factors we expect in the energy landscape in a few years.

Home battery solutions are not quite affordable. The cost of home batteries is reducing, and the technology is improving, but purchase and installation price are still prohibitive for most.

The Tesla Powerwall and its competitors are designed to connect to rooftop solar power systems, with the home still connected to the grid. A new 5kW hybrid solar energy system with a single Powerwall 2 will cost about A$20,000[17]. Adding a Powerwall 2 to an existing solar power system is approximately $15,000.

Even with rapidly rising energy prices, this still means a return on investment after 8 years or more[18].

The notion of a shared local infrastructure and private DER assets becomes appealing with economies of scale. For example, a shared community battery relieves individual households from upkeep which comes with behind-the-meter storage. Also, a shared battery offers the promise of improved utilisation across the community and additional support services for the national grid such as voltage management and demand response.

In 2022, this is all nascent.

[17] https://www.solarquotes.com.au/battery-storage/

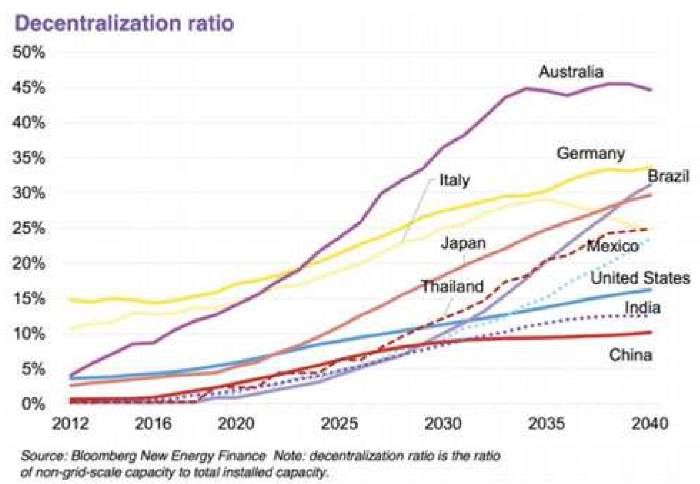
[18] https://www.choice.com.au/home-improvement/energy-saving/solar/articles/living-with-the-tesla-powerwall-for-a-year

## 9.1 Agent-based, Peer to Peer & Decentralised systems

Global energy is taking up the battle-cry of “the three Ds[19]”:

- Decarbonisation: A move to renewable energy
- Digitisation: A massive increase in instrumentation and automation as ‘everything is electrified[20]’. The need for electricity everywhere requires closer monitoring and control of power quality (phase, voltage, frequency)
- Decentralisation: Leaving behind the large, centralised supply chain of coal-fired power plants and hydroelectric power. Moving to DER both at utility scale and rooftop solar scale that is consumed by the household or fed into the grid.

They are all related, but perhaps the most profound is the shift away from large coal fired generators which cannot respond in real time to the needs of a dynamic power system. The experience in South Australia in 2016 of a state-wide blackout where transmission towers were flattened, focussed the general public on resilience. Since then, resilience has become a common theme as extreme weather events increase.




*Many grids globally will demonstrate increasingly high levels of decentralisation over the decades ahead (Bloomberg New Energy Finance - New Energy Outlook 2017).*

***Fig.3. Worldwide decentralisation ratio***

[19] https://www.caf.com/en/knowledge/views/2019/11/the-3-ds-of-energy-decarbonization-digitization-and-decentralization/

[20] https://www.abc.net.au/news/science/2021-09-07/climate-change-solution-electrify-everything-saul-griffiths/100428158

Redgrid uses Holochain open-source software[21]. Sometimes described as 'post-blockchain', Holochain is fully distributed, not just decentralised[22]. It is biomimetic, which means Holochain follows patterns found in nature. Biomimicry becomes especially important in resiliency and scalability; this topic is outside the scope of the study.

## 9.2 Open energy accounting and transactions

The public is becoming painfully aware of the cost of energy. As producer and consumer are moved physically closer together, and can in fact become "prosumers", there is opportunity for a market at a local level.

Redgrid was involved in the Monash University NetZero 2030 - Smart Energy City initiative[23]. As part of this initiative, Redgrid developed the immutable, transactive energy ledger component in each Internet of Things (IoT) device. The project goes beyond emissions reduction in a smart city to a full transactive energy market, or TEM[24], in which its market participants bid for future flexibility.

A full transactive energy market (TEM) moves beyond the 5-minute spots on a 24-hour cycle, as per the current NEM, to the possibilities of *real time adjustment* and ad hoc market creation.

Each device could announce an 'auction' and participate as both market operator and consumer in a hierarchical arrangement, which then begins to resemble how a battery may behave. A battery damps demand as it holds reserves and can price this service based on demand. This has the added benefit of voltage management, smoothing voltage to a steady range to reduce wear and tear on the devices it powers whether they be appliances in the home or equipment in factories and offices.

Monash's smart city is effectively an embedded network and therefore received a Retailer Exemption[25]. The concepts learned could be a model for future community energy markets.

### 9.2.1 Transactive Energy Principles

As defined at a working group in 2014[26]:

- Transactive energy systems implement some form of highly coordinated self-optimization
- Transactive energy systems should maintain system reliability and control while enabling optimal integration of renewable and DERs

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[21] https://www.quora.com/What-is-the-difference-between-Blockchain-and-Holochain

[22] https://www.rand.org/pubs/research_memoranda/RM3420.html

[23] https://www.monash.edu/net-zero-initiative

[24] https://research.monash.edu/en/publications/transactive-energy-market-for-energy-management-in-microgrids-the

[25] https://www.aer.gov.au/retail-markets/retail-exemptions

[26] https://gridwiseac.org/pdfs/te_framework_report_pnnl-22946.pdf

- Transactive energy systems should provide for non-discriminatory participation by qualified participants
- Transactive energy systems should be observable and auditable at interfaces
- Transactive energy systems should be scalable, adaptable, and extensible across a number of devices, participants, and geographic extents
- Transacting parties are accountable for standards of performance.

All of these principles are encapsulated in the technology deployed by Redgrid, with an emphasis on measurement and visibility. "Auditable" means records storage trusted by independent observers.

## 9.3 Behind the meter energy loads and data

Most current residential energy optimisation solutions involve interpretation of energy usage at the meter. Energy monitoring is no longer leading edge as retailers have progressed their smartphone apps from billing information to some basic analytics, based on previous weeks' usage.

Visibility of device usage in the house, "behind the meter" or "load disaggregation", now comes from three approaches:

1. Power signatures[27] - analysis of power, voltage, and current through meter allows the retailer to recognise certain appliances via algorithmic analysis.
2. Machine learning (ML) - takes this approach across thousands of households to apply AI pattern recognition.
3. Inhouse sensors - this is the simplest approach.

Over time, ML/Artificial Intelligence (AI) will become more powerful with predictive analytics combining external factors such as approaching weather with anticipated loads. Sense, a US based company[28] that use machine learning, can now identify brands of appliances in a home and is planning expansion to Australia later this year.

[27] https://ieeexplore.ieee.org/document/1192027
[28] https://sense.com/sense-home-energy-monitor

# 10 Conclusions

In this report, we covered a lot of territory. Using Redgrid standard and new products, we engaged a subset of the Tullamore estate to determine how we could incentivise them to use the grid at greener times, and tested rewards in this territory. Our approach was low risk and low cost, using products available at major consumer goods outlets.

This 'micro' level of visibility shows that not all kilowatt hours are created equal. The current monochromatic treatment can become technicolour, showing value at peak hours (and in saving energy in those peak hours), from green versus fossil fuel sources, and saving the grid in a coordinated 'call to arms' if required to maintain voltage levels or even in potential blackout situations.

Redgrid's approach of engaging average households is labour-intensive but also illuminating; a nascent market is ready for a progressive Market Participant working together with state and local governments to expand battery trials to working, viable businesses[29].

A community battery provides a transition from the old, centralised grid to a local 'energy bank'. Transactions at a community level require trust, and a distributed ledger system that becomes the source of truth as energy value is recognised, and energy becomes a true currency in itself.

## 10.1 Opportunities

### 10.1.1 Battery Operator

Although the current regulations would require a community battery operator to be a Market Participant (as per Appendix C), there is room for exemptions and special categories to emerge. The change announced in July 2022 by the Victorian government to ban embedded networks *unless they are 100% renewable*, may be the starting point.

As decentralisation continues, control will ultimately move to the householder, or even the devices within that house.

### 10.1.2 DNSP

The distributor will continue to play a pivotal role in supplying grid energy and helping to balance the new sources of loads coming onstream. With appropriate policy incentives, the smart distributors will see the shift and apply their expertise in the local environment as additional value/revenue streams are identified that ensure the quality and security of electricity transported to premises.

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[29] As suggested in NBI Phase Two.

### 10.1.3 Retailer

In the new equation, it is the retailer that will be subject to a squeeze play. They must become ever more innovative to maintain relevance, offering to make energy usage easy, providing service guarantees, and bringing the end customer along on a journey through education. We see today's retailer being unrecognisable in five years' time.

### 10.1.4 Households/Community

As mentioned, ultimately the power shift (in all usage of the term) will move to the community and the households. They may create cooperatives for more buying power in obtaining community batteries and improving their microgrid around it. As energy as a currency takes hold, experts who understand community currencies will be in demand, creating a local crypto coin for trade. We envision entire new energy economies around generation and storage at a local level but aggregating up into ever increasing markets.

In the immediate term awareness for urban dwellers will continue to increase. As in the early days of the telephone[30], farmers are pushing innovation in the distributed energy space[31].

### 10.1.5 Redgrid

And lastly, Redgrid and this market are just at the start of the journey. The products used in this study can continue to grow to better model the emerging landscape; the Neighbourhood Energy Simulator (refer Appendix A) can include tariffs and policies as they arise for a richer set of 'what-if' scenarios. The Power App and the Energy Data Platform (refer Appendix B) provide a means for community energy groups to collaborate. Most importantly, Redgrid will continue to pursue true peer-to-peer trading and accounting with its core technology and its affiliates in Australia and around the world. Having close access to a strategic retailer is key, and we intend to continue to reach out to communities. Local governments and communities across Victoria and Australia are identifying the role they can play in the necessary energy transition to a decentralised, renewable, and smart energy grid. Many are inspired by Dr Saul Griffith, his book The Big Switch and his Rewiring Australia initiative.[32]

Redgrid encourages community groups and local government, especially those looking to install neighbourhood batteries, to contact us and consider using our platform and tools.

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[30] https://weekly-geekly.imtqy.com/articles/410779/index.html

[31] https://www.abc.net.au/news/rural/2022-08-28/renewable-solar-energy-use-increases-on-australian-farms/101350382

[32] https://www.rewiringaustralia.org/about

## 10.2 Risks and Obstacles

Although each generation is born into ever accelerating change, there is still inertia to change. Wholesale paradigm shifts require not just new infrastructure, but new models and understanding of 'how this all works.' It is key that any NIH (Not Invented Here) attitudes are replaced with those from well-informed policymakers.

This requires clear messaging at all levels of government, and incentives away from fossil fuels to true renewables, not 'greenwashing' of the old guard.

Other risks include finding and training personnel in the new technologies, unproven techniques, and emerging standards. Battery technology itself is changing rapidly, so installations run the risk of obsolescence before a return on investment. An advantage is that at a community level this is not a large outlay (compared to state infrastructure investments), and an agent-based approach allows the surrounding, emerging ecosystem a soft entry.

## 10.3 Limitations

Our approach was too labour-intensive to work with energy consumers at scale. The biggest issue was education. Until very recently, electricity has been invisible for most people except for the odd, brief outage. We worked with a range of people who wanted to save money and/or 'do the right thing'. However most did not want a learning curve involving one more screen to check regularly.

Our use of generic smart plugs worked around the larger issue of smart home standards, where in the future the appliances and the home itself will be able to aggregate data and take actions. This standardisation is coming, with Matter[33] as part of the Zigbee Alliance in the US and EEBUS[34] in Europe preparing for publishing of standards and wider adoption at the end of 2022.

Smart plugs avoided meter privacy issues because our readings were from within the house, behind the meter. We did have the study participants agree to our privacy policy and terms and conditions before we began.

Peer-to-peer trading in the current regulatory environment involves a retailer; we see this area getting greater scrutiny to reduce transactional friction, and to open up a true local market.

[33] https://csa-iot.org/all-solutions/matter/
[34] https://www.eebus.org/what-is-eebus/

# 11 Recommendations and Next Steps

In this section we address: How does 'local energy trading' using agent-based technology fit in with the current regulations? Under current regulations, only Electricity Retailers can sell electricity across property boundaries.

## 11.1 More trials, solid data, continuous improvement

Redgrid's suite of tools are a good start, but software can always get better with more user feedback and especially in this new dynamic landscape. Some concepts in this report: agent-based architectures, peer-to-peer trading, and local distributed ledgers vs a logically centralised blockchain ledger, need further validation through more use cases and trials.

The agent model can be enriched with more signals; currently it uses grid spot prices and the ratio of renewable-to-fossil-fuel in the grid, but it could include grid stresses such as approaching weather or planned local sporting events.

Manningham Council and Redgrid are extrapolating beyond the findings of this report to new community initiatives being considered, and how Redgrid technology and approach can contribute.

## 11.2 Future Projects in Behavioural Demand Shifting

Behaviour change comes from appreciating the positive changes to the environment and the wallet by going green, where a community battery bridges the gap between variable renewable energy and consistent service. To appreciate this change, energy must be visible, but visibility must not be a burden. Batteries offer more use cases beyond the 'one-sided market' we studied in this project.

The whole concept of 'community' can be used as virtual groups and (anonymously) compare their results with neighbouring suburbs for a friendly competition.

## 11.3 Future Policy Considerations

Since the current policy is only a retailer can sell across property boundaries, does this mean in a peer-to-peer market that every provider needs to be a retailer? How can this definition change to accommodate the resident with solar as a seller and unleash the potential? How do we assist solar PV owners in areas where there may not be enough consumers of their power because of low population density, or the case where everyone has solar?

# 12 Glossary

| Term | Definition |
|---|---|
| AEMC | Australian Energy Market Commission |
| AEMO | Australian Energy Market Operator |
| AMI | Advanced Metering Infrastructure |
| BTM | Behind the Meter |
| CRC | Collaborative Research Centre |
| DER | Distributed Energy Resources |
| DEWLP | Department of Environment, Land, Water, and Planning |
| DNSP | Distributed Network Supply Provider |
| DUoS | Distribution Use of System |
| FCAS | Frequency Control Ancillary Services |
| FOU | Frequency of Use |
| FRMP | Financially Responsible Market Participant |
| LUoS | Local Use of System |
| NBI | Neighbourhood Battery Initiative |
| NEM | National Energy Market |
| NER | National Energy Rules |
| RACE 2030 | Reliable, Affordable, Clean Energy for 2030 |
| RCAC | Reverse Cycle Air Conditioners |
| SAPS | Standalone Power Systems |
| SCADA | Supervisory Control and Data Acquisition |
| TOU | Time of Use Metering |
| TUoS | Transmission Use of System |
| VEN | Virtual Energy Network |
| VPP | Virtual Power Plant |

# 13 Appendix A - Neighbourhood Energy Modelling

This section delves deeper into the findings of the Neighbourhood Energy Simulator.

## 13.1 The Neighbourhood Energy Simulator

To assist in our studies, Redgrid developed a calculator specifically for modelling a typical community that shares a battery. A transactive energy market trades "flexibility," the ability to demand shift. Intrinsic to the model is the community energy ledger which accounts for each individual household, what was generated and consumed behind the meter, and what energy was consumed from the community battery and the grid.

Parameters available to adjust included:

- Household size by persona, which dictated usage patterns and consumption.
- Equipping houses with rooftop solar and their own batteries (e.g. a Tesla Powerwall)
- Dimensioning of a shared community battery.

By suggesting different scenarios, the size of the battery and behaviour load shifting could be quantified. *DemandShift* further made assumptions on costs and savings, which formed the start of a business model in operating and utilising shared battery resources.

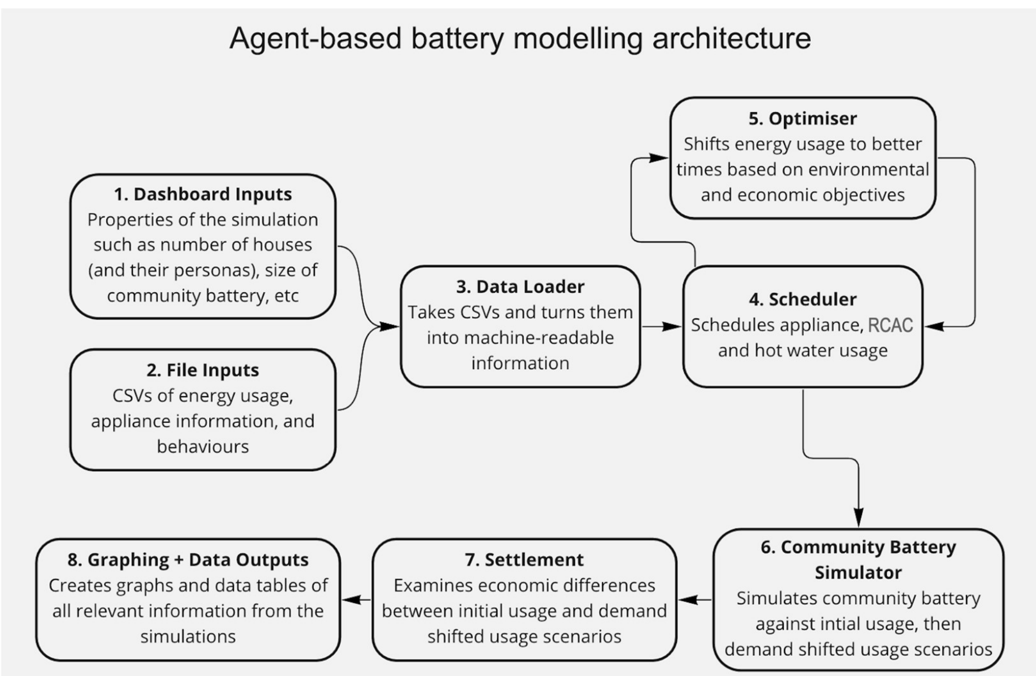


***Fig.5. Agent-based battery modelling architecture***

Note: Step 7 "Settlement" may be expressed using metrics other than financial; it may be measured by CO2 reduction, or it could involve settlement of value in kind (discounts, reward redemption, cryptocurrency).

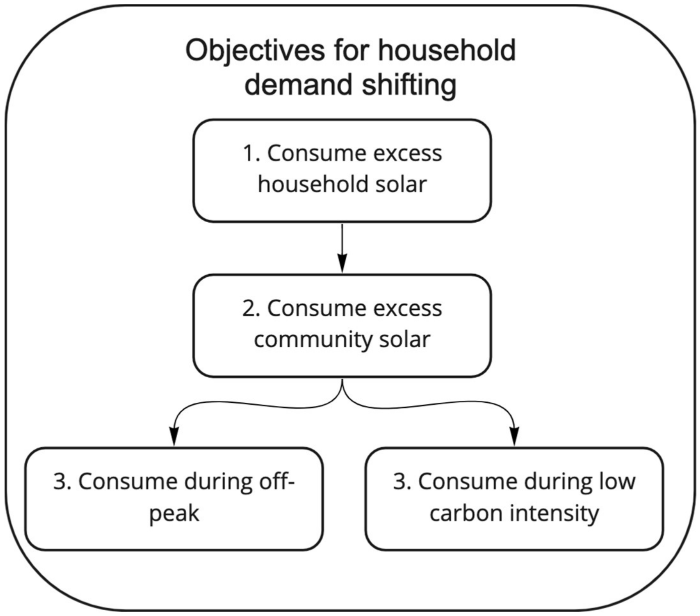


***Fig.6. Objectives for household demand shifting***

## 13.2 Change in electricity usage

The Summer and Winter graphs in this section show how the community changes its use of electricity. Net load refers to load minus solar of the community, therefore when net load is positive, the community is importing that amount of energy (in kW) from the grid, and when net load is negative, the community is exporting that amount of energy to the grid.

The original net load is showing the communities energy usage without any demand shifting the new net load shows the communities energy usage when both behavioural and automated demand shifting is implemented.

Note that in the 'new net load' scenario the net load tends to be less negative (i.e. higher than the blue line when negative), and less positive (i.e. lower than the blue line when positive), indicating that the community is both importing and exporting less energy to the grid, as they are self-consuming more of their own energy.

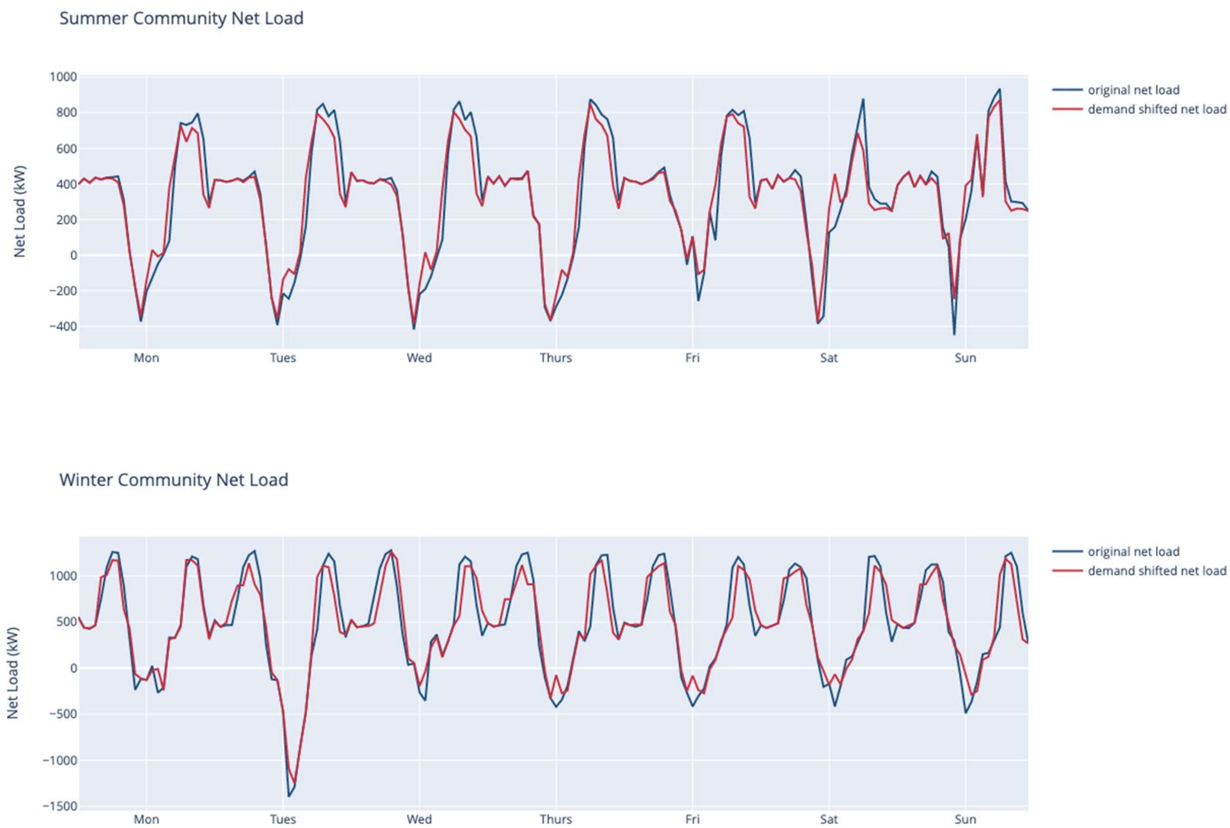


***Fig.4. Demand shifting per week in summer and winter***

## 13.3 Self consumption (Solar Soaking)

Self-consumption is the amount of rooftop solar the community consumes, divided by the total rooftop solar the community generated. For instance, if the community produced 100kWh of solar and consumed 80kWh of it (leaving 20kWh to be exported to the grid), that would be a self-consumption of 80%.

| Period | Original Self Consumption (%) | Demand Shifted Self Consumption (%) | Change (%) |
|---|---|---|---|
| Summer | 94 | 97 | 3 |
| Winter | 79 | 86 | 7 |
| Average | 86.5 | 91.5 | 5 |

***Table.4. Solar soaking from rooftop solar when demand shifted***

## 13.4 Community weekly costs

This is how much the community incurred in energy costs based on the tariff selected. If you divide these numbers by the number of houses, you'll get the average household weekly cost.

| Period | Original Weekly Costs ($) | Demand Shifted Weekly Costs ($) | Change ($) |
|---|---|---|---|
| Summer | 9337.29 | 8646.05 | -691.24 |
| Winter | 14426.74 | 13008.70 | -1418.05 |
| Average | 11882.02 | 10827.37 | -1054.64 |

***Table 5. Seasonal demand shift expressed in dollar terms across a community***

## 13.5 Household annual costs

This is how much the average household incurred annually in energy costs based on the tariff selected.

| Period | Original Costs ($/house/year) | Demand Shifted Costs ($/house/year) | Change ($) |
|---|---|---|---|
| Summer | 1213.85 | 1123.99 | -89.86 |
| Winter | 1875.48 | 1691.13 | -184.35 |
| Average | 1544.66 | 1407.56 | -137.10 |

***Table 6. Seasonal demand shift expressed in dollar terms per household***

## 13.6 Behaviour shifting savings

The total amount of behavioural shifts (dishwasher, washing machine, etc) made by the community on an annualised basis, the cost savings generated by this shifting behaviour, and the amount of savings created by behavioural shift (calculated by dividing the two preceding numbers together).

| Total Annual Behavioural Shifts | Annual Behavioural Savings ($) | Annual Shifts/Household | Savings/Shift ($) |
|---|---|---|---|
| 97734 | 18314.74 | 244.34 | 0.19 |

***Table 7. Annual savings when behavioural shifts are applied***

## 13.7 Changes in peak demand + load variability

Measures the highest amount of grid imports from the community for both scenarios, and the standard deviation. A smaller peak means that less of the network capacity is utilised and a smaller standard deviation indicates reduced volatility in how the community uses the grid.

| Period | Original Peak (kW) | Demand Shifted Peak (kW) | Original Std Dev (kW) | Demand Shifted Std Dev (kW) |
|---|---|---|---|---|
| Summer | 910 | 852 | 287 | 246 |
| Winter | 1287 | 1232 | 497 | 442 |

***Table 8. Standard deviation of peak periods vs demand shifted peak periods***

## 13.8 Changes in weekly community emissions

Compares the emissions generated in each scenario. Emissions are calculated by multiplying average emissions on the grid[35] at that point (using the historical emissions from the dates outlined above in the Tariffs and Objective Inputs section) by community energy imports.

| Period | Original Weekly Emissions (kgCO2) | Demand Shifted Weekly Emissions (kgCO2) | Change (kgCO2) |
|---|---|---|---|
| Summer | 56778.26 | 55923.14 | -855.12 |
| Winter | 74144.28 | 72204.14 | -1940.13 |
| Average | 65461.27 | 64063.64 | -1397.63 |

***Table 9. Seasonal weekly demand shifting impact expressed in emissions reduction***

Emission factors were retrieved for the above outlined dates from OpenNEM. The source provides data by state vise with a 30 min interval. For this model we have taken Victoria's average emission factor for each hour for selected dates in summer and winter.

API End point- https://api.opennem.org.au/stats/emissionfactor/network/NEM

[35] https://opennem.org.au/energy/nem/?range=7d&interval=30m

## 13.9 Battery capacity savings

Showing the reduction in reliance on the community batteries capacity and how much of that reduction can be attributed to behavioural changes, or automated changes. Note that the average is a weighted average.

| Period | Reduction in Community Battery Usage | Total Reduction (%) | Change from behaviour (%) | Change from automation (%) |
|---|---|---|---|---|
| Summer | 175.0kWh | 42.27 | 16.99 | 25.28 |
| Winter | 290.0kWh | 49.07 | 14.72 | 34.35 |
| Average | 232.5kWh | 46.27 | 15.45 | 30.82 |

***Table 10. Seasonal battery capacity savings***

If every day was perfectly the same, you could simply just take the "Reduction in usage" and make the battery that much smaller. Unfortunately, it is not so a discount needs to apply (basically the battery has to be a bit bigger for the days that solar exports are higher). We used a 1/3 discount to approximate reduction in battery usage to reduction in battery capacity (this approximation method will get us within 10% of the detailed outcome).

So as the average reduction in usage is 232.5kWh, we apply a 33.3% discount which translates to a 155kWh smaller battery. That is a 19.36% reduction in the battery capacity required for the community.

# 14 Appendix B - Other Technology Used

## 14.1 Redgrid Home app

The Redgrid Home app is a mobile application used to register and record the energy consumption of participants' appliances through smart plugs. The app is used to register plugs to a residents local Wi-Fi, name the plug based on what appliance it is monitoring and record the energy consumption of that appliance to feed into the Redgrid Powers app. It also has additional functionality such as turning an appliance on/off remotely and setting schedules to automatically turn an appliance on/off.

Each participant received 2 energy monitoring smart plugs to register through the Redgrid Home app and connect to suitable appliances in their home, mostly washing machines, clothes dryers and dishwashers.

Power Plugs offer a soft, non-threatening entry into taking control of personal use of energy.

***Fig.7. Example of a smart plug***

## 14.2 The Redgrid Powers app

POWERS BY REDGRID

Redgrid have built the Powers app as the main engagement tool with participants in this study. The app is native to smartphones and tablets (Androids and iPhones/iPads). The main functions of the Powers app are to:

- Educate residents on the best time each day to use energy from the grid/battery.
- Educate residents on how to earn points and rewards for good energy behaviour.
- Send notifications to keep residents engaged with their energy behaviour.
- Provide analytics on:
    - % of clean energy their connected appliances are using

- Number of points each appliance earns each day and the total points for all appliances each day
- How residents compare with other households in their community

### 14.2.1 Onboarding data collection

Study participants were instructed to download the App from Google Play or the Apple Store for Android or Apple devices, respectively.

The onboarding experience is designed to collect data on the household to develop our understanding, build a persona around the resident, and provide enhanced insights back to them based on their household demographic.

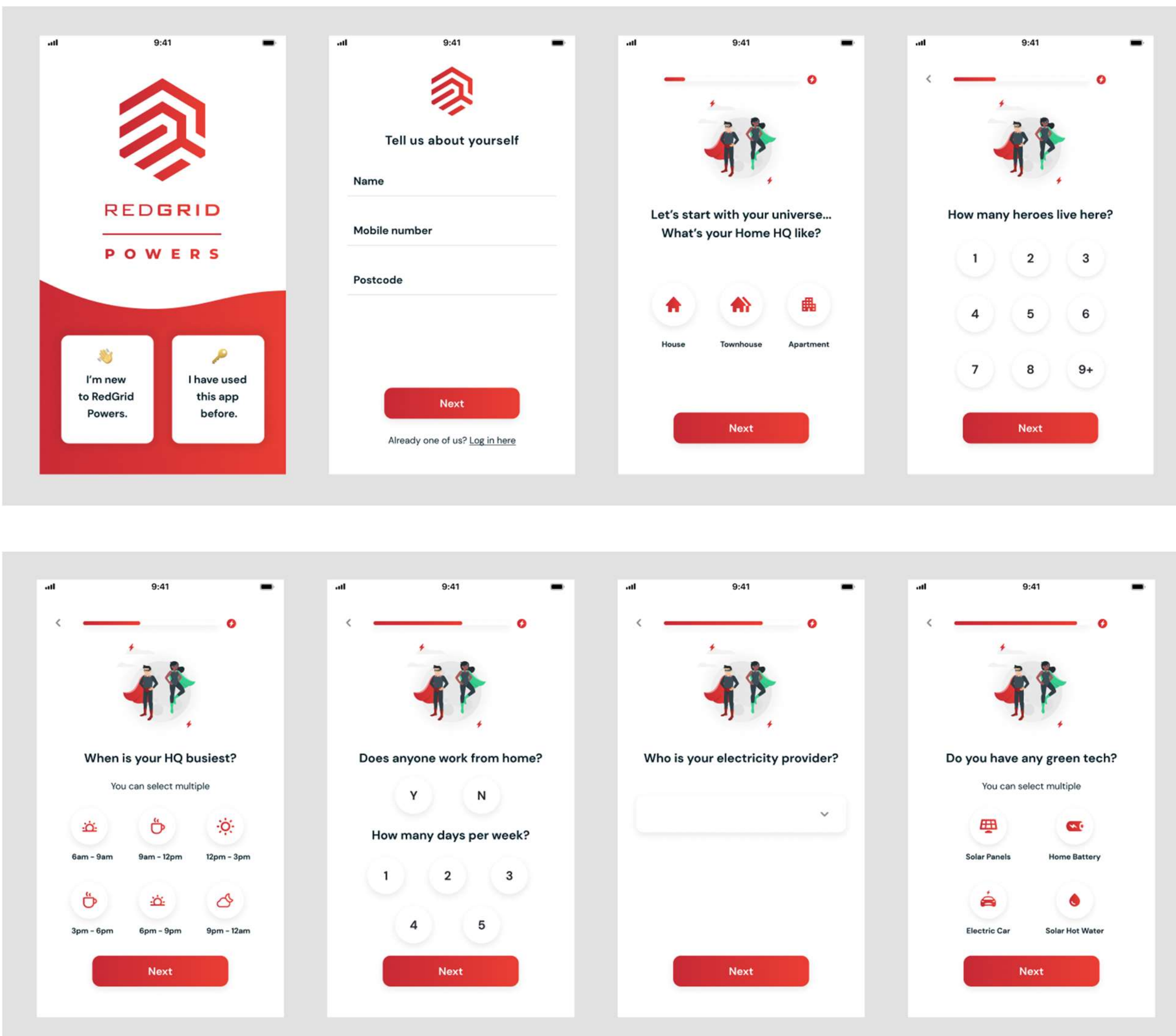


***Fig.8. Redgrid Powers App Onboarding wizard***

## 14.2.2 Training and Guidance for Onboarding

Based on prior feedback of the Powers app, it was important for residents to have a clear understanding of the purpose of the app and how they can change their behaviour to be rewarded continuously.

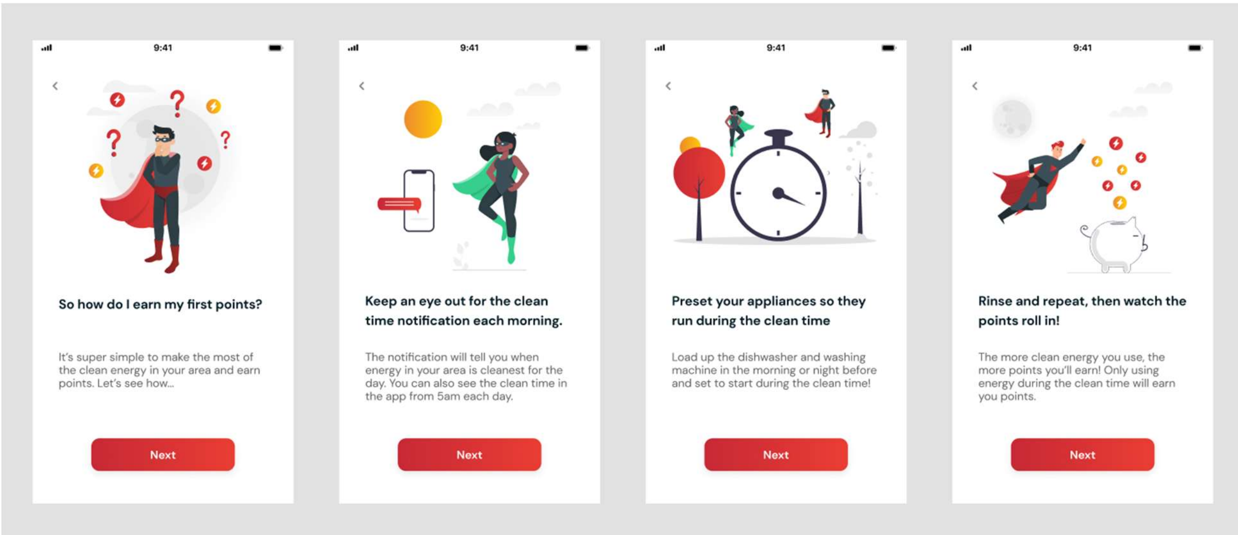


***Fig.9. Redgrid Powers App guidance screens***

The feedback from previous studies with Tullamore residents shaped the Onboarding wizard aspect of the App. Since Redgrid wants to scale this technology, it is key to set up an intuitive user experience for minimal need to engage its support staff.

## 14.2.3 Home Page & Analytics

The home page is where residents see what the clean grid forecast is for today, how much clean energy they have been using and how they compare to others in the community.

On the analytics page, residents can have a deeper look at when they are using their appliances over a 24hr graph and how many points each appliance is earning each day.

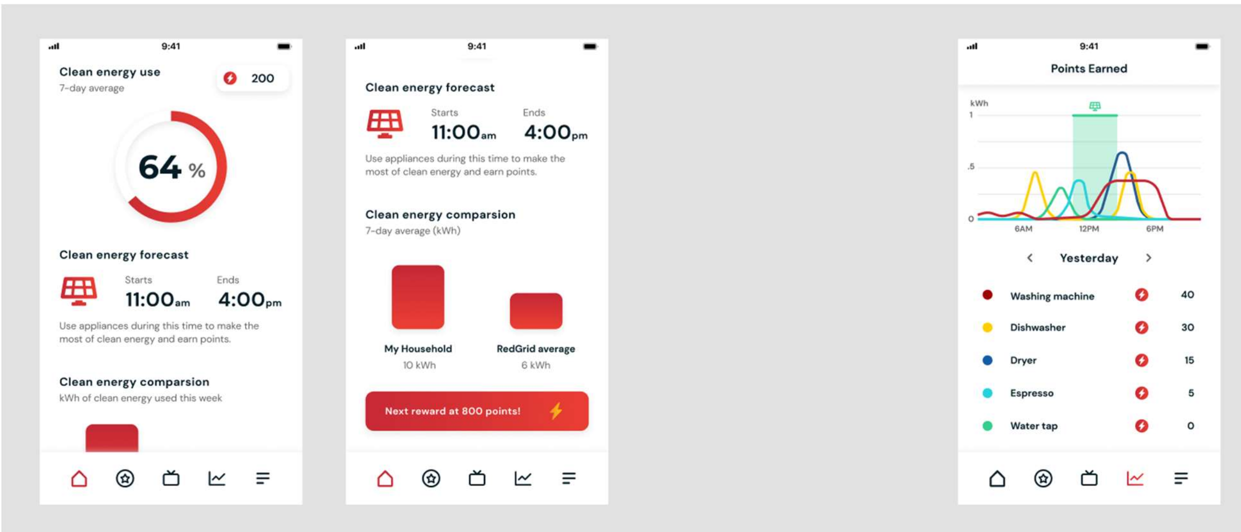


***Fig.10. Redgrid Powers App Analytics screens***

## 14.2.4 Rewards

The rewards component of the app is what keeps providing residents the incentive to continuously shift their energy usage to earn points and therefore rewards. Residents can see the points goal they need to reach to earn a reward and their current points balance that reset when they hit their points goal.

Residents can select the reward they wish to receive when they hit their points goal. These rewards can change, allowing Redgrid to test different reward preferences.

### 14.2.5 Notifications

A key feature in behavioural change is the ability to send notifications to participants. App users can opt to receive messages at the start (e.g. 7:00am) and end (5:00pm) of each day. The morning notification estimates when usage of the grid is cleanest, and the evening message reports how the monitored appliances performed.

Anecdotal evidence is that reaction to these is generally positive, with users anticipating the notifications and being provided a daily reminder that they can change to improve their individual energy usage.

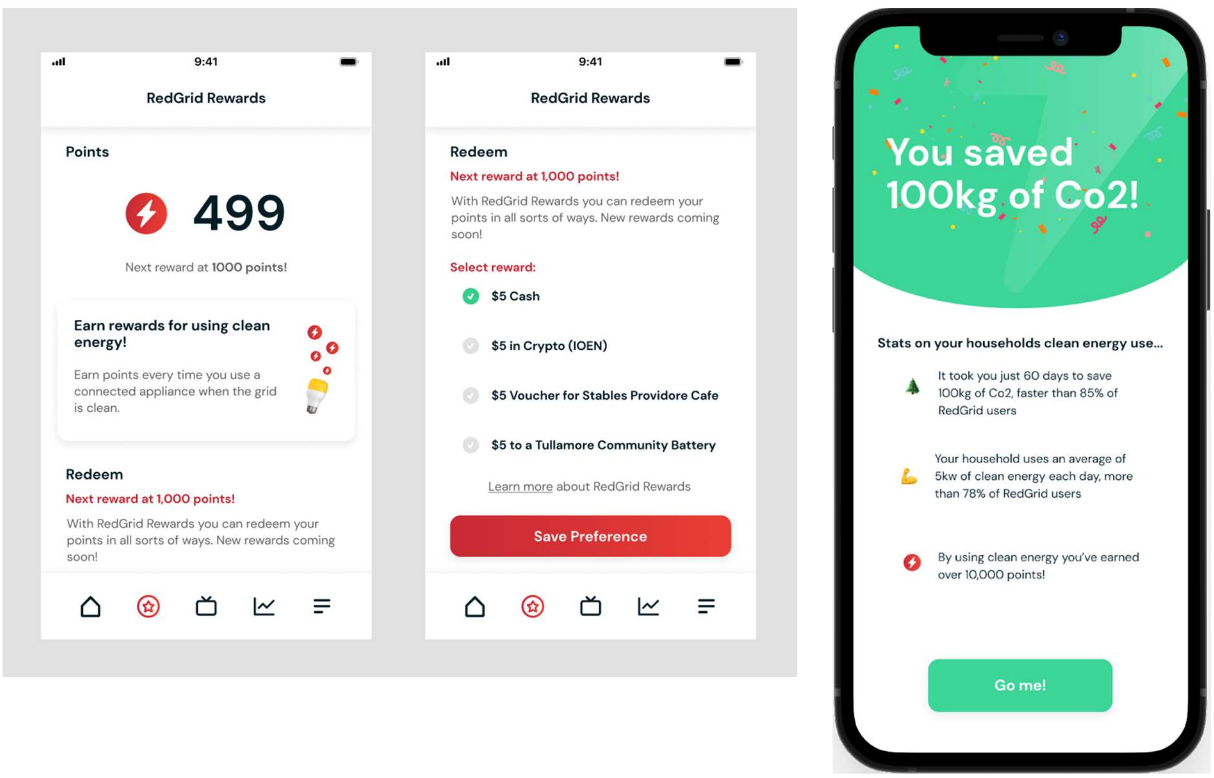


***Fig.11. Redgrid Powers App Rewards screens***

## 14.3 Energy Data Platform

The Energy Data Platform is a neighbourhood view of aggregated, anonymous energy data. Property managers or neighbourhood battery operators would use the Energy Data Platform whereas households would use the Redgrid Home and Powers apps.

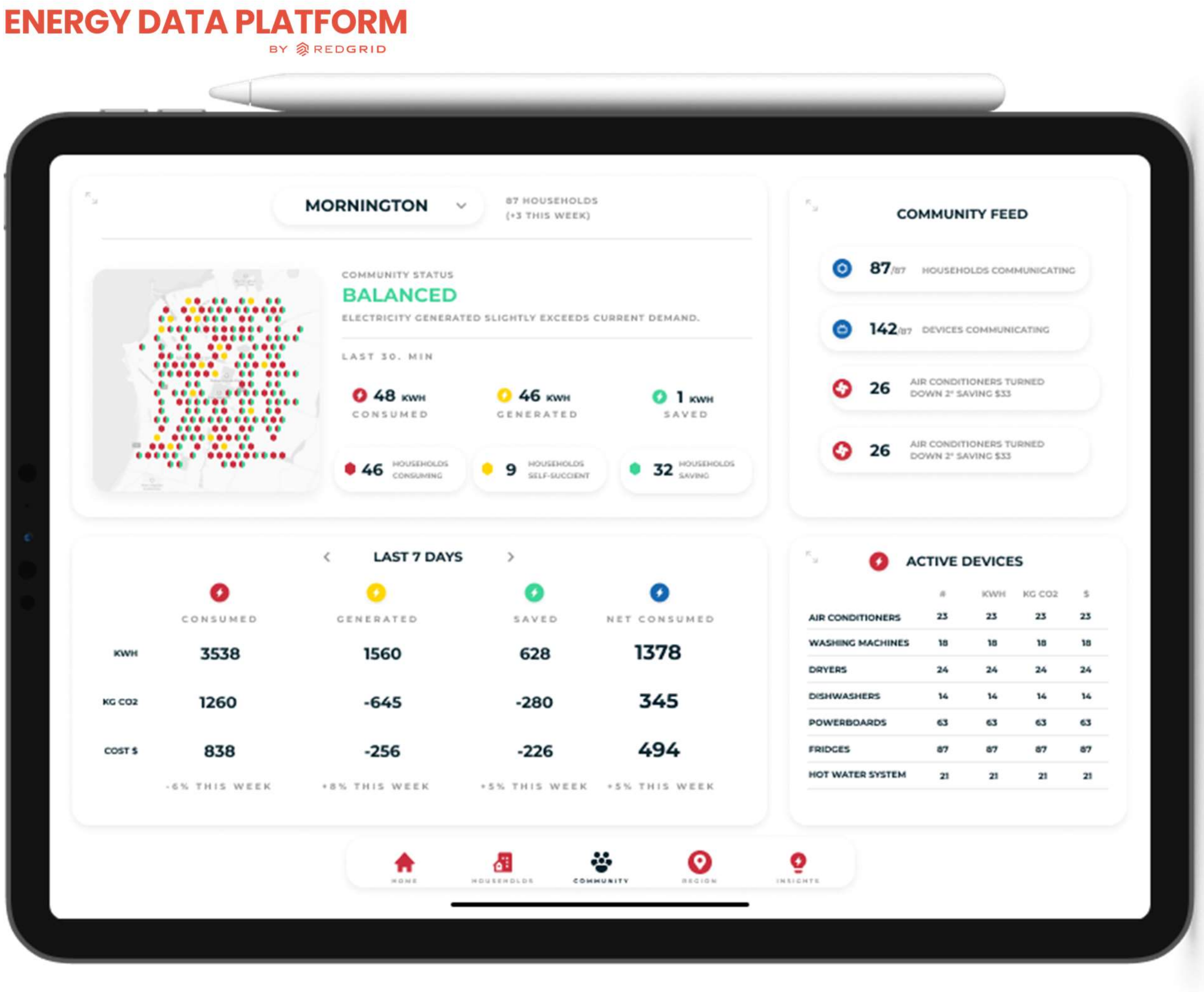


*Fig.12. Redgrid Energy Data Platform screenshot*

The Energy Data Platform was used in this study to provision connections to devices, and to issue custom notifications to one or more residents to coordinate tests.  Data from many households can be anonymously aggregated to see usage patterns per geographic, demographic, or other configurable grouping.

# 15 Appendix C - The Energy Regulatory Landscape

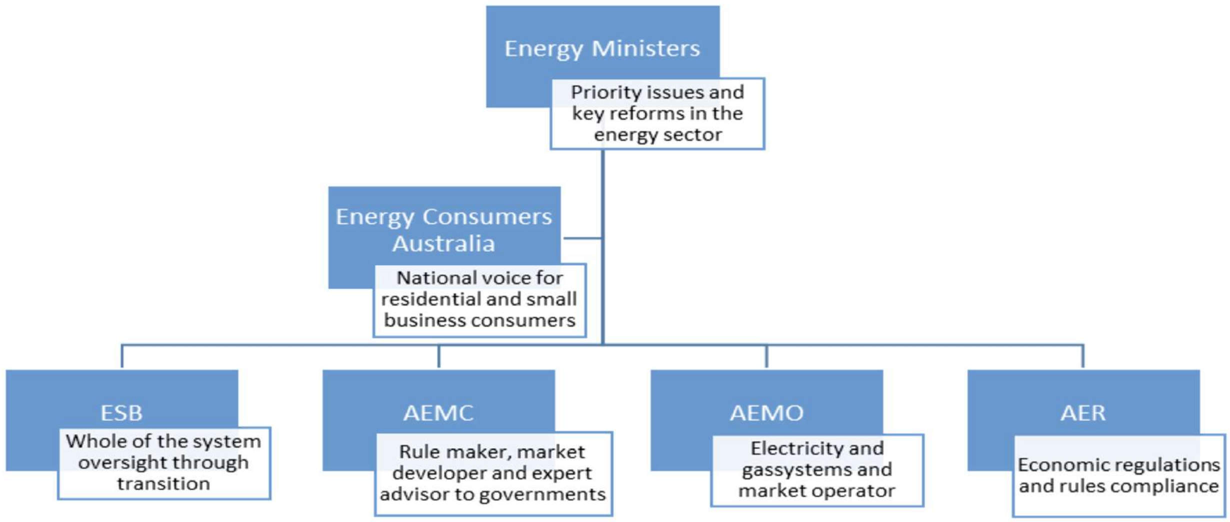


***Fig.13. Australian federal energy regulatory bodies***

As the community and community batteries become a part of the energy value chain, entities such as Energy Consumers Australia may play a bigger role and grow to represent that sector as another source of energy generation.

## 15.1 Participating in the NEM

Assuming the community battery will participate in the NEM, it must follow the National Energy Rules (NER)[36] for registration and operation. Batteries with a nameplate rating of 5MW or above will need to register as both a Scheduled Generator (producer) and Market Customer (load). There can be exceptions, for example, if it never imports electricity from the grid.

[36] https://www.aemc.gov.au/regulation/energy-rules

https://www.aemc.gov.au/regulation/energy-rules/national-electricity-rules.

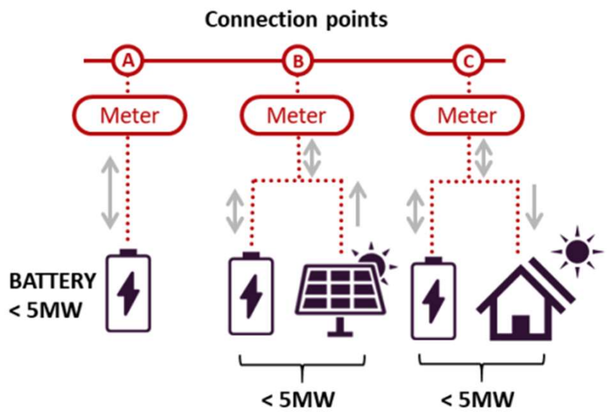


*Fig.14. Energy retailer regulation rule inflection points*

Under the NER, there is a single financially responsible Market Participant (FRMP) for each identified connection point, and there is a NER-compliant meter measuring electricity flows at each connection point.

## 15.2 Obligations as a Retailer[37]

Although different business models are still being developed, there is a high probability that AEMO will treat the operator of the community battery as a retailer[38]. This also comes with obligations:

1. Standard terms and conditions[39] in retail contracts with consumers
2. Certain duties before a contract is signed (e.g. the 30 day cooling off period)
3. Rules for billing and estimation of bills
4. Notification of tariff changes
5. Notification of planned interruption of supply
6. The usual customer confidentiality: this one is interesting if the community battery resembles a strata, where apartment dwellers know their neighbours. Community battery operational rules will need to accommodate a number of models, since current (mid 2022) activity is really at the proof-of-concept stage.
7. Life support systems
8. Customer hardship - communication of policy and allowance for a payment plan

[37] https://energy-rules.aemc.gov.au/nerr/381

[38] Note that AER has the power to exempt where the requirement to hold a retailer authorisation is waived. As Community Batteries become popular, the nature of exemptions should remain exceptions.

[39] https://energy-rules.aemc.gov.au/nerr/381/99424#sched_S1

# 16 Appendix D - Frequently asked Questions

This section addresses some questions which arise, naturally, from reading this report.

## 16.1 Will a neighbourhood battery be installed at Tullamore or anywhere else in Manningham?

For the moment, Manningham Council will not be pursuing neighbourhood battery projects at the Tullamore Estate or elsewhere in the municipality.

The Tullamore study demonstrated that neighbourhood batteries, smart devices, smartphone Apps, and agent-based software can unlock value and opportunity for a distributed energy resources system. However, there is much policy work to be done as actors, markets, tariffs, and capabilities are still very much geared to low resolution, monochromatic, centralised systems rather than highly distributed energy systems with all the various value opportunities awaiting to be unlocked by a higher definition 'colour' system of nuanced tariffs and sophisticated capabilities.

The tools developed by Redgrid can be used to support community energy groups now, even if there is no neighbourhood battery at this time. Then, when the time is right, a community energy group will be more than ready for a neighbourhood battery.

In the meantime, policies, and programs that support the formation of community energy groups, rapid green electrification of homes and business, and the adoption of behind-the-meter home storage are more immediately achievable. Some are advocating for a Battery Energy Storage Target (BEST) and certificate market to accelerate the take up of energy storage. This is analogous to how the Renewable Energy Target and Small Renewable Energy Certificate (SREC) scheme fostered the widespread adoption of rooftop solar.

## 16.2 What is next for Council?

Council will support the energy transition to 100% renewable electricity to power homes and business across the city.

This goal will be pursued in the following ways -

- By advocating for the necessary policy changes, government programs and funding that will foster a rapid transition eg support for behind-the-meter batteries through household rebate incentives and a Battery Energy Storage Target scheme.
- By delivering educational and direct-action programs for the benefit of residents and business.

## 16.3 Who should I contact if I have any further questions?

Any further questions for Manningham Council or Redgrid can be forwarded via email as follows.

**Manningham Council**
Faye Adams, Senior Sustainability Officer, Environment Team
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**Redgrid**
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