



Creating the Yackandandah Community Mini Grid

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Executive Summary

On February 9, 2017, Totally Renewable Yackandandah (TRY) and Victoria's largest energy delivery service company, AusNet Services, launched a proposal to build what they believe will be Australia's first commercially operating community mini grid. One part of the proposal is the installation of a solar and battery pilot mini grid in a small estate within Yackandandah.

This report outlines research undertaken at the estate in preparation for the installation of the pilot mini grid. The purpose of this research was to determine the optimal location for the mini grid, and the optimal mini grid model to be installed. Seventeen of 25 households from the Yackandandah Heights Estate were interviewed and surveyed on their current electricity use habits, their views on the mini grid project and how this mini grid ought to be governed.

All the households surveyed reported that they were supportive of the mini grid project. Households supported the project for its potential to deliver environmental outcomes, its potential to reduce electricity prices for participants, as well as possible benefits to the local community and economy.

Included in the pilot mini grid installation is new technology able to provide households with detailed information about electricity consumption patterns within their homes. Households were surveyed to determine their current forms of engagement with their electricity consumption and their preferences for receiving information about their electricity use.

One third of the estate actively monitored their electricity use and most households had a good approximate understanding of their electricity consumption. However this was rarely due to close analysis of the amount of energy units consumed. Rather, households tended to understand their electricity consumption through an attention to electricity cost, the types of appliances that they owned and the way they were used, any energy saving measures they had added to the house, and the amount of people in the household.

There was not a method for engaging with energy use information that households collectively preferred. There was, however, a preferred type of information. Households were most interested in simple information displayed on an easily readable interface, in an easily accessible position inside the house, that gave information about individual appliance use and was supported by the advice of experts. Approximately two thirds of the households surveyed suggested that they would like more information about the way they used electricity.

Some houses in the estate used electricity use information to reduce their electricity consumption in an experimental manner, using information to trial different electricity reduction measures. The energy reduction techniques of most households, however, were not linked to specific electricity use information and relied more on general knowledge. Turning light switches off and reducing air conditioner use were typical examples of energy reduction measures employed by these households.

Despite almost all households indicating that they would like to reduce electricity consumption, households suggested that they would only do so if it remained within their budgets and did not cause unnecessary discomfort. For many, the solution to this dilemma was not to reduce energy use but to produce more energy through environmentally friendly means.

The optimal functioning of the proposed pilot mini grid requires households to either share or trade electricity with one another. Many households felt positively about the concept of generating and sharing electricity across the mini grid, but most did not want to do this without a clear price attached to the electricity. Households felt that this would offer an incentive for the conservative use of electricity. Households also believed that a model that allowed for the trading of electricity, such that each user paid for their own electricity use, would be a fairer system than one that simply shared from a common pool.

The concept of a community energy retailer was extremely popular. Households believed that such a community energy retailer was likely to be successful in a town like Yackandandah and that it would have a positive impact for the town's community and its economy, as well as helping the town reach its 100 % renewable energy target.

Overall households were excited by the idea of participating in the mini grid project and thought that its benefits would be wide spread, providing outcomes for the environment, the local community and economy, and providing a model that could be emulated across Australia.

1. Introduction

1.1 TRY and the town of Yackandandah

Totally Renewable Yackandandah (TRY) is an incorporated association and community renewable energy advocacy group working within the North East Victorian community of Yackandandah. TRY is working with Yackandandah based residents and businesses to generate (or purchase) sufficient electricity from renewable sources to meet 100% of the town's electricity needs by the year 2022. The group was formed in March 2014 following a Community Energy Forum hosted by the Indigo Shire Council. The township of Yackandandah itself sits within the Indigo Shire Council. Whilst the township has a population of 950, it is located within a rural hinterland, and the wider district of Yackandandah extends to a population of 4,488 residents.¹

The Yackandandah community has a history of applying itself to ambitious community managed projects with success. In 1998 it held the first annual Yackandandah Folk Festival, a volunteer managed music event that is now in its 20th consecutive year. In 2002 the community established the Yackandandah Community Development Corporation, commonly known as YCDCo, to replace the closing fuel station. The YCDCo is both community owned and operated, distributing profits back into the community through a community grant program. The town maintains a community garden, toy library, community centre, radio station (Indigo FM), a local newspaper (Yackity Yack), several active service clubs, successful sporting clubs, and a strong CFA branch. Yackandandah is recognised as a country town with a vibrant community spirit and has been exhibited on Australia's national broadcaster, the ABC, twice in 2016. First on the popular Back Roads television program and again on the 'Back to Yack' event, which hosted national radio programs broadcast on Radio National.

The community of Yackandandah is strongly supportive of TRY's renewable energy target (RET) and believes that it is achievable.² The target is supported both for its ability to promote community pride and spirit, as well as a desire to achieve self-sufficiency and independence.³ Despite the strong community support for TRY's RET, the possible pathways for meeting the target have been under developed. There has been a clear desire within the community for a coherent timeline and strategy to meet the target, one that outlines necessary steps and the role to be played by residents. Within the community there is a preference for this strategy to be inclusive and community driven, providing clear and specific individual actions as well as supporting action at the community level.⁴ For Yackandandah residents the community owned and operated fuel station, YCDCo, exists as a commonly shared example of good community action to meet an agreed need.⁵

With limited resources TRY has, until now, been unable to respond comprehensively to the strong desire for a coherent and inclusive renewable energy strategy. Instead, it has operated

¹ Indigo Know and Grow (2015), <http://business.indigoshire.vic.gov.au/resources/reports/>, accessed 17 March, 2017.

² Ginnivan and Stayner (2015), http://totallyrenewableyack.org.au/wp-content/uploads/2015/12/CSU_TRY-Report_PrintVersion.pdf, accessed 17 March, 2017.

³ Ibid.

⁴ Ibid.

⁵ Ibid.

in an opportunistic manner, focusing on readily identifiable opportunities as they arise. For the most part this has involved the promotion of solar technologies and assisting local residents, community groups and businesses in the installation of solar systems. In promoting these localised transitions TRY has been on hand with relevant technological and economic information, financial assistance through their no interest loan scheme the Perpetual Energy Fund (PEF), and has celebrated individual success stories both through their Golden Yack Award scheme and through publications in local newspapers. At the same time TRY has built a public profile as a renewable energy advocacy group with newspaper articles published in local and national newspapers and speaking roles both locally and at TRY's relevant state and federal capital cities, Melbourne and Canberra respectively. In this manner, TRY has built a local, regional and national profile.



Figure 1. Reaching Yackandandah's 100% RET. A community renewable energy workshop hosted by TRY, March 2, 2017.

In mid 2016 TRY began discussions with the Melbourne based office of the multi-nationally owned business AusNet Services. AusNet Services is Victoria's largest energy delivery service and the company owns and operates the electricity transmission network (or grid) in Melbourne's north east and across all of eastern Victoria, including Yackandandah.⁶ Ongoing discussions between the two organisations has led to a partnership dedicated to the development of Australia's first commercially operating community mini grid in Yackandandah.

In October and November of 2016 TRY was funded, through a philanthropic grant by the Reichstein Foundation, to conduct research into the possibility of creating a functioning mini grid at the Yackandandah Heights Estate (the Estate). This report details the results of that

⁶ AusNet Services About Us, <http://www.ausnetservices.com.au/About+Us.html>, accessed 17th March, 2017.

research. Firstly, however, it gives an overview of the mini grid plan as developed by AusNet Services and TRY.

1.2 The Yackandandah Mini Grid

1.2.1 A new technology

To move the town of Yackandandah towards its 100% renewable energy target TRY and AusNet Services have partnered in order to create Australia's first commercially operating community mini grid. A mini grid is an energy system in which a group of households are equipped with an individual energy generation (solar panels) and storage capability (battery). As a mini grid this group can function as a unified energy unit able to generate, store and share electricity across the community. The community mini grid proposed by AusNet Services and TRY proceeds as a five-stage installation.

Stage 1. The first stage represents Yackandandah's current electricity profile. It is a town where 30% of the population already have solar panels.

Stage 2. The second stage requires a town wide installation of solar panels. A piece of proprietary micro-processing technology called an Ubi will be added to both new and existing solar arrays. The Ubi is able to monitor individual household electricity use to allow users to better engage with their electricity use. The Ubi is also necessary for the installation of batteries. The installation of solar panels and Ubis means that participating households will then be battery ready.

Stage 3. The third stage requires a town wide deployment of batteries. Batteries will be installed based on the electricity use profiles of individual households. Data collected by the Ubi processor will allow each household to determine the optimal time to install a battery system, and the optimal system to be installed. Each household will then be able to generate and store solar energy, feeding any excess back into the grid.

Stage 4. The fourth stage requires the creation of an electricity trading or sharing system that will allow members of the community mini grid to share or trade electricity with one another (Figure 2). This will allow the mini grid to function as a unified energy unit able to generate, store and distribute renewable electricity across the community. Crucial to this stage in the mini grid is the development of a community energy retailer. An energy retailer is required for households to be able to trade electricity with one another and to import electricity to the mini grid.

Stage 5. The fifth stage comprises of the installation of a solar and battery plant proximal to the town. A fully functioning community mini grid is expected to be able to provide 90% of Yackandandah's energy needs. The remaining 10% of the town's RET can be met through the installation of the solar and battery plant which will feed top up electricity into the mini grid.

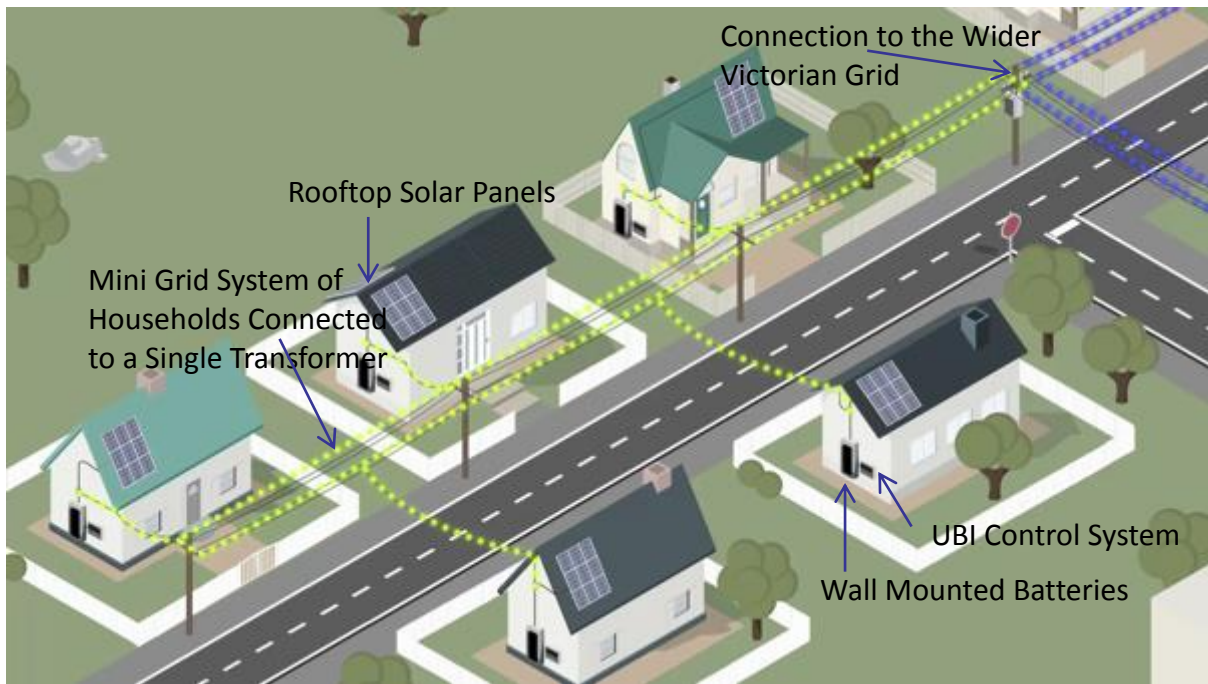


Figure 2. The community mini grid. (Adapted from a presentation by Mark Judd, Energy Solutions: The Community Mini Grid, 2016).

1.2.2 The Advantages of a Community Mini Grid

The community mini grid has a number of advantages. These include:

Building on the Solar Advantage The mini grid is able to expand upon Yackandandah’s already strong solar presence.

A Renewable Energy Storage System The addition of battery storage to a solar array provides the obvious advantage of being able to use stored solar electricity at times when solar panels are not generating electricity (overcast weather and overnight). This increases the town’s use of renewable energy and decreases the cost of purchasing electricity during those times. It also reduces the reliance on the existing network which typically uses brown coal generated electricity. It therefore offers both economic and environmental outcomes.

Ubis Promote Energy Efficiency The Ubi technology has the advantage of being able to optimise electricity consumption, improving energy efficiency within each individual house. It also offers households the chance to engage with their energy use, allowing them to experiment with energy saving measures. Whilst aiming to reduce total energy use in homes it also seeks to increase total solar electricity generation by restoring some unrealised solar electricity capacity by alerting households when solar panels have switched off, are malfunctioning, or require cleaning.

The Mini Grid Benefits the Local Economy The mini grid shifts the production and retail of Yackandandah’s energy supply from remote locations to the town itself. This is expected to deliver economic benefits to the town of Yackandandah. The installation and maintenance of the mini grid is expected to

employ local technicians and the establishment of a community energy retailer is likely to employ at least one, and possibly more, full time staff.

The Mini Grid is Reliable

The mini grid is capable of operating separately from the larger electricity network. If electricity delivery through the wider grid is disrupted the mini grid will be able to continue operating as a stand-alone unit. The proposed Yackandandah mini grid will remain connected to wider AusNet Services network, however. By staying connected to the network the mini grid will be able to draw electricity from the network during times when the solar mini-grid is not generating enough electricity to service each home. When the mini grid is generating more than it is using it will be able to sell this electricity back to the grid.

1.2.3 Governance of the Community Mini Grid

The effectiveness of the mini grid depends on the ability of participants to share electricity with one another. If members of the mini grid are able to agree on a system for sharing or trading electricity then the town will derive the maximum benefit from the mini grid. With a successful system in place, the mini grid will be able to become a cooperative energy generating and storage system. Under current regulations, all trading of electricity, even between households on a mini grid, must be facilitated by an energy retailer. For the Yackandandah based mini grid project a community based electricity retailer is proposed. The community retailer envisaged for Yackandandah would be supported by an established retailer able to perform ‘back end’ functions, such as energy hedging, meeting regulatory requirements and so on. The community energy retailer would provide a localised mini grid service to facilitate electricity sharing and trading across the mini grid.

The responsibility for the installation and maintenance of the mini grid infrastructure would be assumed by AusNet Services. AusNet Services would charge a fixed fee for the installation and service of the mini grid infrastructure, and the community retailer would facilitate transactions within the mini grid (see figure 3.). In this scenario the community itself would produce and sell their own electricity with AusNet Services and the community energy retailer charging for services that facilitate the optimal functioning of the mini grid. The Yackandandah community mini grid would be the first commercially operating mini grid in Australia and the full details of how this cooperative energy system will be governed, so that energy is shared equitably, is a yet to be developed.

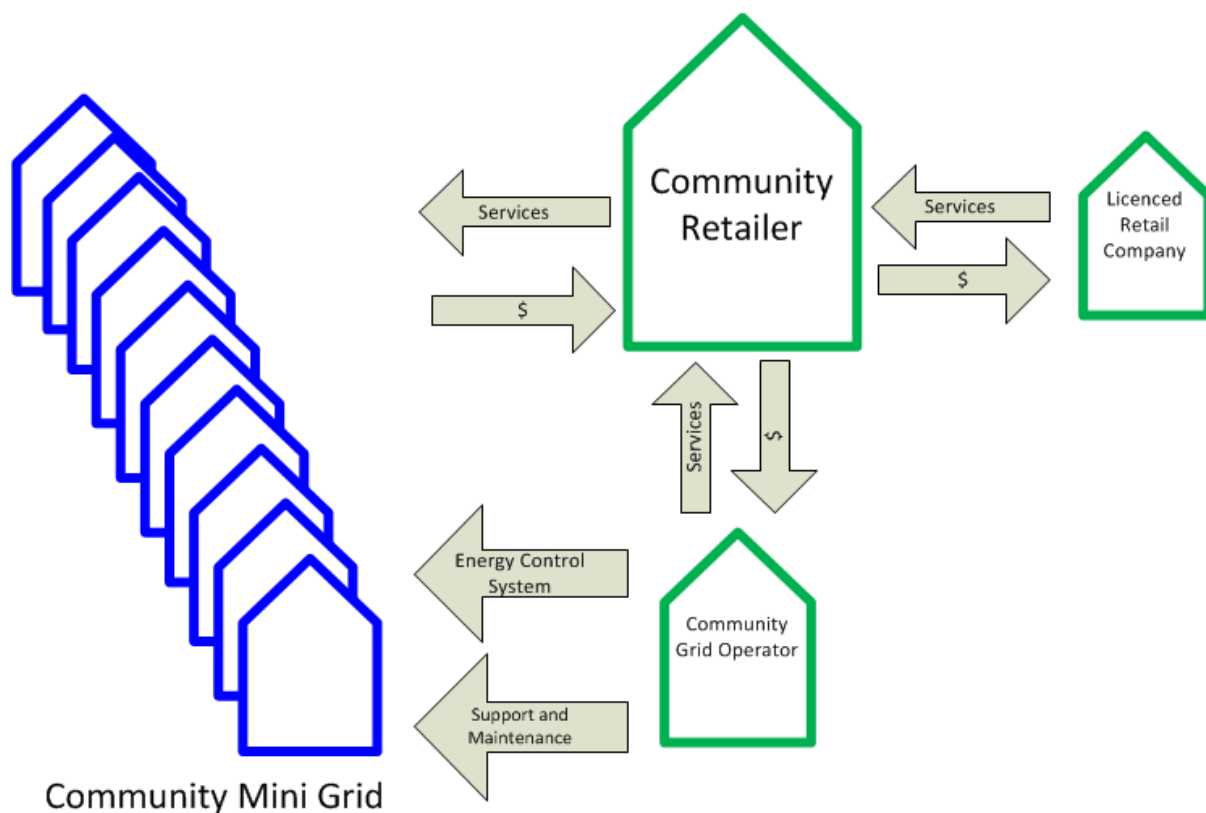


Figure 3. Proposed community mini grid governance arrangement (from a presentation by Mark Judd at mini grid Workshop #3, Dec 13, 2016).

1.3 Purpose of the Research

TRY and AusNet Services are currently preparing for the installation of stage two of the mini grid. The launch of the mini grid project, on February 9, 2017 attracted approximately 300 people with approximately 130 expressions of interest for a solar and/or Ubi installation. Concurrently, however, TRY and AusNet Services are proposing to install a stage three solar, Ubi and battery mini grid as a pilot study. It is this pilot mini grid that forms the focus of this research report.

The current costs of batteries prevents them from being accessible additions to household budgets, however AusNet Services have committed to subsidising their cost to a level believed to be cost competitive. Importantly, whilst the batteries are subsidised, this stage three mini grid trial remains a commercial offering and households will incur charges for the mini grid service. It is therefore important that this mini grid offering be made to a group of households that understand the potential benefits of the mini grid and are positively disposed towards the concept. This being the case, the first aim of this research project was to determine an appropriate site for the commercial stage three mini grid offering.

The mini grid is a concept that most Yackandandah residents are unfamiliar with. As a commercial mini grid offering is intended to follow this research it is important that the research project sensitise residents to the concept in order to prepare them to make an informed decision on the pending mini grid offering. An ancillary aim of the research was to inform potential participants of the mini grid project, and to explain its implications.

The proposed mini grid project offers an opportunity for a detailed restructuring of the ways in which Estate members engage with their energy use. The installation of the Ubi device as a part of the pilot mini grid will offer households a more detailed view of their energy consumption patterns. In later phases of the mini grid installation, the patterns of energy use of mini grid participants will be used to generate efficiencies in energy sharing across the mini grid system. The second aim of this research was to understand the way that residents in the Estate currently engage with their energy use and how they would like to do this in the future.

The pilot mini grid pilot will allow AusNet Services to prove, and improve, its mini grid technology. It also offers the chance to experiment with different models for sharing and trading electricity between households within a mini grid. A third aim of this research was to determine the attitudes of potential mini grid participants to different models for sharing or trading electricity between households across the mini grid, and towards the concept of a Yackandandah based community energy retailer.

2. Methods

Through an analysis of Yackandandah's current electricity grid infrastructure AusNet Services selected three groups of buildings, attached to single transformers, that would be suitable for the mini grid pilot. Due to time restrictions, the research members of the TRY committee decided that the three would be surveyed consecutively, until a suitable neighbourhood was located, rather than concurrently. TRY volunteers assessed the three, deciding that the Yackandandah Heights Estate (the Estate) ought to be surveyed first. This decision was based on the Estate being a recent development that includes useful infrastructure, including a grid position favourable to a mini-grid and accessible gas storage, which may be used to power a generator to help occasional modulation of the electricity quality. The Estate was also known to be a neighbourhood that holds a strong sense of identity and includes known renewable energy advocates.

A mixed methods survey was designed that included a range of demographics, as well as qualitative and quantitative questions. The survey was tested through two trial interviews with two households in the Estate and adapted accordingly. An information sheet and an invitation to participate in the survey was distributed in the letterboxes of the 25 estate households on Sunday the 2nd of October 2016. The survey of the estate was conducted over the month between October 10th and November 12th, 2016. Surveys were conducted in one of three ways depending on the availability of Estate residents. Most surveys were conducted face to face, with households being led through the survey in an approximately one hour long interview. Surveys conducted in this fashion occurred at the respondents place of residence. For those households unable to find the time for a face to face interview the survey was conducted either over the phone or completed by the members of the household themselves. Surveys conducted in these more flexible ways were particularly popular amongst, for instance, those households with young families.

Of the 25 households in the estate 17 responded in the one month time-period. Qualitative data was analysed, using the data analysis software NVIVO, for key themes and quotes. Quantitative analyses were conducted using Microsoft Excel.

3. Results

Due to the urgency to decide on the site for the installation of the stage three mini grid an interim report was prepared for the TRY committee on November 28th, 2016. This report summarised the demographic and survey data relevant to this decision. Following the distribution of the interim report, and a presentation to the TRY committee, Yackandandah Heights Estate was chosen as the location for the pilot mini grid. This report does not cover the suitability of the Estate for the mini grid installation.⁷

The community mini grid project proposes a large change to the way that households currently meet their energy needs. The first section of these results addresses the ways in which households in the Estate currently engage with their energy use and how they would like to do so in the future. Households within the Estate were surveyed on their attitudes towards the community mini grid concept, as well as the factors that might smooth their household's transition to a mini grid model. These are presented in the second section of the results. The third and final section of these results describes the attitudes of the residents to alternative governance models for facilitating the transfer of electricity between households participating in the mini grid. Included in this section are the attitudes of households to the proposed community energy retailer.

The Yackandandah Heights Estate is a new estate. Building began on the first houses approximately ten years ago and the houses range in age from nine years old, up to the two houses that are in currently under construction. Being a contemporary development, many of houses in the Estate had employed various sustainability measures as they built. As some households reported, the estate had been subject to local planning regulations, which required that houses built to meet a certain sustainability rating. For many households this had been met through the installation of a solar hot water system. The estate was also serviced with a gas distribution system, which many households had subscribed to when they first built their houses.

The households surveyed ranged from single person households to families of no bigger than five people (Table 1.). Residents ranged in age from between the age bracket of 30-39 up to 70-79 age bracket (Table 2.).

Household Size (persons)	Number of Households (N = 17)
One	5
Two	4
Three	2
Four	4
Five	2

Table 1. Size of Households in the Estate

Age of House Owners or Leaseholders (Years Old)	Number of Households (N = 17)
30 - 39	4
40 - 49	4
50 - 59	4
60 - 69	3

⁷ Interested readers are referred to Interim Report for further information on this topic.

70 - 79	1
80 - 89	1

Table 2. Age of house owners or leaseholders in the Estate

3.1 Engaging with Energy Use in the Yack Heights Estate

3.1.1 Making Decisions about Energy Types

Households in the Estate used a wide variety of energy sources, and made decisions on the types of energy sources used in recognisable ways. Those households that had built homes in the Estate had the benefit of choosing their own energy sources. Those that had bought houses had their possible sources of energy limited by the decisions made by others during building. Despite this difference, decisions on the energy use of each households collected around several recognisable themes.

Energy Source	Number of Households
Gas	13
Solar Panels	5
Green Electricity from the Grid	5
Unspecified Electricity from the Grid	11
Wood	5
Solar Hot Water	7
Other	

Table 3. Types of electricity sources used by households in the Estate

Pragmatic Decision Making

Households often followed a pragmatic approach in choosing energy sources. This approach could be used to explain the approximately three quarters of people in the estate that used gas as a form of energy. Households four, six, eight, ten, twelve and sixteen had all reported that gas had been chosen simply because it was readily available in the Estate. Similarly, household four had chosen wood fired heating because they had access to a wood supply. Included in these types of pragmatic decisions were those households that made decisions based on direct responses to the material realities of their houses. For instance, households four and seven were in the process of installing heater units as a response to cold winters.

Eco-friendly Decision Making

Many of the households surveyed had made decisions based on an environmental factors. In many cases this was presented as a statement against fossil fuel generated energy in favour of renewable energy. Household eleven for instance, was ‘committed to renewables’ and wanted to ‘close down coal’ and household fifteen was interested to be ‘eco-friendly and renewable.’

When household four was building their house they had been ‘wanting to make a difference and not use fossil fuels’ building a well-insulated house with low heating and cooling requirements and installing solar panels. For their extra electricity needs they had chosen green electricity which was ‘an ethical decision and is not at all based on the cost.’

Similarly, household ten indicated that the new house they were building was of an ‘eco-friendly’ design that included energy saving measures like a concrete floor that was designed to store heat. Both households nine and seventeen also indicated that they based decisions on

‘environmental factors.’ Household seventeen indicated that the last house they had lived in had been ‘off the grid’ and they would like to do the same again.

Others in the Estate had chosen solar panels and green electricity in the belief that these offered a better long term investment than fossil fuels. Household three, for instance, had installed solar panels and had avoided the gas available in the Estate as it was a finite resource, whereas they believed electricity would be around for a long time.

Not all eco-friendly decisions had been made by the households themselves. For instance, household eight had installed solar hot water as a response to guidance from the council that had required every house built in the estate meet a certain number of stars in the national rating system.

Economic Decision Making

Many of the households in the estate had made decisions about their energy types based upon their price. In some cases decisions were made solely on price, for instance household thirteen had chosen based on ‘the cheapest available.’

The cost of energy options was more often a consideration that was included amongst others. For instance, household fourteen made decisions based on ‘initial cost, reliability and efficiency.’

Others who had preferred to make decisions for environmental reasons had often been inhibited by economic factors. For instance both household four, and household twelve had planned to install solar panels and had to postpone their installation due to the price. Household four had gone on to purchase solar panels in the following years. Household twelve had opted to implement lower cost energy efficiency measures instead, including double glazed windows, double curtains, and a garden to shield the house from the western sun. Whilst household four, nine and fifteen suggested that the environment had been a factor in their decision making, each of these households also indicated that the cost of different energy options also formed a large part of their decision making.

Decision Making with Others

Whilst some households had explored different energy use possibilities, others had either been unaware of the availability of options or had been happy to follow the advice of others. Household sixteen, for instance, used gas and unspecified (not green) electricity from the grid, because ‘that’s the only options we’ve got.’ Other households had simply accepted the energy choices of former house owners. Household seventeen, for instance, was not committed to a long-term residence and had simply accepted the energy options available when they had moved in. Similarly, household five had simply ‘took over what was here already’ when they bought the house.

Other households had taken advice from others in their neighbourhood when building. Both households one and seven had made decisions on their energy use options after conversations with neighbours.

Decision Making on Personal Preferences

Beyond decision making based on environmental impact, price, and advice, some households also chose based on personal preferences of different types. Household twelve, for instance, had chosen to include gas as an energy option as they preferred to cook with gas rather than electricity. Household three, on the other hand, chose electricity for their cooking because

they didn't like cooking with gas. Similarly, household four had preferred wood fired heating because they preferred the feel to electrical heating sources.

3.1.2 Making Decisions about Energy Providers

Households in the estate purchased energy from a wide range of providers. The gas company Elgas managed the distribution of gas within the Estate. Those that had gas in their house had Elgas as their provider. In contrast, there were a large number of electricity retailers selling energy within the Estate. Retailers included Tru Energy, Powershop, Momentum Energy, Red Energy, Origin Energy, Energy Australia, and Alinta Energy, seven in total.

Eco Friendly Decision Making

Many of the factors influencing decision making were similar for deciding upon the types of energy, and the retailers of that energy. Many households chose electricity retailers based on the type of energy they supplied, with some companies chosen for the green electricity they provided. Household seventeen, for instance, chose one retailer because 'it had the greenest reputation.' Households four and three both wanted to buy renewable electricity and bought theirs from different an Australian based hydro-electricity retailers.

Economic Decision Making

Many households reported that the cost of electricity was an important factor in who they purchased electricity from. Household thirteen, for instance, made their decision on an electricity retailer based on what was 'cheapest at the time.' Household fifteen also made decisions based on price. Households often reported that price had been the key factor in decisions to change providers. For instance households six, ten and eleven had changed retailers when a cheaper option presented itself, either when approached by another retailer (households ten and eleven) or through word of mouth (household six).

Households sometimes included economic factors beyond household budgets in their decision making. For instance households two and nine reported that they purchased electricity from retailers because they were either 'Australian owned' or 'local'.

Decision Making with Others

Households often relied on input from others when making decision about preferred retailers. Household one made a decision after conversations with others in the estate when they first moved in: 'what day are the bins picked up. Who's your electricity provider. That sort of thing.' Similarly, household nine followed the advice of a friend and household six took the advice of their builder.

Engagement with Electricity Use

Whilst the price and the type of electricity (renewable or fossil fuel generated) are the two main distinguishing variables amongst households, household seventeen suggested that he chose his retailer partly for the access it provided to information about his electricity use. For this household access to information 'gave me the greatest control over my power usage.'

Discrete Decision Making Moments

The occasions for making decisions about energy use tended to happen at certain moments. Decisions about energy types tend to be involve large upfront costs with long term consequences. As such, decisions about energy types tend to occur in discrete moments, when the house is being built, for instance. Decisions about retailers, however, can be easily changed at any moment. Despite this fluidity, however, households in the Estate tended to

change only on certain occasions. Household four and six, had made decisions about their energy retailer when they first moved into their new homes but hadn't reconsidered since. Some households did not seem particularly interested in who their energy provider was. Household seven for instance, couldn't remember how it was that they had come to be with their current retailer. Household eight suggested that they had not really made a decision but had been connected with their retailer when they first moved in. Similarly, household five had taken over the electricity contract of the previous owners of their house.

As mentioned, some households switched providers when they found a cheaper option (households six, ten and eleven), for the most part however, households tended to stick with the same electricity retailer. Household twelve reported that they had been with the same energy retailer 'forever' despite that company being bought out by another: 'we'd probably change but haven't had the time to do it.'

3.2 Household Energy Consumption

This section of the results outlines the ways in which members of the Estate engage with their energy consumption. Households were asked to choose the average price range for the amount they spent on electricity each year, how much they consumed in kilowatt hours per year, and how they thought this rated on a scale of one, very low, to five, very high, and why they chose this rating.

Whereas all but one household in the Estate could give a good estimate of their cost of electricity per year, very few (four) were able to give an estimate of the amount of electricity used per year. Householders primarily understood their electricity use through the amount spent as opposed to the amount of energy consumed. As table two shows, households placed themselves on an even continuum in relation to others in the Estate. Those who paid less for their electricity tended to give themselves lower ratings and those who paid more tended to give themselves higher ratings. Householders in the estate tended to have a fairly good understanding of their energy use in relation to others. When asked how they had come to those ratings, however, households offered a wide array of explanations suggesting that households were able to approximately estimate their energy use in relation to others despite having very different ways of understanding their energy use.

Price Range (dollars)	Ratings (N = 17)
0 - 500	Low (2 households) Very low (1 household)
500 - 1000	Medium (1 household)
1000 - 1500	Low (2 households) Medium (1 household)
1500 - 2000	Medium (2 households) High (2 households)
2000 - 2500	Medium (2 households) High (1 household)
2500 - 3000	Medium/High (1 household) High (1 household)
Unknown	Unknown (1 household)

Table 4. The average cost of electricity compared with household ratings

3.2.1 Understanding Energy Consumption

Understanding Energy use through Billing and Electricity Units

When asked to explain how they rated their household's energy consumption three households suggested that they had followed the advice on their bill. Household seventeen for instance had selected the 'very low' rating on the basis that when compared 'to other single occupant residencies I use approximately 50 – 60 % less than other households for the same demographic.' Similarly, household three can see what the averages are on their bills and notices that 'we are always below average.' Household fourteen and four had also given a rating based on evidence from their bill.

Understanding Energy use through Design and Household Factors

Although some households understood their energy consumption through an analysis of the figures, most households tended to focus on everyday actions they took to reduce their energy use, measures they'd taken around the house, and household factors, like the number of people, or a combination of these. Household one, for instance, had based its decision upon the fact that their house was fully insulated and the fact that the air conditioner or heater was only on when absolutely necessary. Household twelve had installed double glazed windows and curtains as well as having 'done a few things to reduce' around the house. Household four based their decision on the fact that they don't have any electrical appliances that use a lot of electricity, including an air conditioner, and they don't use their microwave much. Households six, eight, nine, eleven, thirteen sixteen and seventeen all helped make decisions based on their careful use of appliances and lighting.

The response by household seventeen was a typical, but more detailed, example of these explanations:

'[we've been] conscientious about energy use for a long time, turning lights off and appliances at the wall etc waiting for whole loads of washing, not using clothes dryers if possible.'

Most households understood air conditioners and heaters to be large energy using appliances. Household thirteen, for instance, chose a higher rating as their electricity consumption was 'generally pretty good, except in summer when the air-con is on.' Similarly, household seven had used the heating a lot in winter and had given itself a higher rating. Houses often knew which different appliances were using most energy. For instance, household three knew that the pump attached to their fire that moved heated water around the house used a lot of energy.

Knowledge of the consumption of different appliances was used in comparisons between other households in the Estate. Household twelve for instance had given themselves a medium rating because 'when we compare to neighbours we know that we're not using heating and cooling as often.'

Other households based their decision on the number of people within their house. Household fifteen had given themselves a low rating being a single person household. Household sixteen had given themselves a medium rating based on the belief that they were an average family of two adults and two children.

3.2.2 Current Engagement with Energy Use

Most households reported that they undertook activities to reduce their energy use. Eleven of the seventeen households surveyed suggested that they were actively engaged in activities to reduce their energy consumption, five were not. A smaller cohort of six households were

engaged in a more detailed analysis of their energy use, actively monitoring how much electricity they were using. Whereas six households were currently monitoring their energy use, eleven households indicated that they would like more information provided to them about their energy use. All households but one indicated that they were interested to reduce their energy consumption.

Question	Yes	No	Unanswered
Do you currently engage in any activities to reduce your energy consumption?	11	5	1
Would you like to reduce your energy consumption?	16	1	
Does anyone in your household currently engage in any activities to monitor your household electricity use?	6	11	
Would you like more information provided to you about the way you use energy?	11	5	1

Table 5. Activities and views relating to the engagement of households with energy use within the Estate.

Reducing Energy Consumption through House Design

Those who responded that they did engage in activities to reduce energy consumption did so in several ways. As mentioned, many of those living in the estate had designed their own homes and included elements of house design in their examples of the ways in which they reduce energy consumption. Household fifteen, for instance, had designed a solar passive house with a verandah; double glazing on the north facing side of the building; floor, wall and ceiling insulation; as well as rubber backed curtains. Household ten had installed shutters, doors to reduce heat dissipating, drop down blinds on the western side of the building, and curtains. The house they were building in the estate was to be ‘smaller and hoping not to have air con and all that in it, or even fans.’ Similarly, household eight had installed glazing on windows, and had planted trees and grape vines to shade the western aspect.

Reducing Energy Consumption through Appliance Monitoring and Control

Other households focused on controlling the amount of electricity that different appliances used. For instance, household fifteen used a timer on its heater and cooler that turns the appliance on when the household wakes up or arrives home, and turns it off when the household leaves the house or goes to bed in the mornings and evenings. Households one, four, seven, and ten all suggested that they limited their heating and cooling use, using it strategically. Household four, six, twelve and sixteen all suggested that they turned unused appliances and lighting off to save electricity and household six suggested that they only bought appliances with good electricity use ratings.

Household four and nine both had solar panels and used appliances during the day in order to use more of their own free electricity. Household fifteen washed its clothes and dishes in during off peak periods, with cheaper electricity, on the weekend.

Reducing Energy Consumption through Abstinence

Many households reduced their energy consumption through abstinence. Households one and four reported that they were more likely to put on warmer clothes than put on the heater. Household nine reported that it only kept small sections of the house warm. Household three had decided to do without an air conditioner even though they would have liked one.

3.2.3 Reasons for Reducing Energy Consumption

All but one of the 17 households surveyed responded that they would like to reduce their energy use. The one household that didn't, household one, reported that they thought they would not be able to reduce their energy usage anymore without experiencing discomfort. Many of the households surveyed referred to this balance between reducing consumption, whilst maintaining a budget and a functional and comfortable lifestyle.

Household eight, reported that 'everyone would [reduce consumption] if they could but there is not too much that we'd do differently.' Similarly, household eleven were caring for their elderly mother and had 'decided we'd rather [the mother] be able to use things when she needs including the heating the cooling. Within limits.'

Household six, thought that reducing their electricity consumption would involve spending large amounts of money. To reduce their electricity use further they believed they would have to spend money buying new appliances or cut electricity use in some areas, both things they were reluctant to do. Household six was less interested in finding ways to reduce their electricity use and more interested in finding ways to generate and use environmentally friendly electricity.

Household twelve was also less interested in reducing electricity consumption and more interested in producing renewable electricity 'we know it's a benefit to the environment if we use solar, and it's free.'

When households talked about reducing electricity consumption it was typical of them to refer to these points of balance, between reduction and production, comfort and cost.

Reducing Electricity Consumption for the Environment

Many of the households that indicated an interest in reducing electricity did so for reasons related to the environment. This was true of households six, seven, nine, ten, twelve and seventeen. The comment of household ten was typical of those seeking to reduce consumption for environmental reasons: '[it] reduces the output on the atmosphere and the environment.'

Some households elaborated upon this sentiment, suggesting that efforts to reduce electricity consumption helped to contribute to the common good. As Household four explained, the price that they received for their solar electricity that was sold back to the wider grid was so low as to be insignificant. What made the low price tolerable was the sense of contribution to a larger cause, both by contributing green electricity and by demonstrating what was possible for other households:

'...there's not much to incentivize us to decrease use during the day because the feed in tariff is so low. We under utilise our large generating capacity and produce way more than we use but we are still paying bills because the [feed in] tariff is so low. I don't mind doing that. It feels good that we are putting something back into the grid and someone else is using our

green electricity...I'd like to reduce it [energy consumption] to save money but also to demonstrate that we don't need that dependence on heaps of electricity to have a comfortable life.'

Household seventeen shared a similar intent, hoping to contribute to a collective effort to reduce carbon emissions: 'Every bit helps and it feels good!'

Reducing Energy Consumption to Save Money

Another equally strong imperative for households to reduce electricity consumption was to reduce costs and improve household budgets. Households five, six, seven, nine, ten, thirteen and fourteen all expressed a wish to reduce electricity consumption in order to save money.

3.2.4 Energy Use Information

Only six of the seventeen households indicated that they engaged with information provided to them about their energy use. Of those that indicated that they did, households one, two, three and four did so through an analysis of their electricity bill. Households nine and seventeen bought electricity from a retailer that offered an app on their mobile phones, and both reported that they monitored their electricity use that way. Household seventeen also receiving SMS updates. Households two, three and seventeen also monitored their electricity use through frequent readings of their meter. Household three employed their own electricity monitoring device, the Wattson energy monitor, which sits inside their house and allows them to monitor their electricity use from moment to moment.

Using Energy Information to Monitoring Spending and Maintaining Awareness

The six households monitoring electricity use did so on two distinct levels. The first was a type of monitoring for awareness. Household one for instance, analysed its electricity bills to remain aware of how much money they were spending. This household looked at its daily electricity usage and compares it to the average to be sure that the household's consumption wasn't excessive. Similarly, household two undertook weekly monitoring, which 'gives us an idea of where we are up to and allows us to keep an eye on supplier's charges.'

Household three also monitored electricity use in order to be aware of how much electricity they are using.

Using Energy Information to Experiment

Whereas household three now monitors electricity use to remain aware, they previously used the information much more actively. When they first started monitoring their energy use they relied on their Wattson monitor to discern how much electricity each appliance was using. Now they only actively monitor when circumstances change. For instance, when they installed a new heating system they used the Wattson to monitor how much electricity it was using. Household nine also monitors 'to be conscious of general power usage.' However they too attempt to identify any significant increase in usage and attempt to locate what is causing it, 'some defect of a certain system eg water pumps,' for instance.

Household seventeen enjoys the challenge of keeping electricity use down to a bare minimum: 'If my energy use is getting above what I like then I try to decrease my use, although this is getting harder as I have pretty much got it down to the bare minimum.' For household seventeen information about electricity usage is extremely useful for reducing it:

'Most people wouldn't realise, I don't think, how much certain things consume while in use or even while in standby. Especially if that figure could be put into dollars or kilos of carbon

produced. Until I saw the carbon usage through [my retailer] I had no idea how much carbon I pumped into the atmosphere every year.'

Household number four also uses electricity information to determine the best strategies for keeping consumption down. Realising that their winter bill had been very high they decided they would have to do experiment with something different next winter:

'Let's look at what we've done in the last quarter and what we can change. Can we replace the light globes?' This household has, for instance, begun to use the dishwasher only when their solar panels are generating electricity during the day.

3.2.5 Preferred Options for Information on Electricity Consumption

Despite only six households currently monitoring electricity use information, eleven households reported that they would like more information provided to them about the way they used electricity. Of the options presented by the survey, households one and fourteen indicated that they would like emails. Households one, two and eight supported computer programs. Household one thought SMS updates would be 'excellent'. Households seven, eleven and four would like information displayed on a telephone app. Household four was most interested in the real time information that the app might be able to provide so they could see, for instance, how much electricity the heating had used over the day. Households three, five and ten suggested that they would like a detailed bill. Others were turned off by the technological component of some options. For instance household ten reported having a lot of difficulty with mobile phones and programs and apps. Similarly, household five reported being not very good with computers and phones.

Households one, three, seven and ten were interested in receiving information through a meter. Household one, was interested with a meter 'you could really engage with.' Household ten thought that the meter ought to be in a prominent place because it would 'make you more conscious of your use.' Household three would like a better metering system than the one they have. They have a solar system and find it difficult to read the meter because the numbers are too small. At the moment they have to leave the house to check the meter box to see whether their solar system is exporting or importing, so they would like that information available inside the house.

No consensus emerged on the way information ought to be committed. Households were clearer about the type of information they sought. Besides being easily readable, and in a readily accessible location, household four was interested in advice of experts who might be able to tell them the most efficient way to use electricity with their current solar installation. Many households were interested in electricity use figures relating to individual appliances. Households three, four, five and sixteen were interested to know how much each appliance was using.

For household twelve any information needed to be readily accessible and simple to accommodate the time limitations associated with supporting a young family. This household thought that 'we're overloaded with information sometimes.' For household five any attempt to explain information use would be welcome but it would have 'to be simple, understandable and broken down.'

3.3 Attitudes to the Mini Grid

3.3.1 Support for the Mini Grid

All households surveyed reported that they were either very supportive or generally supportive of the mini grid project (table four).

Question	Very Supportive – A five rating	Generally Supportive – A four rating	Other
To what extent do you support the concept of a community solar mini-grid as outlined in the information sheet?	12	5	

Table 6. Support for the community mini grid project within the Estate.

The mini grid is good for society or the community

Households supported the concept of the mini grid for different reasons. One theme emerging in household’s responses was the benefit it offered either the local community or society in general. Household one for instance was ‘prepared to pay that little bit more for the good. It’s good for society in general.’ For household eight the mini grid represented a chance to leave a better legacy for future generations. For them the mini grid represented benefits for both ‘the environment and humanity.’ For household four the mini grid represented a chance to create wider social change. For them the mini grid:

‘... promotes the benefits for all the spin-offs that occur when you have neighbourhood schemes. The social benefits. People have a reason to communicate with their neighbours. A lot of social problems for example mental health, I think, this will provide greater communication. It’s not just about the environment.’

Household four thought the mini grid might also deliver other local benefits through ‘sharing locally generated electricity rather than buying it in from Tasmania.’ If successful, household four thought the mini grid:

‘would be a great role model for other communities and these small new residential developments need to incorporate such local scale grid connect systems at the design phase. That can influence campaigning and architecture. I just think that it’s got to be the future. It is a model that gives better power security. Not a whole town blackout but only blackout occurs in the tiny area where the tree has fallen.’

Household seven was similarly excited about the prospect of the mini grid: ‘I think it would be an exciting thing to be a part of.’

Households ten and fifteen found the community element of the mini grid appealing. Household fifteen was ‘happy to be in a community that supports renewables’ and household ten was a strong supporter of the mini grid:

‘I support it greatly. I love the idea if I’m involved as one of the first in the town. I love the idea of being part of a group and information sessions.’

The Mini Grid Benefits Renewable Energy and the Environment

Some households were interested in the mini grid for its ability to contribute towards a shift away from fossil fuel generated electricity and towards renewable energy. As household eight suggested ‘something is going to have to replace Hazelwood.’ Household eleven was ‘committed to renewables’ and thought that everyone in the Estate would be interested in the project. Household three reported that they were ‘against coal,’ and in relation to the mini grid that it ‘was good to be thinking along those lines.’

Others thought that the mini grid would personally benefit their current solar systems. Household four, for instance, suggested that the addition of batteries to their solar system would allow them to continue using renewable electricity at night, allowing them the use of more self-generated power. This household believed that benefits would accrue to the wider electricity system also, through the ability to generating and sharing electricity locally. Household two were ‘already on the way to being self-sufficient’ and ‘with our solar panels it makes sense and is exciting to go to the next level.’

The Mini Grid Might Offer a Financial Benefit

A large number of households were interested in the mini grid for its potential to generate a financial benefit. Household sixteen responded that they ‘hope there’d be a financial benefit to people’ for instance the ‘young people in the estate.’ Financial considerations ranged from those of household thirteen, who were primarily interested in costs and savings, to other households like household six who were ‘very supportive’ but ‘work to a budget and we are getting to retirement age so don’t want to have to pay it off in retirement.’ Households five, six, seven, twelve, thirteen and sixteen were all interested to see whether the mini grid could provide some financial benefit to their household budgets.

3.3.2 The Cost of the Mini Grid

The cost of participating in the mini grid project was a large consideration for most households but often in different ways. Many householders referred to the need to find a balance. Household one, for instance, suggested that ‘naturally’ it was important to look at what was financially affordable. It couldn’t ‘be an open chequebook,’ but household one was excited about the project proceeding, so thought it was a question of balance. This household ultimately decided that the cost was *generally important*, ‘because it is important, but not the only factor.’ Household ten was building its house and the addition of sustainability elements to the house’s architecture had already added \$100 000. Being involved in the project was important, however, and if the mini grid project went ahead they were ‘prepared to sacrifice something because this is likely to be better.’ Similarly, household eleven thought that ‘if we can’t afford it we can’t do it’ but that they’d ‘try and find a way to make it affordable.’

Other households were less interested in balancing objectives. Household four, for instance, was ‘prepared to invest in it as a high upfront cost. It is a small factor for me.’

Question	Very Important	Generally Important	Fairly Important	Slightly Important
To what extent would cost be an important factor in your	11	4	1	1

decision to participate in the solar mini-grid project?				
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Table 7. The importance of cost as a factor in household decision making.

Households fourteen and fifteen were interested in the long term financial impact of participating in the mini grid hoping that long term benefits might outweigh short term costs. For household two, the cost was very important ‘as we are both retired and don’t have access to lots of funds.’ Household eight was also retired and also concerned about possibly large upfront costs.

Concern for large upfront costs meant that many households suggested that they would be interested in a payment plan that was possibly included as a part of the electricity bill (households five, seven and sixteen). Household six, however, preferred to pay the costs over a short time period not wanting the expense ‘hanging around for years.’

3.3.2 The Mini Grid and House Values

Most households surveyed believed that participating in the mini grid would have a positive impact on the valuation on their house. The reasons given for this belief varied. Household one thought that the mini grid was ‘a sign of the times’ and would ‘show that the house is up-to-date.’ Both households twelve and seventeen suggested that the value of the house was likely to increase if the mini grid model proved successful.

Household four thought that this was likely, with the mini grid model likely to become an integral part of future estate developments:

‘...it will make people sit up and take notice of the idea of incorporating mini grids into estate design and in doing so it will be promoted as an asset in a real estate advertisements, and for the house. Already I see real estate ads selling solar power. There could be another line saying “mini grid connected”.’

Household six also thought that the value of the house would increase as the idea spread: ‘AusNet would make a big splash about it. They’d try and do it in other places in Australia.’ They also thought that the increase in value would be linked to the decreased electricity costs just ‘like our rain water tank that runs half the house. The water bill is negligible.’

Household sixteen thought that the value of the house would increase as the reputation of Yackandandah developed, ‘within Yack where there’s a lot of greeny types.’

Question	Yes	No	Unsure
Do you think that participating in a mini grid trial would influence the value of your property?	12	1	4

Table 8. Views on the mini grid’s impact on house prices.

Both households two and four suggested that the value of the house was likely to increase but that this was not an important consideration for them as they were primarily interested in

other factors. For household three, however, it was an important factor. As they reported, the valuation of the house is linked to the rates they pay, increasing as the value of the property increases. For this now retired household, this was irritating as they were not considering ever selling their house.

Households three, seven, eight, ten, eleven, twelve, fourteen and fifteen all stated that they were uncertain of the impact of the mini grid on their house value but were generally hopeful that it might improve the value.

3.3.3 Participating in the Mini Grid Project

Households were asked whether there was anything that would make participating in the mini grid project more attractive to them. Some households, like household two needed no prompting and were already strong supporters of the concept. Others responded around a range of themes.

Economic Assistance

Many households reported that financial assistance of different types would make their involvement in the project much easier. Households four and fourteen suggested that the upfront cost might be offset by a no interest payment plan. Households eleven and twelve suggested that grants, subsidies or incentives would be helpful. Household three enjoyed a concession rate on their current electricity price and economic assistance of that sort was important. These households (three, four, ten, eleven, twelve, fourteen) expressed an interest in participating that could be smoothed with financial assistance of some sort.

Community

Some households suggested that they were more likely to be interested if many others were also involved. Household one for instance suggested that 'if it were communal' then it would be more likely to be involved: 'I think if there was a majority then I would very much want to be a part of it.' Households seven, three and ten also suggested that they would be more likely to participate if it were 'cooperative' (household ten), and there was an enthusiasm for it, and it included a large part of, the local community.

Reliable Support

Some households suggested they were more likely to be involved if they understood more about how the mini grid would work and be supported. Households eight and fifteen were both interested in more information on the mini grid, its options, the consequences and the support offered for the equipment to be installed. Household four was interested in support also. For them, the solar market had become a mess with many different providers offering a confusing array of options. For this household, the support of trusted technical people was important.

Delivering Outcomes

Other households were interested in the outcomes a mini grid might deliver. Household seven wanted 'reduced electricity costs and less impacts on the environment.' Similarly, household six was interested in the cost effective production of renewable energy 'we're not greenies by any stretch but there has to be a better way. We need to reduce our footprint on the planet.' Household thirteen was interested in the project if it could be shown to be cost effective, wouldn't cost any more than their current electricity and would save money for the household once the system was paid off.

3.3.4 The Suitability of the Yackandandah Heights Estate for the Mini Grid

When asked whether the Estate would be a good place to trial the mini grid technology most households thought that it was. Some, like households two, four and six, thought that it would depend on the attitude of others in the estate to renewable energy. Household six thought most people anywhere would be interested. They would be surprised if people said ‘no let’s keep using coal.’ Household one thought that it was hard to know what other people’s circumstances are and it would depend on those. Household seven thought that Yackandandah as a whole was known for supporting projects of this type and household nine thought that Yackandandah residents were very ‘environmentally conscious.’

3.4 Governance of the Mini Grid System

For the households within the mini grid to trade electricity with one another a new governance model must be developed that is able to facilitate electricity transactions between individual households. This next section of the research explores household’s attitudes to different models for organising these transactions. It does so by testing the attitudes of households to a number of different hypothetical models. These models sought to elicit responses on the way that electricity ought to be shared, who should pay for it, and the amount of responsibility and engagement each household was interested in pursuing. The three models, listed below, were described to households before asking for general thoughts, questions, worries or concerns on each model.

- 1. A Shared Model.** Each participant buys the solar and battery equipment needed to generate and store electricity. Electricity is shared across the grid according to who needs it. Those who use less electricity than they generate receive a 5c per unit credit. Those who use more electricity than they generate go into a 5c per unit debit. The cost of buying extra energy into the mini grid is split evenly between each household.
- 2. A User Pays Model.** Each participant buys the solar and battery equipment needed to generate and store electricity. Electricity is shared across the grid according to who needs it. Those who use less electricity than they generate receive a 5c per unit credit. Those who use more electricity than they generate pay a variable price for that electricity. The more electricity they use the more they have to pay. The cost of buying extra energy into the mini grid is mostly paid by those who use more electricity.
- 3. A Retailer Model.** An electricity retailer pays for the installation of the solar and battery equipment needed to generate and store electricity. The electricity retailer then owns the solar and battery equipment and pays for its upkeep. The electricity is then shared across the grid with participants buying electricity from the electricity retailer and paying only for what they use.

3.4.1 Reactions to Model One: A Shared Model

Generally speaking this model was unpopular amongst households in the Estate. Households nine and ten didn’t think the model would work. Household ten liked the idea of sharing electricity but thought that it was ‘a bit airy fairy, everyone must be good to each other and share, I like that model. But the fact of life is it’s not like that.’ For household ten, model one would be the ideal model but it would only work if the mini grid produced enough energy and none needed to be bought from the grid.

As many households recognised, model one offered a chance for large energy users to benefit at the expense of lower users. For this reason household seven, which considered itself to be a large electricity user, selected the first model. The conundrum was nicely captured by household eleven which thought the shared model would be better if they were to rent the house out but worse if they continued to live there as a single occupant.

3.4.2 Reactions to Model Two: A User Pays Model

An incentive for energy efficiency

When considering models one and two many households preferred model two. For many, this was due to the clear price signal it gave to participants in the mini grid. Household one preferred the second model over the first because, ‘with the first model people may become flippant because others are paying for their excess. You might have people who say “bugger it I’ll use the drier for five hours”.’ Household one thought that model two was more likely to make people more conservative energy users.

Household four thought that the system should be designed so that the mini grid was able to generate enough energy for each household. Under these circumstances there ‘would be a need to operate within our limits so that we never need to buy extra power in.’ On the other hand, this household worried whether it would be possible to reduce energy use without the incentive to minimise offered by model two.

Household three initially preferred model one and was interested in having a flat unit price across the mini grid, ‘it should be the same for everyone.’ Talking through the models, however, they realised that smaller households may have to help pay the bills of larger families. They decided that it was difficult to keep a flat rate fair and decided it would be good to keep track of how much electricity households were consuming so that those using more were forced to think about whether they are able to reduce their consumption. This household did not want to waste the benefit of their eco designed house which currently helps them save on electricity costs. Ultimately household three settled upon the second model. ‘I don’t mind sharing, but a little stick is okay.’

Fairness

Many households thought that model two offered a fairer system. As household thirteen suggested, ‘two seems to be the fairest system.’ When referring to the fairness of model two, households tended to point to the probable disparities in electricity consumption. As household twelve responded, model two would be fine if the mini grid were generating enough power for everyone, but not if it was not generating enough. As this household told me, they were a large electricity using family of five and their next-door neighbours were an older couple using less, and then there was the elderly lady living by herself across the road who likely used hardly any electricity at all. There were also very large electricity users in the estate, some with pools. For household twelve then, model two was fairer and offered a system where those who used more could pay for it themselves. Household eight also preferred people to pay for their own use, also pointing to neighbours, especially those with pools, who might be using large amounts of electricity. Household six was also very aware that they did not want to pay for someone else’s electricity use, pointing to others in the estate who used welding equipment. As they suggested, ‘some people spend a lot of time keeping electricity low.’ Household sixteen also thought model two to be the fairest model ‘[Another household] is across the road and I wouldn’t expect her to pay more because of my family’.

Comparison to Model Three

The perceived fairness of the second model and its incentive for conservative electricity use set model two apart from model one. Some households also suggested model two compared favourably to model three. Household six, for instance, preferred model two over model three as it offered the chance to do away with electricity bills. Whilst model three reduced the upfront costs of installing the mini grid system, household six preferred the option that model two offered to pay off and ultimately own the equipment and the electricity it generated. This would mean high upfront bills to start with, with very low or non-existent ones once the system had been paid for. Household one preferred model two out of the three models because it kept the communal aspect found in model one but added an incentive that promoted conservative energy use.

3.4.3 Reactions to Model Three: A Retailer Model

Model three was appealing to some households for a different set of reasons. As household four reported, the retailer model reminded them of the way they currently bought their gas. They would seriously consider this model if they had not already taken the step of investing in solar panels. Household two thought that the retailer model ‘suits us’ because any upfront costs would be offset, ‘we don’t want to be out of pocket. We are both retired and simply don’t have funds for large expenses.’ This household also had the expectation that the retailer would somehow ‘come to the party’ due to the fact that ‘they will be making their own profits.’ Household thirteen thought that the retailer would have to be able to provide some benefit and that ‘if we are going to let them put panels on the roof the electricity would need to be cheaper than what we pay now.’ Household five thought that model three suited them most, ‘depending on what they were going to charge.’ As household six noted, model three also offered a fair system, linking the amount paid to the amount of electricity used.

An External Regulator

For household four, the presence of a third party offered a better chance for positive interpersonal relationships between members of the mini grid. For them, a third party would prevent arguments and accusations. The retailer ‘could be the regulator of the system’ because ‘you can’t leave it to people to self-manage.’ A trusted third party could also monitor household meters in an attempt to keep the mini grid from having to buy too much power. This would mean that they ‘can see who is going over what they said [they would use].’ At the same time this would prevent a deterioration of relationships between households on the grid, ‘it needs to be set up so there are no accusations of each other. For instance “you guys are using too much”.’

For household four, the retailer suggested by model three offered a chance for an external party to do all the hard work of managing the governance of the mini grid and ensuring that people’s systems and mini grid connections were functioning. As this household told me ‘it has got to be easy. Who’s got the time to do that anyway. [We] would pay extra to have it all taken care of.’

Household three was similarly interested in model three as they thought that this would be the best way of keeping the whole system maintained. The maintenance of the mini grid as a functional system was a particular point of concern for this household, who were also interested to know how the technological components, the solar panels and batteries, would be maintained. Household nine was also concerned about how the system hardware would be maintained, including who would take responsibility for the cost of repair or replacement.

Household eight thought that the retailer model sounded like the easiest and least complicated model. Household sixteen thought that model three also seemed simplest as the ownership and responsibility for maintaining the system is with one organisation.

The Community and YCDCo

Whilst household twelve also found model three appealing as the retailer could pay for the cost of installing and maintaining the system they were concerned about the monopoly that this system created. The retailer has ‘got us up against the wall because they are the single provider and there is no competition as such.’ Household nine was also concerned about this retailer monopoly, suggesting that they could set whatever price they wanted. Whilst concerned about this monopoly, household twelve thought that if it were a trusted Yackandandah based retailer then they would be ‘all for it’ because they see Yackandandah as ‘a community based town,’ but ‘if it’s a big provider then I’m a bit sceptical.’ Household three thought that the retailer might be similar to YCDCo. They thought that a retailer run in a similar way could work well. Being shareholders in YCDCo they are sure that this company doesn’t ‘rip them off,’ because YCDCo ‘is local has to be honest. We are all part of the same community.’ Household seventeen was similarly blunt about model three: ‘I would not be interested in a retailer model unless the retailer was set up in a community model something like the Yack servo [YCDCo].’

3.4.4 Factors to be Included in the Design of the Mini Grid Governance System

Households were asked a series of questions and invited to rate their responses on a scale from one, not important, to five, very important. The questions were designed to determine which factors the mini grid should prioritise in the governance of the community mini grid. Questions focused on household budgets and local economies, energy efficiency, concessions, community, innovation, and the environment. All objectives were rated highly, with all receiving an average rating of above four (generally important). Most highly rated was the objective that the mini grid deliver environmental outcomes (an average rating of 4.82) followed by the promotion of energy efficiency (an average rating of 4.71) and innovation in renewable energy technology (an average rating of 4.59). Taken together these results suggest that households within the Estate believe that the community mini grid ought to focus on delivering a set of outcomes that shifts electricity production to renewables and in so doing benefits the environment. Also rated highly was the focus on delivering savings to households in the Estate (an average rating of 4.53). Of less concern to households was an attention to the social benefits that the mini grid might provide, with delivering concessions, building community, and building local economies rated the lowest.

Question	2 Slightly Important	3 Fairly Important	4 Generally Important	5 Very Important	Average Rating
A mini-grid should be designed to ensure bill reductions for participants		1	6	10	4.53
A mini-grid should promote energy efficiency		1	3	13	4.71
A mini grid should include a concession for those who need it	2	3	3	9	4.12

(for instance the elderly, the poor, or the unwell)					
A mini-grid should encourage greater community cooperation	1	3	5	8	4.18
A mini-grid should facilitate innovation in renewable energy technology		2	3	12	4.59
A mini-grid should facilitate positive environmental outcomes			3	14	4.82
A mini-grid should assist in growing the local economy		3	7	7	4.24

Table 9. Household priorities for the governance of the community mini grid.

3.5 The Community Electricity Retailer

Under current regulatory settings an electricity retailer is required to facilitate transactions between households within the mini grid, and to purchase any grid power that might be required to support the mini grid. AusNet Services and TRY are proposing that, for the Yackandandah based community mini grid, a community energy retailer be created. Households within the estate were asked whether, if they were to participate in the mini grid, they would be happy to join a Yackandandah based community energy retailer. All 17 households indicated that they would be happy to join such a retailer.

The response of households one and eleven were typical of the comments that this question provoked:

Household one: ‘The way Yack is community minded I think it would be a winner. I can only see positive outcomes.’

Household eleven: ‘I think it’s a good idea and Yack’s a great place to do it because it’s already that sort of community.’

Many of the households suggested that the community energy retailer should follow the successful example of the YCDCo.

Household four: ‘I had no idea! If they could pull it off that’s awesome. I’d feel so much better about giving my money to the same sort of model as YCDCo.’

Many households thought that this would be a positive development for Yackandandah’s local economy. Household eight thought that YCDCo was ‘reliable’ and that ‘a pretty significant business should be set up properly alongside the grid.’

Household two: ‘Excellent! Keep all our local resources employed and on board so that we retain tradies in our community.’

Household ten thought that a community based retailer may be able to promote community values and address equality issues:

‘I really like that idea. Fantastic. I think it’s great. It might be a bit more expensive to the consumer but it promotes community and you can make allowances for those who need it.’

Many households within the Estate offered enthusiastic expressions of support and household four thought that they ‘would be happy to join this type of retailer even if there were no mini grid project’.

Other households, whilst supportive, questioned the nature of the model. Household four, for instance, thought that an electricity retailer based in a town the size of Yackandandah may not be the best model and suggested that it may be more appropriate to have a regional provider, due to the economies of scale. Household three questioned the role of the retailer at all, suggesting that the mini grid might work equally well without it.

Selling Electricity from the Mini Grid

The Yackandandah based community retailer would be responsible for purchasing electricity into the mini grid at times when it was using more electricity than the system was able to provide. The retailer could also sell any electricity generated by the mini grid that was surplus to its requirements. Households were asked what they thought of the idea of selling the mini grid’s excess electricity and whether they had any issues or concerns. Responses tended to be ambivalent suggesting that if benefits were shared equally and there were no detrimental outcomes for the estate then they would support such an idea.

Households one, three, six, and seven thought that the idea was a good one so long as it didn’t compromise electricity users in the mini grid. Households thirteen, fourteen, and sixteen echoed the comment of household seventeen that it was ‘a good idea as long as a fair price was received.’ Households four, eight and twelve expressed an interest in using the excess renewable electricity to help power the town. Household four reported that they ‘would love it if we could power the whole town,’ with household eight suggesting that ‘in a sense that’s what it’s all about.’ Household twelve thought that the excess electricity could be used strategically to support key organisations in the town:

‘If we are generating more than what we are using then fabulous. Particularly if it could go to businesses, for example the hospital because that’s what keeps our town going and employs our kids. I’m sure the town can come up with something that’s fair. If it’s shared then share it with businesses and the hospital because that’s what keeps the town vibrant and if we can reduce their costs then they’re likely to stay there.’

4. Discussion: Building a Yackandandah Community Mini Grid

4.1 Participating in the mini grid

TRY and AusNet Services are proposing a Yackandandah Community Mini Grid as the means of meeting Yackandandah’s renewable energy target. It is hoped that this commercially operating mini grid will be the first of its type in Australia. The results outlined above begin to describe how mini grid technology can successfully interest and engage consumers in the Yackandandah community. The first step in implementing the mini grid, and one that TRY and AusNet Services are currently taking, is to invite Yackandandah residents to participate. To understand how to successfully convince local residents of the value of the mini grid proposition this research explored how households in the Estate make decisions about their energy use. As the research showed, households made energy related decisions based on the combination of several factors. Households often made pragmatic choices based on what was easiest, what was available, or in response to material realities

(the heat or the cold for instance). They often included environmental factors in their decisions, as well as economic factors relating to household budgets, but also a consideration for local economies and 'local' providers. Interestingly, many households had made decisions based upon the advice of others in their social networks.

Having been chosen as the pilot mini grid site, households in the Estate are now faced with a decision on whether or not to participate in the mini grid. When initially surveyed about their attitudes to the mini grid concept all reported that they were either 'very' or 'generally' favourably disposed. Many believed the mini grid was important for the benefits it could offer others. Some reported that it would be good for society, particularly as a model for a transition from fossil fuels to renewables. Others supported the concept for its possible positive impact on the Yackandandah community and its economy. Many reported that they were interested to participate in what they felt to be an important and innovative community project. These households were excited by the project and supported it for its contribution to an environmental cause, and for the sense of community and social connectivity it gave them. Many households were excited about the potential of the mini grid to deliver personal benefit, including reductions to household energy bills. Others were interested in the ways in which the mini grid might optimise their already existing solar systems.

For households in the Estate a number of factors emerged as recognisable pathways to participation. Many households reported that whilst they supported the project they could not participate in what they could not afford. Many households suggested that some sort of financial assistance would greatly improve the prospects of a favourable decision. A popular suggestion was a payment plan that allowed households to pay off the installation cost at a rate comparable to their current energy bills. Households were also interested in more solid demonstrations that their first positive impressions of the project - that it might reduce bills, reduce emissions or build community, for instance - would actually be fulfilled in practice. These households also reported that they would be more likely to participate if there was widespread enthusiasm and it was a whole of community project. Whilst most thought that house prices would increase with a successful mini grid operating in the Estate, this was not a large or compelling factor for households.

4.2 Engaging with the Mini Grid

The mini grid offers a new energy generation, storage and sharing product. It invites households to rethink how they engage with their energy use. At the same time, however, the mini grid must fit the needs of its customers. The Ubi device, designed and developed by AusNet Services, forms the key component that allows households to interact with their energy production and consumption. The Ubi device both optimises the household solar and battery system and provides information to households about their electricity use. It is currently being deployed in Yackandandah, as a commercial offering, for the first time. Research on the ways that households currently engage with their energy use, and engage with information about their use, aimed to provide information to optimise the ways that households interact with the community mini grid.

Households engage with their energy use through an attention to the cost rather than units of energy consumed. Households within the Estate were good at estimating their electricity use in comparison to those around them, however very few actively monitored their use. Those that did tended to look at billing information. Only the most attentive monitored the actual amount of energy use, either through an app on their phones or by checking the electricity meter. Most households were more approximately aware of how much electricity they were using through a general understanding of their household energy systems. Households knew

the types energy saving measures they performed, the types of appliances they owned and how they were used, and the amount of people in their house.

When households attempt to modify their energy consumption they did so across two levels. A majority of households attempted to reduce their energy use by applying a more general understanding of their household systems. As such they switched appliances off when they could and made changes to their house, particularly to block out the sun and the retain heat. A second cohort of households attempted to reduce their electricity consumption in a more experimental manner, using more detailed electricity use information to experiment with which reduction measures were most effective. Some of these households responded to price signals and used large appliances during the day, when their solar panels were generating electricity. Others use appliances during off peak periods. Approximately two thirds of the households surveyed suggested that they would like more information about the way they used electricity. There was no consensus about the way this information ought to be transmitted however households wanted simple information displayed on an easily readable interface, in a prominent position, that gave information about individual appliance use, used financial rather than energy units and was supported by the advice of experts.

Despite almost all households indicating that they would like to reduce electricity consumption, households suggested that they would only do so if it remained within their budgets and did not cause unnecessary discomfort. For many, the solution to this dilemma was not to reduce energy use but to produce more on terms favourable to the environment, finding a balance between reduction and production, comfort and cost.

4.3 The Governance of the Community Mini Grid

An important component of the proposed community mini grid is the sharing or trading of electricity between households. Households understood the opportunities and complexities involved in re-organising the governance of Yackandandah's electricity system in this way. Many households felt positively about the concept of generating and sharing electricity across the mini grid, but most did not want to do this without a clear price attached to the electricity; households were more interested to trade than share electricity. Households preferred a type of model that offered a suitable incentive for mini grid participants to use electricity conservatively. Besides the price incentive to use less electricity, households also thought that a 'user pays' system was fairer, with those households using more having to pay more and those using less receiving a financial benefit. The idea of fairness was promoted both by families who did not want to unduly shift their electricity costs onto others and by low users who did not want to have their bills increased by high consumers. Whilst the user pays model was a trading system it did retain the community feel, which many households supported.

The retailer was popular for its potential to act as a regulator of the system, ensuring positive interpersonal relationships between members of the mini grid. The retailer model was also popular for those households looking to defer responsibility for the work of monitoring and maintaining the mini grid to a third party. For many in the Estate, this retailer model brought to mind YCDCo and many suggested that they would prefer a YCDCo type retailer. The price of the electricity was an important factor when households were thinking through the retail option. Some preferred the idea of avoiding the retailer model so that they might pay their solar battery systems off and not have to pay electricity bills in the long term.

The concept of a community electricity retailer was one that most households found appealing. Again, YCDCo was a common reference and households enthusiastically

supported another such community owned and operated retailer. These households also felt positively about the success of such a retailer in a town like Yackandandah. Many thought that the retailer would have a positive impact for both the town's community and its economy, as well as helping the town reach its 100 % renewable energy target.

4.4 Getting Started on the Yackandandah Community Mini Grid

Following the completion of the data collection component of this research TRY and AusNet services invited households in the Estate to a BBQ, under the old oak tree at the bottom of the Estate, to offer more details on the proposed mini grid pilot. AusNet Services are now conducting site visits, following up on expressions of interest from households within the Estate, to determine the optimal solar, Ubi, and battery offerings for each household. The installation of the infrastructure is scheduled to occur in the second half of 2017.

TRY and AusNet Services publically launched the Yackandandah Community Mini Grid project on the 9th of February, 2017. The second stage of the community mini grid, a solar and Ubi installation across the whole town, was pitched to approximately 300 community members. AusNet Services are now conducting site inspections, in response to expressions of interest, across the town of Yackandandah to determine optimal solar and Ubi installations for individual households. Concurrently, AusNet Services and TRY have begun the preliminary work necessary for the launch of a successful Yackandandah based community energy retailer.



Figure 4. A community mini grid BBQ held with households from the Yackandandah Heights Estate beneath the old Oak tree ,in the Estate. Mark Judd (AusNet Services) outlines the mini grid proposition for the Estate (11th December, 2016).

4.5 Conclusion

In order to reach its 100% RET TRY has partnered with AusNet Services to develop a five stage mini grid plan for Yackandandah. As this research shows, the mini grid plan is strongly supported within the community for its perceived social and the environmental outcomes, possible cost savings to households, and its potential to build the local community and economy. Support for the mini grid extends to the concept of a local community energy retailer, an idea that was very enthusiastically received. The research showed that the community felt the retailer would be both good for the local community, and very likely to succeed, given the past success of similar models in the town, particularly YCDCo. An in depth analysis of household decision making suggests that households make energy related decisions based on a combination of factors that included environmental, budgetary, and pragmatic considerations, but are also influenced by conversations held with those around them. Many reported that they would like to participate in the mini grid project to achieve environmental and social outcomes but felt inhibited by the cost. In relation to household engagement with energy use, most households reported that they would like more information about their energy use patterns, and all but one reported that they would like to reduce their energy consumption.

The mini grid offering currently available to Yackandandah residents aims to include these considerations. It offers a no interest five year payment plan to assist households with the financial burden of participating. Furthermore, the addition of the Ubi technology to the mini grid installations offers households the chance to reduce electricity consumption and offers in depth detail about household energy use patterns. The Ubi technology also optimises the progression of households through the staged mini grid plan, notifying each household the optimal economic moment for the purchase of a battery system, as well as the optimal type of system. As the research shows, the stage three mini grid offering – solar, Ubi and battery –, fits the reported interests of the community very well. The preparation of the community energy retailer, a model for trading electricity across the mini grid and the installation of a solar and battery plant proximal to the town loom as significant challenges for the execution of the full mini grid plan. This research project has been the first step along the path to meeting these challenges.

Appendix One: TRY Survey Questionnaire 2016

****Survey Objective: Read out to respondents**

The purpose of this survey is to gather your views on a range of topics relating to energy and the concept of community solar mini-grids. The confidentiality of all personal information collected will be protected and you will not be identified in anything written (or otherwise) following the interview.

A.

B. General Information

Interviewer name	
Date of interview(dd/mm/yyyy)
Time interview	Start:.....am / pm; Completed:.....am/pm
Respondent name	
Respondent address	
Respondent phone number	
Data errors noted	

B. Respondent and Household Characteristics

B.1 How long have you lived in this house?.....

B.2 How many people live in your household?

B.3 How old are you?

- 29 and under
- 30 – 39
- 40 – 49
- 50 – 59
- 60 – 69
- 70 – 79
- 80 and over

C. Energy sources and use

C.1 What types of energy do you currently use in your house?

- Gas
- Electricity

- Solar hot water
- Wood
- Other (please describe)

C.2. What sources of electricity do you use?

- Solar panels
- From the grid
 - Green
 - Unspecified

C.3 What factors influenced the types of energy sources that you use?

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C.4 Do you have a swimming pool at your house? Yes/No

C.5 What types of heating and cooling do you have?

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C.6 Who is/are your current energy retailers (i.e., the companies that send you your bills)?

C.7 Why did you choose this/these particular retailers?

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C.8 What is the average price of your electricity bill for the year?

For those who cannot provide an actual number, identify the average price range.

- 0\$ – \$500
- \$500 – \$1000
- \$1000 – \$1500
- \$1500 – \$2000
- \$2000 – \$2500
- \$2500 – \$3000
- \$3000 – \$3500
- \$3500 – \$4000
- \$4000 – \$4500
- \$4500 – \$5000
- \$5000 and above

C.9 How much electricity do you use per year? kWh per day, month, quarter or year.....

C.10 How would you rate your energy usage?

- very low
- low
- medium
- high
- very high

C.11 Can you explain why you chose that rating?

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C.12 Do you currently engage in any activities to reduce your energy consumption?

Yes/No

C.13 For those who answered yes in C.11, what types of things do you do to manage your energy consumption? Why is this important to you?

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C.14 Would you like to reduce your energy consumption? Yes/No

C.15 Can you explain your answer (why)?

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D. Engagement with energy use

D.1 Does anyone in your household currently engage in any activities to monitor your household electricity use? Yes/No

D.2 [For those who answered yes in D.1] What kinds of tools do you use to monitor your household electricity use?

- telephone apps
- computer programs
- remote access
- frequent readings
- bill analysis
- SMS updates
- other (describe)

D.3 [For those who answered yes in D.1] How do you use that information?

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D.4 [For those who answered yes in D.1] To what extent do you think that monitoring household energy use influences your energy consumption behaviours?

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D.5 Would you like more information provided to you about the way you use energy? Yes/No
If yes, how would you like it provided to you?

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E. Views on community mini-grid concept

E.1 Have you read the information sheet? Do you have any questions?

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E.2 To what extent do you support the concept of a community solar mini-grid as outlined in the information sheet? Where five is very supportive and one is not supportive.

1	2	3	4	5
Not Supportive	Slightly Supportive	Fairly Supportive	Generally Supportive	Very Supportive

E.3 Can you explain your answer (why)?

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E.4 To what extent would cost be an important factor in your decision to participate in the solar mini-grid project? Where five is very important and one is not important.

1 Not Important	2 Slightly Important	3 Fairly Important	4 Generally Important	5 Very Important
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E.5 Can you explain your answer (why)?

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E.6 Is there anything that would encourage you to participate in a community solar mini-grid trial?

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E.7 Do you think that participating in a mini grid trial would influence the value of your property?

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There are many factors that need to be considered as AusNet Services develops the business model for the community solar mini-grid. We are keen to gather your perceptions on a range of these factors.

Please rate the extent to which you agree with the following statements where five is very important and one is not important.

E.9 A mini-grid should be designed to ensure bill reductions for participants

1	2	3	4	5
Not Important	Slightly Important	Fairly Important	Generally Important	Very Important

E.10 A mini-grid should promote energy efficiency

1	2	3	4	5
Not Important	Slightly Important	Fairly Important	Generally Important	Very Important

E.11 A mini grid should include a concession for those who need it (for instance the elderly, the poor, or the unwell)

1	2	3	4	5
Not Important	Slightly Important	Fairly Important	Generally Important	Very Important

E.12 A mini-grid should encourage greater community cooperation

1	2	3	4	5
Not Important	Slightly Important	Fairly Important	Generally Important	Very Important

E.13 A mini-grid should facilitate innovation in renewable energy technology

1	2	3	4	5
Not Important				

	Slightly Important	Fairly Important	Generally Important	Very Important
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E.14 A mini-grid should facilitate positive environmental outcomes

1 Not Important	2 Slightly Important	3 Fairly Important	4 Generally Important	5 Very Important
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E.15 A mini-grid should assist in growing the local economy

1 Not Important	2 Slightly Important	3 Fairly Important	4 Generally Important	5 Very Important
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E.16 An electricity retailer is required to operate the mini grid including the purchasing of any grid power that might be required to support the mini grid. What do you think of the idea of a Yackandandah based community electricity retailer?

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E.17 If you were a member of mini grid would you be happy to join a Yackandandah based community electricity retailer. Yes/No

E.18 A Yackandandah based community electricity retailer could also sell the excess energy generated from the mini-grid to those not included in the mini-grid. What are your thoughts on this? Do you have any concerns/issues?

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F. Community Connectivity

F.1 How many people do you know in the estate? (estimate a percentage)
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F.2 What are your thoughts on community willingness to participate in a mini-grid like the one proposed by AusNet Services? (ask participants to explain their answer).

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F.3 To what extent do you agree with the following statement, where one is strongly disagree and five is strongly agree:

I feel a part of the Yackandandah Heights neighbourhood

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree

Are there any other comments you wish to make?

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Thank you very much for your information and cooperation!