

## Executive Summary

Solar energy is surging in Australia, rising from 2% of total energy consumption in 2016 to 7% in 2021. Despite these promising statistics, solar energy still has a long way to go before it becomes the country's main source of energy. Renewable energy in the residential sector is becoming increasingly affordable with the advent of solar and continuously improving battery technology. Renewable energy alternatives not only reduce natural gas emissions and pose little environmental threat, but also provide homeowners with the opportunity to make significant financial savings.

The housing sector accounts for roughly 10.5% of Australia's total energy and is crucial to the transition to renewable energy, as household energy practices tend to carry over to the industrial sector. Unfortunately, due to the high commission costs and the arduous installation process of switching to renewable energy, some people are reluctant to adopt solar energy and continue to rely on fossil fuels. Currently, only 21% of Australian residents use solar PV systems. It will be difficult to convince the rest of Australian homeowners to switch to solar.

To meet this challenge, the Victoria State Government is promoting renewable energy at the residential level. The government is actively working on a net-zero carbon target in the housing sector by providing homeowners with many means towards renewable energy. One initiative is the solar home program, which offers qualified candidates a \$1,400 discount on the purchase of solar panels. The government is also supporting several renewable energy nonprofits, including the Yarra Energy Foundation, which aims to work on local renewable energy projects.

The Yarra Energy Foundation (YEF) is a non-profit organization that aims to promote renewable energy in order to create a more environmentally friendly and climate friendly energy environment. By connecting homeowners with trusted solar installers and energy retailers, YEF and other renewable energy organizations streamline the solar installation process, making it as cheap, easy and convenient as possible for all homes. To improve the solar user experience, YEF needed information about the previous solar user experience and the personalized user perspective of the solar system. YEF aims to communicate with current solar users, identify both strengths and weaknesses in all aspects of the solar user experience, and be able to adjust and improve their solar programs accordingly.

Part of optimizing the installation process and improving the solar user experience is to look at previous residential solar installations to understand how solar has affected them. This included interacting with current solar energy users and ask questions about their experience with both the installation process and living with solar energy. This revealed shortcomings in various aspects of the solar user experience and allow YEF to customize and improve future solar programs and initiatives.

The purpose of this project was to assist the Yarra Energy Foundation (YEF) with their goal of advancing the uptake of residential solar. We achieved this goal through researching and analyzing why current homeowners invest in solar, their experience with it, the financial benefits of it, and finally by suggesting how YEF can best serve homeowners in the future.

Our methods for completing these goals involved developing three surveys to be sent out to Yarra Energy Foundation's previous clients, who are homeowners that installed solar panels through one of YEF solar initiatives. The surveys were done in two rounds of data collection, the first being the initial survey. The main goal of this survey was to gauge interest for the second round of surveying by asking residents to opt into either a more in-depth survey or phone interview. The initial survey also acted to collect preliminary information about residents and was a method of reconnecting the Yarra Energy Foundation with their clients as most of them have not had contact with YEF in multiple years. The client base consisted of 444 solar residents, out of which 44 responded.

Initially, the in-depth survey was only sent to those who opted into participating which was 20 residents. After receiving an inadequate number of results, we decided it would be best to send the survey to YEF's initial contact list of 444 solar residents. This turned out to be the right thing to do and the survey ended with 49 responses. This survey was the bulk of our data collection with the goals of understanding the user experience with solar, understanding the financial savings solar can provide, and gauging residents interest in future YEF initiatives. Along with the in-depth survey, residents who solely opted into the phone interview were called and interviewed to collect more qualitative data. Of the 8 residents who agreed to be called we only managed to get in contact with and collect data of 3 residents.

To investigate the financial benefits of solar, an important aspect of the initial survey was to ask users if we could access their NMI data. The users NMI data (National Metering Identifier) provided access to solar homeowners' energy metering data that details all the quantitative information on how residents consume energy. While the NMI data received was limited and contained little data on residents' energy usage before they installed solar, it allowed us to calculate the amount residents saved by analyzing their energy consumption before and after adopting solar, although more data was required for the findings on savings to be assertions.

As a result of our project, we found results that can be separated into 7 different categories. The first of these are demographics, which showcased who current solar customers are. We found that the average age of respondents was 62 years of age. Additionally, the average income range of participants was \$79,787.23 AUD, and most participants were retirees. This data will be beneficial to YEF in the future, as YEF can utilize this information to target underrepresented groups of differing age and income ranges.

Next, we analyzed the perceived savings homeowners thought they were saving. We discovered that there were homeowners who were not very aware of their savings, as there were both no relationships and illogical trends. For example, people who practiced energy efficient habits actually saved 2% less on average. Because of this, it is safe to say that homeowners are both not aware of their savings, and possibly unaware of possible improvements they can make to make their solar PV systems more efficient and effective.

To understand the user experience with residential solar, the in-depth survey asked residents about the installation process, their overall satisfaction, and any power outages they experienced. Overall, respondents were satisfied with their system as 37 of 48 or 77% reported being satisfied, where only 9 or 19% reported being dissatisfied with 2 respondents being neither satisfied nor dissatisfied. The 9 dissatisfied respondents were asked if they would still install solar knowing what they know now being a solar owner, 3 would be likely to, 3 would be unlikely to, and 3 couldn't say. This question shows that even if residents experienced frustration during installation or aren't saving as much as expected, most still don't regret installing their system.

When asked what was the most contributor to their decision to install solar panels, it was found that the biggest factor for residents was their desire to reduce expected energy prices. The second most frequently reported factor was environmental issues. This shows that many people are always interested in switching without saving money as the main motive (although this was still a secondary motive for most users). In addition, 34 of the 45 respondents (77.7%) were found to be willing to change dealers to achieve this. 100% green power. Still, 58% of respondents say they don't want to pay more than \$50 a year to get 100% green electricity, and 25% don't want to pay at all. This data is still very promising however, as it shows that quite a few people are willing to raise their annual electricity bills to be more environmentally friendly. Fourteen respondents (31%) said they would pay an additional \$150 a year. The new initiative could help Victoria continue to work towards 100% green energy, as a significant proportion are willing to pay extra.

One of the biggest factors affecting the efficiency of a solar system is whether it is connected to a household battery. One of the main goals of cost analysis was to evaluate the savings household batteries provide, as they significantly increase the initial cost of solar systems. The Yarra Energy Foundation provided us with the energy use data of 11 residents, 3 with batteries and 8 without. Based on the energy consumption of these 11 residents, our calculations show a reduction in the energy cost for battery systems compared to systems without batteries. Residents without batteries consumed an average of 448kWh of grid energy per month, while residents with batteries consume 287kWh per month. At a cost of 24 cents/kWh, we estimated that those without batteries could expect to be charged \$107.42 per month, compared to \$68.81 for those with batteries. This may seem like a significant reduction, but before making any claims, we need to consider energy residents sold back to the grid. Those without batteries exported an average of 293kWh per month, and those with batteries exported 269kWh per month. If this energy is sold back to the grid at 6 cents/kWh, the average residents' energy cost is brought down to \$89.85 without a battery and \$52.68 with a battery. This means that on average residents with batteries pay \$37.17 less per month than residents without batteries. Of the 11 residents with energy usage data, we had the initial system cost of 6.2 with household batteries, and 4 without. The average system cost for the four residents without batteries was \$10,434, while the average cost for the two residents with batteries was more than double the \$22,111. On average, those with batteries paid \$11,667 more for their system. Due to the limited data, we will not make any definitive claims, but when comparing a battery to a regular system, it is important to consider the cost of the system along with the monthly savings.

When looking at our analysis of water heater data, our prior research suggested that most residents were equipped with gas storage water heaters, but the data collected suggests that this is not the case. In fact, only 32% of homeowners surveyed have gas conventional storage water heaters. With 61% having any type of gas-powered water heater. 61% is certainly the majority, but it's not overwhelming, as this suggests 39% of homeowners have electric water heaters, a relatively new technology. This means that many homeowners have taken initiative to switch to renewable energy alternatives.

As solar and heat pump water heaters are still commercially new technologies, it is surprising that 39% of homeowners have already adopted them. The survey participants were early adopters of solar energy, who are more likely to be energy and environmentally friendly than the average person, which could explain the high percentage. Because of this, the results of this sample may not scale to all households.

Based on our analysis, it is clear that residents are very interested in adding batteries to their solar systems in the near future. 84% of those surveyed are interested in batteries and 69% are interested in adding batteries within the next three years. In addition, we found that 94% of users are interested in participating in community batteries. The main concerns we identified were the cost of acquiring a battery, as well as the fact that the user does not feel they generate enough power for the battery to be necessary. Given that this is a relatively small population, we still believe that YEF should work to help users install batteries in their systems and consider battery initiatives for the community. Additionally, 56% of the respondents were interested in buying electric vehicles, and almost everyone was interested in participating within the next three years. Given the data, it would be beneficial for YEF to pursue this initiative in the near future.

In summary, these are the initiatives we believe that YEF should be prioritizing as a result of our analysis. Since between 80-90% of participants were interested in residential batteries, community batteries, or both, it is worth pursuing both residential and community batteries as an initiative. Secondly, we believe it would be beneficial to help residents change their water heaters, as 61% of respondents still have gas water heaters. The data collected about the age of each participant's water heater should help YEF roughly estimate when to replace each participant's water heater and contact them at an appropriate time. Lastly, there was 56% interest in the bulk purchase of electric vehicles. There is not as much interest as batteries and water heaters, but it's an initiative that seems worthwhile, as almost everyone that was interested is interested in doing so within the next three years.

For the Yarra Energy Foundation to advance the uptake of residential solar in Victoria, they must understand why homeowners choose to invest in solar as well as their previous clients' experiences as solar owners. Our research was meant to assist YEF in better understanding these topics and through this we have developed multiple assertions. YEF's average solar client is a middle-class retirement age homeowner which does not seem to be a very diverse group. We have also found that most of these homeowners are satisfied with the savings solar provides and almost none regret installing their system. While we identified that residents primarily installed solar to reduce electricity bills many also chose to install out of concern for the environment,

with residents being in favor of making changes to adopt green energy and some would even pay more for green energy.

Deciding whether residents should buy residential batteries or not is too case specific to make a definitive claim for either side, but they do provide a significant reduction in monthly bills and a significant increase in system cost which prolongs the time to earn a return on investment. YEF should still investigate a residential battery program or bulk buy due to the high level of interest from residents. An electric water heater program should also be a priority for YEF due to the large population of solar investors that still have gas powered water heaters and the overall interest from homeowners. Residents also showed interest in an electric vehicle bulk buy which YEF should implement at some point but should come after batteries and water heaters.