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Household Decision-Making for Home Batteries

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Abstract

This paper explores the future of home storage uptake in the developing Battery Energy System (BES) market. A survey of over 500 households and interviews with 51 homeowners in Tasmania were used to ascertain motivations for installing BES's. BES cost projection curves were used to model uptake under various scenarios. Our study found that there is a high interest in purchasing batteries yet the timeframe for purchase is largely dependent on a satisfactory payback period. Nearly 80% of respondents are considering batteries within the next two years, but on average stated that a payback of 7 years would be required to make the investment palatable, at least from a financial standpoint. However, the market for batteries will likely not reach the acceptable price point for another 4 years. Our projections suggest a slow uptake until around 2023, after which we anticipate a considerable increase in installations in Tasmania. As the technology becomes cheaper with improved efficiency, more households will turn to batteries as a means to reduce household power bills. Our study highlights the necessity of understanding financial and non-financial consumer motivations and uptake timeframes for household BES's, in order to effectively manage the transition to a future with increased Distributed Energy Resources across Australia.

1. Introduction

Australia has the highest number of 'prosumers' per capita on the planet with more than 1.95 million Photo Voltaic (PV) installations in 2018 (APVI, 2018). Many of these prosumers - consumers and producers of energy (Parag and Sovacool, 2016) - are also utilising or actively considering Distributed Energy Resources (DER) such as smart meters, home batteries (BES) and other "smart" enabled devices that allow householders to understand and choose to modify their behaviour. Theoretically, as the technologies become more affordable, they become more attainable.

DER's provide opportunities to reduce household expenditure on electricity and potentially improve household economics by allowing users to change energy behaviours and reduce reliance on grid supplied electricity. Furthermore DER's can provide a means to maximise the benefits of feed-in tariffs, Time of Use (TOU) tariffs, and engage in emergent business models such as peer to peer trading, when and where they are available (CSIRO and Energy Networks Australia, 2017). DER's enabled with appropriate smart technologies can also be utilised by the networks to support the electricity grid through provision of ancillary services (Lovell et al., 2017, Sandoval and Grijalva, 2015).

The challenge for planners and operators of the electricity system is that it is unknown how prosumer households will be shaped by, and will shape, this distributed energy transition (Finkel et al., 2017, CSIRO and Energy Networks Australia, 2017). Policy makers and planners need to understand how householders transitioning from being consumers to prosumers can best be efficiently and effectively integrated into the energy market, in order to create an energy system that is affordable, sustainable and reliable (McCabe et al., 2018).

The Tasmanian electricity system, because it is small and in part separated from the mainland system, offers the opportunity to test new policy and economic strategies to achieve positive deployment of Distributed Energy Resources (DER). An understanding of the motivations and intentions of energy users will be critical in enabling this.

Energy systems are enmeshed in wide-ranging patterns of social, economic, political and organisational life. The substantial changes in energy systems we are witnessing today are more often accompanied by social, economic, environmental (Shove and Walker, 2007) and political shifts (Miller et al., 2015). Within this multifaceted system, householders are faced with a myriad of complex decisions in the transition to become prosumers. Improving householder energy literacy is vital ensure an efficient integration of prosumers (Stephenson et al., 2010, Lopes et al., 2016) in Australia's energy future.

Regarding BES, this study focusses primarily on early adopters of technologies, to better understand future pathways for mainstream DER integration. Previous studies show a convincing correlation between early adopters of DER's and strong environmental preferences (Gardner et al., 2008). While having environmental values does not equate to direct action (Boughen et al., 2013), it can be an important contributing factor in the decision-making process. Testing the validity of this assumption is part of this research.

While the BES market in Australia is still in its nascent phase, householders still have quite a variety of technologies to choose from. As of October 2018, there are more than 42 different BES's with multiple configurations available in Australia (SolarQuotes, 2018), and payback periods vary depending on energy behaviours, export tariffs, electricity prices and install costs. Cost projection data for home storage is varied depending on the source (TrendWatch, 2012, CitiGroup, 2014, Mckinsley, 2012, Navigant, 2014a, Navigant, 2014b, Catenacci et al., 2013, Gerssen-Gondelach and Faaij, 2012, Hoffmann, 2014, Curry, 2017, Schmidt et al., 2017).

Mainstream media and commercial marketing has also played a major role in generating household consumer interest following Tesla's residential BES launch and installation of the 100-megawatt lithium-ion battery in South Australia (McConnell, 2018). In the 24 hours following blackouts in South Australia in 2016, BES installers received 228% more inquiries for batteries (Parkinson, 2016). As with diffusion of any innovation, peers can also have an influence on the choices made by householders (Karakaya et al., 2015). In order to make appropriate and informed decisions, householders must decide which sources of information are trustworthy and reliable (Agnew and Dargusch, 2017).

There are various factors that drive householder motivations to purchase batteries, such as desires to decrease the amount of electricity drawn from the grid, influenced by high electricity prices and the cessation on premium feed-in tariffs. Frustration with incumbent energy retailers, generators and networks increasing fixed costs of electricity, rising energy prices (AEMC, 2018), and uncertainty of federal commitments to energy policy (Blowers, 2018) has led to an all-time low in consumer trust of energy retailers (ACCC, 2018). This is an important consideration for the networks as trust is essential if they wish to engage with and retain householders with DER's. As PV and BES become cheaper, disconnection is likely to be a viable financial option for many households (Brinsmead, 2015).

Many Australian households would prefer avoiding losses in comparison to securing gains and can be willing to pay premiums of up to 20%, against economic rationality, to reduce their electricity costs and secure their power supply (Vorrath, 2017).

The energy landscape in Australia is currently experiencing dramatic changes in its energy infrastructure, driven by impacts of climate change, changing energy consumption patterns, rising costs of electricity and associated social inequity (Graham et al., 2015). It is clear batteries are becoming part of the energy landscape in Australia even though uptake make be initially slow.

Actuation lags are often seen in technology uptake, as had been the experience with rooftop solar PV (Semso et al., 2017). According to solar consultancy SunWiz, a total of 28,000 BES's had been installed across Australia by the end of 2017(Johnston, 2018). Of the 172,000 household PV installations in 2017, 12% included a BES as opposed to 5% in 2016 (Vorrath, 2018).

Increasing scale of production shows that prices for lithium-ion storage systems are dropping faster than PV or wind technologies. The cost per kWh of lithium-ion batteries may drop faster than anticipated, with some projections pointing towards $100/kWh in 2019 (Kittner et al., 2017). As new business models that add value to BES arise, prosumers will have opportunities to participate in and even shape the future of energy the energy system as a whole (Sandoval and Grijalva, 2015).

This research highlights the complexity of the decision-making process pertaining to home storage options that are often left unconsidered in conventional analysis of home storage uptake. It seeks to understand how householders will adopt DER's such as BES and rooftop PV in the state of Tasmania. Findings from this study are also applicable to mainland Australia. The levels of solar irradiance in Tasmania are comparable to Germany, which has some of the highest PV per kW per capita (Palisade, 2017). Extrapolating results from Tasmania to mainland Australia we predict even stronger drivers for BES uptake, due to higher energy prices in most states and territories and higher levels of efficiency for solar PV due to greater solar irradiance.

The paper is structured first with a background review of changes in the energy sector in Australia, followed by an overview of the methodology used. Presentation of the survey results, interviews, cost projection and uptake curves for lithium BES storage then sets the stage for the discussion of drivers for BES uptake in Tasmania and concludes with details on the relevance to Australia as a whole. Analysis of interviews is still in progress and a forthcoming publication will provide further details within this analytical framework.

2. Methodology

To better understand current societal attitudes and potential adoption trends toward storage in Tasmania, a mixed methodology of quantitative and qualitative data collection and analysis was employed.

2.1. Survey

A variety of means were employed to access a broad cross-section of the Tasmanian community while endeavouring to maximize respondent numbers. The recruitment process utilised online forums, industry and community networks, social media, local newspapers and radio stations, with the only restrictions on participation being that respondents had to be from Tasmania and over 18 years of age.

The Survey focused on identifying demographic details, current knowledge and understanding of Feed-in Tariff's, Solar PV and energy storage. Topics and questions in the survey were developed after a thorough literature review to highlight present household energy use, demographic information and preferences for home BES be they financial and or non-financial motivations, such as a desire to reduce their carbon footprint by generating, storing and utilising energy from solar PV, energy security for both mitigating the impacts of rising energy costs and independence of power supply. After pilot testing, the final survey comprised 45 questions and was administered using an online survey software (SurveyMonkey). The survey was live from February 5th 2018 to March 19th 2018. At the time of the survey the premium feed-in tariff in Tasmania was set to end in 9 months. Those who completed the survey were then offered the opportunity to provide more detail in a follow-up interview.

2.2. Interviews

Excel was used to generate a random selection of SurveyMonkey respondents who indicated willingness to participate in interviews (n=51). These interviews were conducted to gain a deeper understanding of participant responses from the survey, and allow for exploration of a broader range of perceptions and experiences of householders. They were conducted in person and over the phone from August to September 2018. The semi-structured nature of the interviews allowed participants the liberty to express their opinions and experiences in their own terms while providing reliable, comparable qualitative data (Cohen and Crabtree, 2006). Each interview ran between 30 minutes and 1.5 hours. Beyond providing greater detail on survey responses, participants were also asked their level of energy literacy, and to consider any foreseeable changes to their energy consumption or generation. As there are many reasons why households may decide to invest in batteries other than pure economic rationality, both financial and non-financial drivers were discussed such as, desire to reduce their carbon footprint by generating, storing and utilising energy from solar PV, energy security for both mitigating the impacts of rising energy costs and independence of power supply. Trust in incumbents and information providers was also explored. Digital recordings were made of all interviews to transcribe for thematic analysis. Qualitative interview analysis is still underway, and this paper discusses preliminary interview findings only.

2.3. Battery Energy System uptake projections

BES cost projections were synthesised from a range of industry and academic literature (TrendWatch, 2012, CitiGroup, 2014, Mckinsley, 2012, Navigant, 2014a, Navigant, 2014b, Catenacci et al., 2013, Gerssen-Gondelach and Faaij, 2012, Hoffmann, 2014, Curry, 2017) and used with survey data to infer a variety of uptake projections for the state of Tasmania based on variations in the rate of BES price decline and export tariffs.

We combined survey responses and BES cost data to arrive at a bottom-up estimate of the likely BES uptake by Tasmanian households over the next decade. All survey participants were asked to nominate a payback period (between 0 and 20 years) which they would require before investing in a BES. The frequency of responses for different payback periods was used as the basis for defining the probability distribution function that we then applied to the broader battery-eligible Tasmanian population. We define the battery-eligible population to be households who are owner-occupiers of separate dwellings and who have solar PV installed or otherwise will have within the projection period of 10 years. Both increased PV uptake and increased general population drive the numbers of battery-eligible households up over the projection period. We used this data alongside installed BES cost projections and estimates of the retail arbitrage value - the difference between the export tariff and the import tariff - of batteries in a residential solar PV context, to arrive at an uptake probability as a function of time, projected over the next decade.

Finally, to reflect a more natural uptake response to any change in the BES payback period, we created a response function which simulated a gradual uptake. This was done by modelling uptake as a first-order response to a step function, having a time constant of 2 years. For example, if a certain cohort of the population deems investment in a BES to be warranted after payback falls below a particular level (eg. 4 years), then uptake from within that population is assumed to proceed immediately (Rogers, 2010). This process will then be rate-limited such that after 2 years 63% (1 – 1/e) of the cohort will have installed a BES. We believe this is consistent with uptake rate-limits effectively put in place via both the information diffusion process and by physical constraints on installation rates.

A desktop study provided data for projected Lithium-ion home BES costs, electricity prices, export tariffs and Tasmanian demographic information to inform a model projecting BES uptake (Table 1).

To create the model, the following assumptions were made;

- We assume that batteries installed are appropriately sized for both household electrical demand and solar PV generation, for an average BES use of 0.8 cycles per day, that is on average, 80% of the rated capacity used on a daily basis (Naumann et al., 2015)
- BES capacity fade was set at 3% per year, and an average round-trip efficiency of 80% was used which falls within commonly reported round trip efficiencies for lithium ion batteries (Naumann et al., 2015).
- Any auxiliary benefits that batteries may offer were ignored, such as Tariff Arbitrage and compensation for exporting stored electricity with systems similar to Reposit's GridCredits (Reposit, 2018). Where available these have a positive bearing on BES payback times.
- We assumed that BES systems have the same installed cost irrespective of the city and state.
- We have not factored in the cost of finance; in its place we assume that PV & BES are purchased outright.
- We have assumed a 4% p.a. growth in population (ABS, 2016) and calculated eligible households for PV and BES to be free standing houses owned by householders.
- The modelled scenarios assume TOU tariff with an average 14c/k/Wh daytime and 33c/k/Wh peak and a 2% annual tariff increase (OTTER, 2017).

Battery price (per kWh storage)		**Retail tariffs (per kWh)**	
Initial price	$900	Initial daytime tariff	$0.14
Fixed comp	20%	Initial peak period tariff	$0.33
annual % drop scenario 1	15%	Tariff annual increment	2%
annual % drop scenario 2	22%	Export tariff scenario 1	$0.09
		Export tariff scenario 2	$0.06
Battery system		**Population uptake**	
* assume sized appropriately to		eligible households	120000
load and PV generation size		Decision and actuation	2 years
daily cycling	0.8	delay time constant	
yearly capacity fade	3%	Annual population growth	4%
Total cycles	5000		
Years of operation	10		

Table 1 Input data for BES uptake

Two different scenarios were generated to compare potential uptake of batteries under realistic conditions for price reductions in BES costs and plausible export tariffs.

<u>Scenario 1</u> assumes a 15% annual price drop in BES costs and the current export tariff for Tasmania of 0.09c/kWh.

<u>Scenario 2</u> adopts 22% annual price drop based on previous years trends (Curry, 2017) and the average wholesale price for electricity in Tasmania of 0.06c/kWh.

3. Results

3.1. Survey results

Of the 502 participants, 307 had solar PV installed. The majority of participants were from the cities Hobart, Launceston and Burnie (Figure 2). Over 60% of the households participating in the survey had incomes higher than the State average of $57,200 (Eslake, 2017). This follows the global trend for affluent households adopting DER (Semso et al., 2017). Over eighty percent of survey participants are considering home BES, the majority within the next two years. A spike at 5 years and 10 years was recorded. The average desired payback period stated was 7.3 years with a median of 7 years (Figure 1).

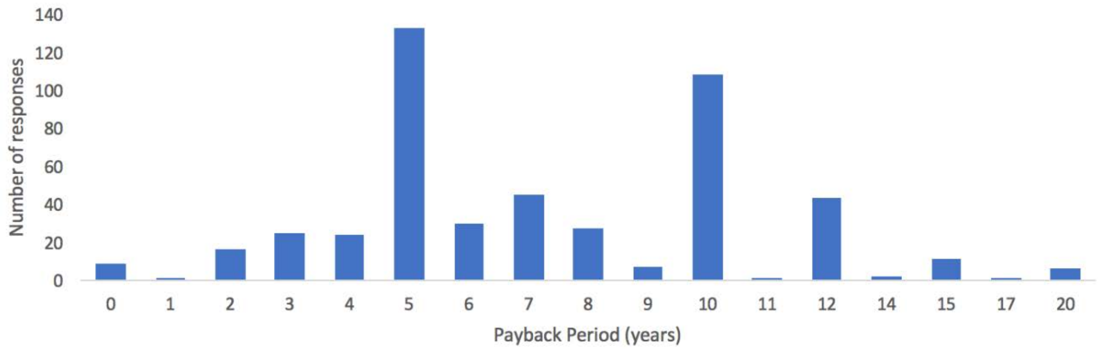
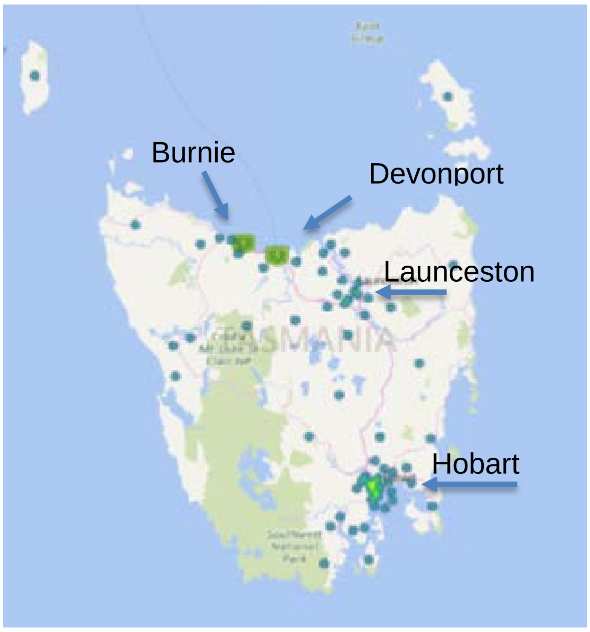


Figure 1 Frequency of responses for different payback periods

The key drivers to install batteries were to store excess solar generation and reduce bills, people made the choice to install or not, based on information available at the time. The most common sources of information were solar and BES installers, product vendors and internet forums, family and friends. Interestingly there was a lack of trust in the financial motivations of solar and BES installers and product vendors. Family and friends were the most trusted sources of information; however, a distinction was made in survey responses and interviews that they may not be the most reliable. Networks, energy retailers and utilities were amongst the least trusted, an important consideration for incumbents to consider when planning for prosumer integration in the gird, especially given the potential for household disconnections from the grid when BES costs decline (CSIRO and Energy Networks Australia, 2017). Reliability of supply motivates 37% of surveyed households to adopt batteries and hedge against future outages.



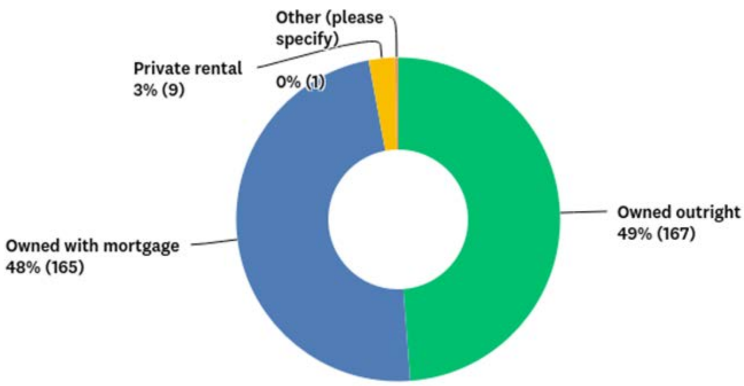


Figure 2 House tenure of survey participants

Figure 3 Location of survey participants

3.2. Interview results

A total of 51 interviews were conducted from mid-August to mid-September 2018. Over 80% of those interviewed indicated that the consideration to install batteries was financially driven. Many of the recipients of the premium solar feed-in tariff were looking for ways to maximise the efficiency of their investment and saw batteries as a means to do so; *"you can't get away from the fact that when the feed-in tariff ends my income from exporting solar will effectively be cut by a third. That's why I'm installing batteries" (P21, 2018).*

Over half of the participants indicated that environmental considerations were a high priority, however only 3% would make a purchase on those grounds alone. Rising electricity prices spurred a desire to be self-reliant and potentially defect from the grid if it were to be an economically viable option. *"I see batteries as a way of protecting myself from vulnerability to greed, whims and failures I cannot control. I also want to reduce my carbon footprint because our government isn't taking adequate action" (P38, 2018).* In parallel to the survey results, distrust was high for incumbent generators, networks and energy retailers.

Major foreseeable changes to energy consumption were identified as either changes in household composition or the acquisition of an Electric Vehicle (EV). Six participants had already purchased an EV and over half were planning to purchase an EV as their next vehicle. As a result, they were considering upgrading to a suitably sized PV with additional BES storage to accommodate the increase in electricity demand. While some householders viewed EV's as batteries on wheels, particularly if they were integrated with bidirectional functionality, they did not have the same expectations for a return on investment. They were more willing to pay a premium price, stating *"it's the future. I want to experience that. This is why I have bought an electric vehicle and am seriously considering installing batteries" (P16, 2018).*

Generally speaking, most people were unclear about options for BES. A desire for batteries did not always translate to knowing what kind would suit their needs or how much it was going to cost, therefore stated timeframes for BES purchase were inconsistent with desired payback. 5 and 10 year payback periods were the most commonly stated preference from the surveys with a common rationale stated in interviews that it was the first number that came to mind and similar to what they expected from their PV systems.

3.3. Battery Energy System, cost and user uptake projections

BES costs are predicted to fall below \$200/kWh by 2020 with installed costs ranging from \$550/kWh to \$800/kWh (figure 4). The installed BES price assumes fixed components and installation costs to be 20% of total costs. Based on the stated desire for payback period, averaged out to 7.3 years, an installed BES price of \$300/kWh is necessary to reach that milestone. Scenario 1 model shows that within the next ten years installed BES price falling to \$300/kWh under a conservative 15% annual price reduction. Scenario 2 demonstrates that with a 22% annual price reduction, an installed BES price of \$300/kWh may be reached as early as 2024 (figure 4).

The cumulative probability for uptake for households that are likely to install or realistically consider installing BES in Tasmania under the 2 scenarios are compared in figure 5.

For a payback period of 5 years the simple payback in scenario 1 occurs in 2023. Simple payback in scenario 2 occurs in 2027. For a payback period of 10 years the simple payback in scenario 1 occurs in 2023. Simple payback in scenario 2 occurs in 2027. For a payback period of the median 7 years, the simple payback in scenario 1 occurs in 2024. Simple payback in scenario 2 occurs in 2021.

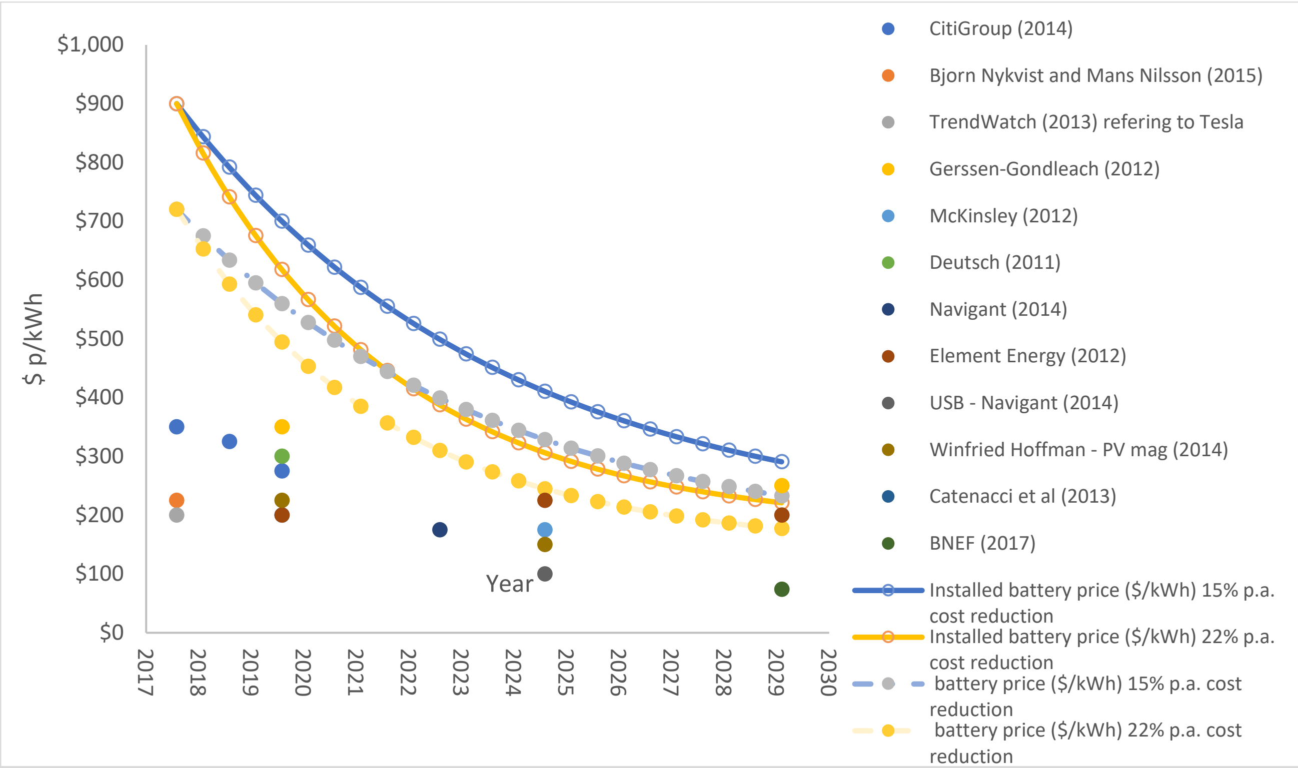


Figure 4 BES price forecast from sources (TrendWatch, 2012, CitiGroup, 2014, Mckinsley, 2012, Navigant, 2014a, Navigant, 2014b, Catenacci et al., 2013, Gerssen-Gondelach and Faaij, 2012, Hoffmann, 2014, Curry, 2017) and modelled BES price projections ($/kWh)

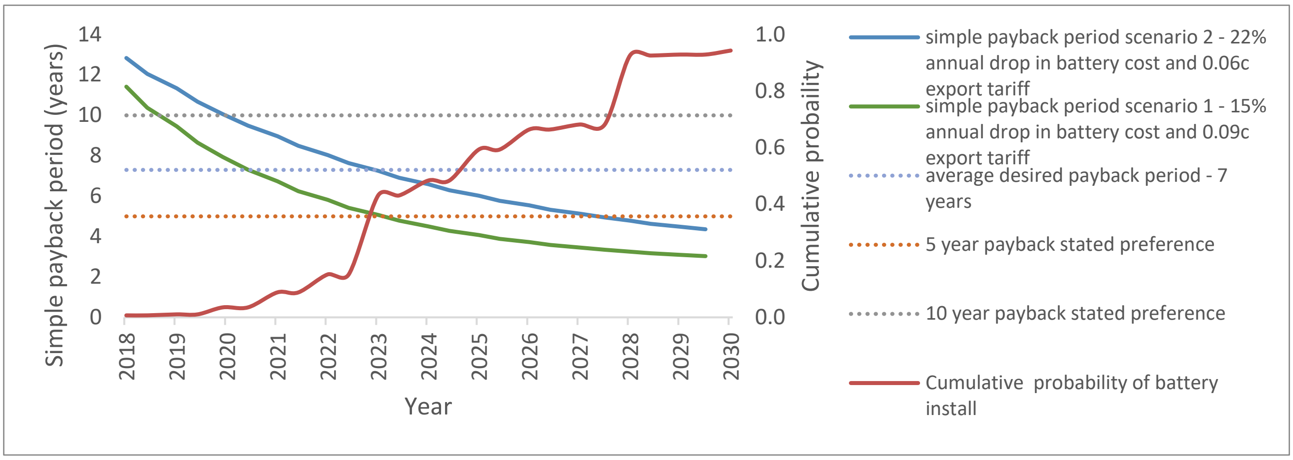


Figure 5 Predictions of BES install and simple payback period for households

Modelling was then made to determine number of households likely to install BES at any given time over a 10 years period and the number of BES install per year, under the two scenarios (figure 6). The total number of batteries installed per year is representative of the population. the survey respondents represent, who either have or in a position to have PV. That is home owners who live in a standalone house and do not rent it out and. The higher the threshold for payback period e.g. 10 years or greater, the sooner we see uptake of batteries, however at ab BES reach a low payback period we see a much greater uptake of BES. The peaks and drops in install per year are based off the stated payback period from survey respondents, with cumulative probability of installing given the stated payback periods. It should be noted that the assumption was that these were for first time BES installs only. If we account for replacement of batteries in 10 years it is likely that there will be a repeat of install range and the trend will follow an even upward trajectory, particularly if conditions for uptake improve. Actuation logic was applied to account for the lag time people generally take when making decisions about technology purchases (Gardner et al., 2008, Rogers, 2010).

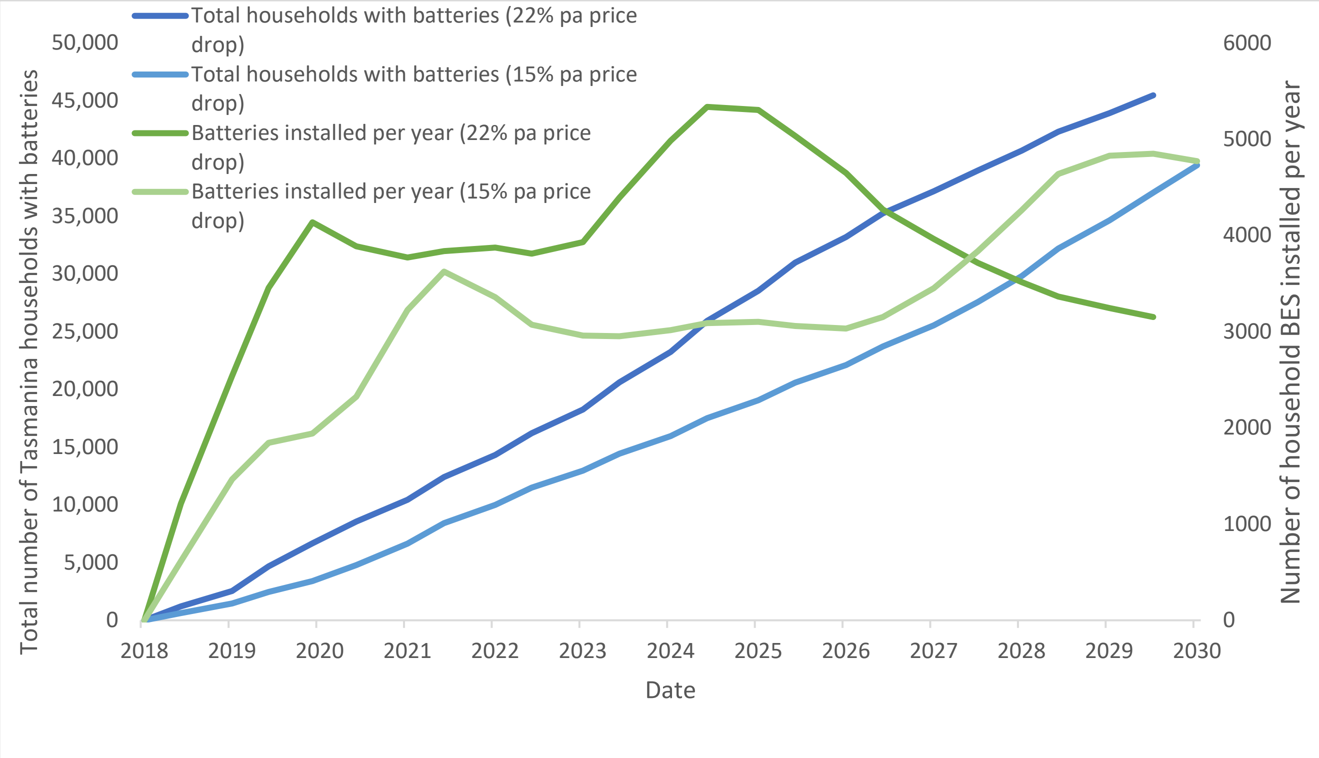


Figure 6 Predictions of BES uptake and number batteries installed in Tasmania in each 12-month period

4. Discussion

This research demonstrates a high level of support and intention to install home BES. Over 80% of participants in the study stated that they would consider installing a home BES in the next two years. While some participants indicated that they would be satisfied with a payback period of 10 years or longer, the average response of the cohort wanted at least a seven year return on investment. Our modelling suggests that the desired timeframe for the return of investment will not occur within the next two years, in fact that point may not occur until 2021 at the earliest.

The reasons for this discrepancy is due to the lack of clear, concise and reliable information available to householders and the various drivers for decision-making, i.e. that household decision-making is not just about the economics of batteries, and the level of trust in various information providers. An example of these factors are seen in Figure 1 and Figure 5 indicating a spike at 5 years a 10 years, 2023 and 2028 respectively. This was clarified in interviews whereby householders stated these payback times were the most familiar due to what they had been quoted for Solar PV.

Financial motivations proved to be the strongest consideration for BES install, however 3 in 5 participants in the study stated other accompanying non-financial reasons. Non-financial reasons included a desire to reduce their carbon footprint by generating, storing and utilising energy from solar PV, and to provide energy security for both mitigating the impacts of rising energy costs as well as an independent power supply. Householders stated in interviews that they would consider purchasing batteries to protect themselves from uncertainty and future energy price hikes, some even considered grid defection if it were finically viable.

Grid defection or independence from the grid was given a medium to high priority from over half of the participants in metro and rural areas, however the price of installing a stand-alone system is currently cost prohibitive. The falling costs of batteries may lead to a situation whereby grid defection is economically achievable especially when other non-financial considerations come into play.

As more and more households become less reliant on conventional centralised energy it will be vital for utilities and energy policy makers to understand householders with DER. Building and maintaining trust is key to effectively engage with households, in order to retain customers, manage increased levels of DER in the networks, and to predict supply and demand (Graham et al., 2015). While this study shows that almost 85% of households with batteries would be willing to allow network utilisation, it was a low priority and would only be considered if adequate compensation was offered, with over half of the respondents stating that they would expect amount proportional to the power contributed to the network. This compensation would also have to account for the lost opportunity to use their own stored energy and the increased cycle counts.

The participants in the study displayed a medium to high level of energy literacy, shown in both enthusiasm and interest in understanding their energy usage. They were also above the state average for income, education, home ownership and solar PV installations. These attributes have been accounted for in our modelling, the sample population still remains significant, particularly in regards to the characteristics of early adopters of emerging energy technologies (Ozaki and Sevastyanova, 2011, Bergek and Mignon, 2017) such as BES uptake. Despite the higher level of energy literacy, uncertainty attributed to the avenues by which people obtain information, and who they trust, still make decisions surrounding home storage quite complex.

Providing information to householders that is accessible to a range of energy literacy levels can facilitate the effective integration of prosumers in to the network. Properly manged DER could mean an overall reduction in costs by mitigating the need for investment in new large-scale generators and network assets. A future with poorly managed DER integration could lead to a future where increasing numbers of consumers have less reliance on grid-supplied energy, and may even lead to grid disconnection, concentrating the burden of the cost of the grid on those who are unable to invest in their own DER or household energy efficiency.

Elaborating on the modelling results, it is clear that a growth in uptake of residential batteries in Tasmania will likely occur once a suitable payback period is reached, particularly when non-financial motivations fortify the decision to purchase home storage.

Noting that sampling bias is inherent and unavoidable due the limitations of advertising, access to technology, and willingness to participate. A randomised survey would offer greater probabilistic accuracy. This was evident as many of the households participating in the survey were home owners and had incomes higher than the state average. The results for the survey are still considered valid given the This follows the global trend for early adopters in middle to upper-middle-class households adopting DER (Semso et al., 2017). The presence of smart meter installations at households has also been excluded from paper as it is assumed that new PV and BES installs will have this enabling technology.

Follow up studies will explore a range of leading and lagging indicators to assist with predictive analysis, to better understand the dynamics of the rapidly evolving landscape of BES installations, smart meters, and EV uptake. This will include an examination of the primary and secondary considerations behind purchasing BES together with a sensitivity analysis to determine which parameters and components of desired payback periods most influential.

The likelihood of Electric Vehicle (EV) adoption will also be focused on as this study revealed that the majority of interviewees stated that they are considering purchasing an EV as their next vehicle. As part of that decision-making process many householders suggested that they would want to increase or install a larger PV system and BES storage. Having a BES on wheels offers potential for bidirectional grid connection and an effective means of transporting energy from one home BES to another (Robinius et al., 2017). An indicator of this imminent change is the 2018 Nissan leaf, which comes standard with vehicle to grid technology, allowing the possibility of the 24kWh battery to power the household or feed back into grid (EnergyMatters, 2018).

5. Conclusion

This study contributes to the empirical data regarding householder attitudes and motivations relating to BES adoption, and offers insight into the complexity of decision-making elements. These are often left unconsidered in conventional analysis of home storage uptake. For policy makers a clear understanding of the role of prosumers in Australia's energy future can lead to a more effective integration of DER and BES in the long-term, and the benefits that can arise in the form of improvements in energy efficiency, reduction in electricity demand and generation capacity, and an overall reduction in costs for all consumers.

Most of the studies regarding predictions of battery uptake are based on cost projections for technology, and then make assumptions about decisions and behaviour of energy consumers or simply about market size (McIntosh, 2014, Brinsmead, 2015, Graham et al., 2018). In this study we do the opposite, which is to start by better understanding how customers make decisions, their level of energy literacy and self-predicted changes in their future energy composition and then work up from that to model BES uptake.

This paper demonstrates that despite a high level of BES uptake intention, the current upfront costs are not yet an economically attractive option for the average Australian household. Non-financial motivations can positively influence the willingness to pay for BES installation, particularly in households identified as early adopters, and those who already have or are considering solar PV. As BES prices decrease and lifespans increase as predicted over the coming years, BES storage will become a significantly more attractive option for homeowners.

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