School of Design and the Built Environment

Adoption of Solar Photovoltaic Cells in Western Australia: A Marketing Behavioural Perspective

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made. This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Human Ethics

The research presented and reported in this thesis was conducted in accordance with the requirements described in the National Health and Medical Research Council's (NHMRC) National Statement on Ethical Conduct in Human Research (2007).

The study received human research ethics approval from the Curtin University Human Research Ethics Committee (EC00262), Approval Number: HRE2018-0713.

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Adoption of Rooftop Solar Photovoltaics in Western Australia:
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Abstract

To date, there has been limited research on the adoption of rooftop solar photovoltaic (PV) panels by households in Western Australia. This study is conducted to examine the factors that have led to the adoption of PVs in Western Australia, to determine the drivers that influence people's decisions, and to investigate how the penetration ratio of rooftop solar can be increased by means of appropriate marketing strategies. The Technology Acceptance Model (TAM) is applied in this study.

A survey of 110 households was conducted in 2019 and analyzed statistically by using the online survey platform Qualtrics. The results show that environmental and financial considerations are the most significant factors influencing adoption. These findings can inform any marketing strategies aimed at increasing the adoption rate of rooftop solar in Western Australia and transitioning towards renewable energy.

Given Western Australia's climate and high level of sunshine, residential photovoltaic systems are a sustainable technology for the production of electricity. One third of Western Australian households already have solar PV systems and their further adoption would help transition the traditional system of electricity generation which continues to be dominated by coal and gas. Places which have suitable conditions, such as ample sunlight and appropriate dwellings, make installation and use of PVs feasible. Marketing strategies can focus on the environmental advantages of rooftop solar and emphasise the financial benefits achieved through cooperation between people and government as is the case in Western Australia where the uptake of PV technology by households can continue to increase.

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Chapter 1. Introduction

1.1 Introducing rooftop solar

In many countries, solar photovoltaics (PVs) are increasingly being adopted for domestic use as a clean energy source to replace fossil fuels. In 2017, Germany was the leading country in terms of PV implementation, accounting for 32% of the world's total solar PV generation for domestic use (Qureshi, Ullah and Arentsen, 2017). Italy and USA followed with 16% and 7.2%, respectively (Qureshi, Ullah and Arentsen, 2017). However, the share of solar PV-generated electricity remains relatively modest. It is the highest in Italy at 7.9% and in Germany at 7.1%, followed by Spain at 3.4% while in the USA it is less than 1% (Qureshi, Ullah and Arentsen, 2017). Similar to the developed countries, many developing countries in Asia, Africa and South America are striving to include solar power in their energy mix to lessen the burden on non-renewable and expensive sources of energy (Qureshi, Ullah and Arentsen, 2017).

This study focusses specifically in Australia, where 3.1% of all electricity was generated by solar PVs in 2017, the majority being through rooftop solar panels (ARENA 2021). In 2017, the total capacity generated by solar PVs in Australia was 7.2 GW, reaching 20.2 GW by 2020 (Australian PV Institute, 2021). Approximately 21% of all Australian households had rooftop solar PVs in 2017 (ARENA 2021), considered the highest uptake in the world (Department of Industry, Science, Energy and Resources, 2021). Despite this sharp increase in the adoption of solar PVs by households, there is still a lot of potential for expansion on remaining roofs. The Australian experience is of interest to other countries where the adoption of solar PVs by households has been slower.

1.2 Background of the study

Energy has become indispensable to human activities as it ensures the functioning of buildings, transportation, households, manufacturing and construction work. Although there are numerous types of energy resources, currently, fossil fuels are the predominant source of electricity worldwide. They are considered to be non-renewable sources of energy and, therefore, their consumption results in depletion. Moreover, the consumption of fossil fuels increases global warming, environmental pollution and acid rain. The scientific community has long been calling for a transition to less damaging and renewable energy sources (Newell & Simms, 2020). However, compared to fossil fuels, the sources of renewable energy are able to supply only a small portion of global energy requirements.

Photovoltaic systems, which provide a green source of energy, have various advantages, one of which is that they can reduce the amount of CO_2 emissions because they produce electricity without releasing greenhouse gases (Zhang, Shen and Chan, 2012). A transition to renewable energy, including the adoption of rooftop solar energy by households, is a much-needed approach in response to the challenges of climate change.

However, changing to a new source of energy has social and technical complexities because there are constant alterations in the substructure of energy generation and circulation, and the way it is used by consumers. Moreover, the adoption of renewable energy often faces economic, policy and social challenges. For instance, in terms of cost, the change to renewable sources of energy may require greater capital expenditure, particularly when renewables need to be integrated into existing power grids. These issues need the consistent application of strategies to address market inequalities. Although arrangements intended to increment either power supply or demand are regularly authorized at various administrative levels, this may bring about

conflicting policy objectives, impeding the transition to renewables. An example would be a carbon cap-and-exchange strategy that unintentionally boosts the dependence on fossil fuels. The underlying high capital expenses or cost decreases related to solar photovoltaic (PV) market development determine the best strategy drivers as the market moves from early adoption to maturity. Interdependencies of different factors influencing PV adoption make it difficult to determine the influence of any one single on the diffusion of renewables. Thus, the transition to renewables is a complex process. The power systems itself has been defined as an arrangement of frameworks where electricity generation, dissemination and utilization comprise various, associated elements influencing the adoption of renewable energy sources (Walters, Kaminsky and Gottschamer, 2018).

With increasing access to information, people are becoming more concerned about their natural environment. In Australia, in 2020, 79% of those who were surveyed expressed a preference for solar energy (Australia Institute, 2020). Because of an increase in environmental awareness, more people are opting for green energy. The adoption of green energy is becoming more popular as, nowadays, an increasing number of people feel that they need to take responsibility for safeguarding the planet's natural environment, which will be passed on to forthcoming generations. Furthermore, in Australia, we have already begun to experience the effects of climate change. Bushfires, prolonged droughts and extensive floods have become a regular occurrence, making people question their lifestyles, including energy options. The Australian government also supports the adoption of PVs by providing monetary incentives that make it financially feasible for people to adopt PVs. Escalating energy prices in addition to the desire to reduce CO_2 emissions, are encouraging many Australians to install rooftop solar PV panels.

1.3 Aims of the study

To date, there has been limited research on the adoption of rooftop solar panels in Western Australia. Therefore, this study is conducted to examine the factors that have led to the adoption of PVs in Western Australia, to determine the drivers that influence people's decisions, and to investigate how the penetration ratio of PVs can be increased by means of appropriate marketing strategies.

1.4 Research gap and research questions

This study primarily addressed the following research questions:

RQ1- What are the main factors that influence the decision regarding the adoption of solar PV panels by residential consumers in Western Australia?

RQ2- How can the penetrating ratio of solar PV panels be increased through the implementation of appropriate marketing strategies?

1.5 Research approach

The methodology applied in Zhang et al. (2012) is adopted in this exploratory study. It is based on the mixed-methods research approach (Shorten and Smith, 2017) and includes both quantitative and qualitative methods for the collection, analysis and interpretation of the data. The methodology uses both primary and secondary sources for the data collection, and comprises a literature review, questionnaire survey, and structured face-to-face interviews with members of households who have adopted photovoltaic systems. Further details about the methods adopted in the research are presented in Chapter 3.

1.6 Significance of the study

Western Australia is one of the regions in the world blessed with plenty of sunshine, making photovoltaic cells a more sustainable alternative for electricity generation. The State ranks third in terms of solar PVs adoption in Australia (25%) behind Queensland (32%) and South Australia (31%) (Cassells et al., 2021). If this continues at the same pace, the State's rooftop solar PV capacity is anticipated to exceed 2,000 megawatts by 2022 (Cassells et al., 2021). In addition to having an adequate amount of sunshine, houses in Western Australia have ample space on their rooftops for the installation of solar PVs. The photovoltaic technology is becoming more advanced and there are many companies that offer PV services to households. Hence, there is increasing encouragement for people to adopt PVs nowadays in Western Australia. However, the proportion of solar PVs in the State's energy mix can still be improved.

This study explores the factors that have impacted rooftop solar PV adoption so far in order to understand better how the State's energy mix can be improved. Given the need for the world to transition to renewable energy and reduce carbon emissions, some of the insights from this analysis can be used in other geographic settings within and outside Australia.

1.7 Limitation

The results derived from the study pertain to Western Australia, and any generalization to other regions needs to be done with caution. Further localized research and further verification of the results are needed as there may be other factors influencing the adoption of PVs, such as different policy environments and incentives.

Adoption of rooftop solar is explored only from the point of view of home owners. The benefits from solar PVs extend to all residents, including people who rent. Although important

from the point of view of energy transition, the perspectives of non-owners have not been analyzed and can be a topic of further research.

1.8 Chapter organization

The structure of this thesis is as follows. Chapter 1 introduced the study. Chapter 2 presents a review of the current literature pertaining to the research topic in order to identify any gaps in previous research that need to be addressed and develop a conceptual framework. The methodology applied in this study is explained in Chapter 3. Chapter 4 presents the results and findings of the research; these are discussed in detail in Chapter 5. The concluding chapter, Chapter 6, presents a summary of the thesis, acknowledges the limitations of the study, and offers suggestions for future research directions.

Chapter 2. Literature review and conceptual framework of the study

The decision to install rooftop solar PVs is a complex one that households make under the influence of a variety of factors. This chapter presents evidence from previous research indicating how such a decision is being made. It starts with an overview of studies conducted around 2010s, which was early in the adoption process. This is followed by an overview of more recent developments across the world and specifically in Australia and Western Australia. The chapter concludes that understanding the factors that influence households to adopt solar PVs in the particular geographic setting is essential to promote a transition to renewable energy.

2.1 Technology diffusion and adoption of rooftop solar PVs

Over the last two decades, moves have been made to decrease the world's dependence on petroleum products, and this has been facilitated by innovative technologies (Jager, 2006). The Kyoto Agreement has placed pressure on nations to reduce their consumption of fossil fuels in order to decrease carbon emissions. The use of solar energy is one way to reduce the reliance on non-renewable sources of energy (Jager, 2006). Evidently, financial issues are expected to be critical drivers of PV acceptance, although other factors such as environmental concerns and local policy may also influence the choice to accept solar PVs. A consideration of the factors which encourage people and businesses to adopt PVs can help with the design of strategies that increase the uptake of this technology (Jager, 2006).

Adoption of solar PVs is very beneficial for households and the factors leading to such decisions have been studies for more than a decade. They include environmental considerations and policy issues that may have impacted people's decision. Other factors, including social and economic, have also been examined. Previous research has concluded that socio-economic

factors, income level, house price and education were interrelated in the decision to adopt PVs with environmental motivation being the leading cause (Schelly and Letzelter, 2020). Research has also shown that economic incentives enhance the adoption of solar PVs (Crago and Chernyakhovskiy, 2016). Some further argue socio-cultural dimensions are also important (Elmustapha et al., 2018). From a gender perspective, it was notable that environmental factors were more motivating for women than men while trust in solar installers could increase the adoption rate in households (Schelly and Letzelter, 2020). Stakeholder engagement and the reputation of the developer for new projects were also found to be important along economic and environmental factors (Shelly et al., 2019). Customer segmentation and targeting who should be approached and how have been shown to be essential in developing the market for household solar energy (Hai, 2019). Ultimately, however, rooftop solar PVs are a new technology that households are gradually adopting, and parallels can be drawn with the spread of many other innovations.

Since the publication of the works of Hägerstrand (1952) and Rogers (1962), many researchers have studied the features of technology diffusion together with the influence of policies, economic factors and social interactions on the adoption of new products (Bass, 1969; Brown, 1981; Webber, 2006). Diffusion patterns should be understood not only from an academic perspective, but also geographically and from a policy and marketing point of view. This is particularly true when exploring the diffusion of technologies that have both private and public benefits, such as renewable energy, evident in photovoltaic systems (Graziano and Gillingham, 2014).

The installation of solar panels is a significant investment that people make generally only once in their lifetime. Hence, before adopting this technology, people are likely to give it a great

deal of consideration and engage in inquiries that will explain its benefits and indicate whether it meets their individual or household needs. People have various requirements for comfort in their homes, some of which can be met simultaneously by the installation of a solar power system. The factors influencing people's choice of PVs include: financial considerations, desire to emulate friends and neighbours, group investments to establish a local network of PVs, personal and household circumstances, awareness of environmental issues such as climate change and carbon emissions, and opportunity (Jager, 2006).

Also, individuals can spend any savings from utilizing PV systems to meet various other personal, social and household needs. Early adopters give more weight to individual needs, and later adopters tend to be concerned with social benefits (Jager, 2006). The level of dispersion of an innovation, including rooftop solar PVs, depends on (1) its perceived benefits, (2) familiarity with the technology, (3) complexity of the required technological system, (4) trialability in terms of previous experience, and (5) "observability" as it relates to positioning among adopters (Jager, 2006). Although these factors influence the spread of new renewable technology at an organizational level, they also impact the way households make decisions.

The literature reveals that there are several factors that can impede the adoption of solar-powered photovoltaics (PVs) by households. These factors include: costs, security of supply, issues of vulnerability and trust, inconvenience, and the effect on the home (Balcombe, Rigby and Azapagic, 2013).

One of the main factors discouraging the adoption of photovoltaics is the associated expense. Caird and Roy (2010) found that the most significant financial barriers are related to capital expenditure, long payback time and the absence of grants or other incentives offered by government. It was found in a review of 601 London Mortgage holders that the initial capital

investment required is the main factor preventing households from installing PVs, but people were more likely to install these if they had some financial assistance (Balcombe, Rigby and Azapagic, 2013).

The second most significant factor influencing adoption was the environmental advantages offered by PVs. Issues related to climate change and carbon dioxide emissions can be addressed by having an alternative, enviro-friendly means of generating electricity (Caird and Roy (2010).

Microgeneration innovations might be seen by the general public as only being low-carbon; however, there are benefits to the environment that are not always discernible. Additionally, in another investigation, Palm and Tengavard (2011) found that ecological advantages and showing a green picture of the organization are significant in influencing decisions to install PVs. In their study conducted in Sweden, Palm and Tengvard (2011) found that families install PVs to contribute towards a better natural environment and to demonstrate to others the necessity and benefits of being eco-friendly. Fischer and Sauter (2004) maintain that the adoption of solar PVs makes a strong socio-political declaration which resonates with those who have a “green political direction”.

Caird and Roy (2010) found that some people install PVs because they are driven by the desire to be early adopters of a new technology. Similarly, it is stated in the literature that individuals with a fondness for innovation are more likely to want to be responsible for generating their own energy utilizing PVs (Balcombe, Rigby and Azapagic, 2013).

The matter of "autonomy" or "security of supply" is related to the desire for greater energy-generation independence. Individuals embrace PVs to obtain their own energy for free and to make savings in the event that energy costs increase in the future. Additionally, Jager (2006) found that the desire for autonomy and not having to depend on a central system for energy

generation is a motivation for PV adoption and the acceptance of solar-generated energy. A review of 197 Dutch families with solar PV installations found that individuals who believe themselves to be environmentally responsible want to be able to generate their own electricity (Jager 2006).

Numerous investigations have shown that there are several obstacles impeding the acceptance of PVs. They include execution weaknesses, uncertainty about return on investment, lack of secure reliability and not being sure about the advantages of adoption (Jager 2006).

Some sectors of the population are not receptive to PVs on the grounds that they need more information about this technology (Balcombe, Rigby and Azapagic, 2013). However, there are limitations to the data available. Individuals for the most part search the Web for relevant information, although what they find could often be inadequate or unreliable. Likewise, numerous investigations have found that some people do not totally trust the performance and reliability of PVs. The study conducted by ORC Worldwide (Balcombe, Rigby and Azapagic, 2013) found that people did not think enough about the available data and often based their opinions on very little information. Scarpa and Willis (2010) found that positive feedback or suggestions by friends and relatives made individuals more willing to embrace PVs. However, since a great deal of the feedback is subjective and not based on well-qualified assessment, this could be obstructive.

Apart from homeowners having to find a reliable operator, the installation of rooftop solar PVs might not be feasible or convenient (Balcombe, Rigby and Azapagic, 2013). Solar PVs require a significant amount of space and a certain time of exposure to the sun, and this might not be convenient for the householder. For instance, high-rise structures might not be able to have an adequate number of PVs installed to service the whole building due to a limited rooftop

area. The geographic orientation of the home and surrounding vegetation of other buildings may limit the exposure to the sun.

Despite the fact that prospective buyers may have a favourable opinion about PVs, choosing a supplier and installer is often problematic. Various suppliers offer systems and configurations which differ in terms of size, cost and returns. Additionally, household clients are not offered a trial period. Thus, they need to be aware of possible issues, such as the suitability of their home for solar panel installation, whether any excess power produced can be stored (e.g. through the main grid or a community battery), and the likelihood of obtaining returns on their investment. The vast majority of households do not have such insights and it is difficult to acquire reliable information quickly (Jager, 2006).

Generally, the installation of solar energy systems requires the approval of local government agencies. This is another step or barrier that the household needs to manage. Monetary concerns are another serious consideration as PV installations are quite costly, and people wait a long time before seeing any returns on their investment. Generally, those who choose to install PVs are people who have researched the benefits and any issues related to installation, and have decided that this technology adequately meets their needs (Jager, 2006). However, not all individuals have the capacity to access the relevant information and are reluctant to invest in a technology about which they have limited understanding (Jager, 2006).

McEachern and Hanson (2008) studied the adoption of PV systems in 120 villages in Sri Lanka. They found that the adoption of PV systems is determined by anticipations of whether the government will connect the villages to the electricity grid. Such findings suggest the likelihood of social interactions influencing the choice to adopt a PV system, consistent with numerous studies on spatial knowledge spillovers with a variety of neighbour or peer effects (Graziano and

Gillingham, 2015). It can be concluded that people's adoption of photovoltaics is influenced by a range of diverse and interdependent social, political and monetary factors (Walters, Kaminsky and Gottschamer, 2018). These factors are demonstrated differently in various parts of the world as decisions depend on the particular circumstances surrounding the policy, economic and energy environment that can speed up or delay the adoption of renewable energy. There has also been a significant progress with time in the way the PV systems are designed and in their costs.

2.2 Factors influencing adoption of PVs worldwide

Globally, the net production capacity of solar photovoltaic (PV) energy in 2017 was more than the net production capacity of coal, natural gas, and nuclear power collectively (REN21, 2018). Using PVs for electricity generation at household level enables families to reduce significantly the amount of money they pay for electricity. Moreover, it decreases the carbon emissions related to fossil fuels which are used for the production of electricity. Globally, the number of households adopting PVs is increasing (Best, R., Burke, PJ. and Nishitateno, S. 2019). The diffusion of the latest technologies is typically facilitated by spatial, socioeconomic and policy factors. Worldwide, electricity is essential for most human activities. Due to the economic improvement of countries across the globe, there has been an increasing demand for electricity, especially in developing countries and in areas with expanding manufacturing industries. Market analysts and policymakers have recognized the relationship between energy consumption and the economic circumstances of countries. There has been a call for governments worldwide to put in place policies to reduce carbon emissions in order to address climate change and other environmental issues, and to encourage the use of cleaner, sustainable, and renewable energy sources (UN, n.d.). This has affected adopters at both, an industry and household level.

Economists and geographers have been fascinated by the factors controlling the patterns of dispersal of recent technologies (Graziano and Gillingham, 2015). In Connecticut, USA the spatial patterns of diffusion showed a significant clustering of adoption which seems to be independent of income or other demographics (Graziano and Gillingham, 2015). However, it was found that smaller areas have a greater adoption rate than larger urban spaces. The results revealed a strong relationship between adoption and the number of previously installed systems in the neighbourhood, combined with policy factors. According to the study, the influence of neighbouring systems decreases with distance and time, suggesting a spatial neighbour effect transferred through social interaction and visibility (Graziano and Gillingham, 2015). These results provide an insight into the diffusion of PV systems and offer guidance to stakeholders, including households, within the solar energy market.

Bollinger and Gillingham (2012) were the first to demonstrate the impact on PV system diffusion of previous nearby adoptions. They used data from California to demonstrate that any additional adoption in a particular suburb increases the probability of a new intake in this suburb by 0.78%. Bollinger and Gillingham (2012) found evidence of even stronger neighbour effects on a particular road within a suburb. Richter (2013) found a similar neighbour effect existing in the adoption of photovoltaic systems in suburbs within the UK.

Solar PV adoption rates are related to political, economic and environmental issues within the energy sector. However, the emergence of photovoltaic energy poses new operational and management challenges in terms of the stability of electricity services and affects not only consumers, but also operators. Distributors operate on economies of scale, and the high penetration of solar energy means that these companies not only influence the movement of other consumers, but also incur economic and financial consequences. Therefore, a study conducted by

do Nascimento et al. (2020) systematically identifies the key factors and indicators that can help distributors to predict consumer adoption of solar PV technology. The results show that the value of electricity, the power capacity and the cost of photovoltaic systems are the most important indicators.

The study carried out by do Nascimento et al. (2020) reveals the key factors that can predict consumer adoption of distributed PVs, and assist distribution network operators with complex processes to ensure stability in energy distribution. It also describes the Brazilian scenario and its theoretical, political and practical impacts on developing countries (do Nascimento et al., 2020). Maintainability, strategies to ensure energy security, and insurance against further deterioration of the natural environment are possible considerations (do Nascimento et al., 2020). In Brazil, the energy sector is undergoing a change characterised by small and miniature scale generation with the view of similar adjustments in Europe. Solar energy is part of the change from fossil-fuel based power generation to sustainable energy sources. Being among the nations with high consumption of electricity, Brazil stands out in terms of solar energy because of its large topographical zone with positive conditions and abundant amount of sunshine. However, although there is great potential for the use of solar energy, operational and administrative issues are impeding the change to solar (do Nascimento et al., 2020). This impacts the entire economy of the country, but also individual households that are considering rooftop solar PV systems.

Specific issues such as voltage control, power stream reversal, and the increasing incidence of mishaps, ought to be considered by wholesalers, in addition to the transformation of the physical network and the introduction and improvement of smart grids. With the increased uptake of photovoltaic energy, the revenue of energy providers may decrease. Utility companies in the US and in some European nations have recognised that clients would decrease their

spending on electricity when they adopt solar energy and also would generate an excessive amount of power that can be fed into the grid (do Nascimento et al., 2020). Any lack of clarity about the reaction of energy providers would impact on individual households in their decision to adopt rooftop solar systems.

Currently, users of solar power rely on utility companies to supplement their energy supply when the solar PVs are generating inadequate amounts of energy. This places pressure on energy operators who should take some responsibility for the financial impacts on customers. The literature emphasizes the importance of grid operators recognising the heterogeneity of energy consumers and their behaviours and, in particular, their motivation for adopting a solar energy system. Hence, it is important for energy operators to know their customers so that they can make solar energy an economical option for them (do Nascimento et al., 2020).

The adoption of innovations by the general public has been of great interest to researchers who investigate the motivations underlying consumer behaviour when a new technology emerges that supplants or is an improvement on an existing product. In regard to solar photovoltaic technology, a distinctive characteristic is that the reason for adoption is associated with an environmentally-oriented value system. The diffusion and uptake of this innovation is related to monetary and environmental issues, as opposed to traditional energy-generation frameworks, and include mechanical and social vulnerabilities (do Nascimento et al., 2020).

Similar to other innovations and their uptake, there are several steps in the consumers' acceptance or otherwise of photovoltaic technology (do Nascimento et al., 2020). The first step is the acquisition of information when the individual becomes acquainted with the innovation and understands its purpose. This is followed by the influence stage, which indicates the effect the product has had on the consumer, and determines any positive or negative attitude. The third step

is choice; this is where the consumer decides to accept or reject the innovation. If the decision is to accept the innovation, the fourth stage is the execution, when the individual begins to utilize the new technology. The fifth stage is the affirmation during which the individual plans to reinforce an advancement in the choice that has already effectively been made (do Nascimento et al., 2020). In the case of acceptance or rejection of photovoltaic systems for energy generation, the consumer similarly goes through all these decision-making stages.

The literature reveals several factors that can significantly influence the consumer's decision to adopt a solar-powered system to meet household energy requirements. Financial considerations linked with people's personal circumstances can be factors determining consumer behaviour when it comes to adopting a solar energy system. The study by do Nascimento et al. (2020) reveals the various factors determining the acceptance of solar power based on 13 worldwide contextual analyses, presenting a systematization of arrangements and administrative changes that affect the diffusion of the new technology. It also raises issues related to the performance of the main grid in regard to increasing the supply of photovoltaic energy. This is a complex process requiring dynamic improvements and interconnected components about which grid administrators need to be aware. The operation of the grid with an increasing number of photovoltaic systems operated by consumers will impact the diffusion of this innovation (do Nascimento et al., 2020).

There is much evidence to suggest that adopters of solar energy systems play a significant role in creating sustainable power sources as photovoltaics benefit both families and the environment. The aim of the study conducted by Bashiri and Alizadeh (2018) was to find the factors which influence the selection of photovoltaic systems in Tehran, Iran. They examined the influence of population density, level of air pollution, energy cost and government subsidies, on

photovoltaic adoption. In addition, they identified the households that were likely to adopt this technology. The findings suggest that low- to moderate-income householders living in one-storey dwellings were more willing to opt for solar energy. However, the overall cost of a rooftop solar system is a deterrent. Environmental concerns, information on sustainable power sources and the number of families sharing the house, are all elements that increase the likelihood of adoption. The findings of this study carried out by Bashiri and Alizadeh (2018) are valuable for strategists, policy-makers and proponents of an eco-friendly environment who want to promote cleaner energy in the context of developing economies.

The production of energy and the protection of the environment have in the past been at odds with each other. However, continuous research and development have been endeavouring to address any perceived conflict by creating efficient means of harnessing renewable resources such as solar energy. This has resulted in the production of efficient solar PVs which have been shown to have two major benefits: providing cheaper energy and helping to address the issue of climate change. Given these benefits, it is reasonable to question why this source of energy has not been promoted and adopted more widely. One possible answer may be the low cost of petroleum products. However, because petroleum is a limited resource, even oil-rich nations like Iran see their energy future in sustainable power sources. The other explanation might be the difficulty of convincing utility companies to relinquish their hold on non-renewable energy and opt for a greener energy source that requires a large initial capital investment. One way to address this issue is for governments to offer subsidies, concessions and rewards to utility companies and to consumers. Private consumers constitute a large sector of the energy market and are therefore the ideal target for sustainable power sources. This area has its own difficulties, and potential consumers must have a sound understanding of market requirements and the

implications of solar energy for household use. Bashiri and Alizadeh (2018) offer some insights into this market with an emphasis on families as the primary clients for photovoltaic systems.

As of now, customers are quite possibly the main concern for utility organizations and suppliers of PV systems. The prosperity of businesses is linked to appropriate marketing. It is essential to know the target market and suitable messages to implement appropriate marketing strategies. Forecasting the response and behaviour of customers helps organizations to design effective marketing strategies. Understanding household power utilization can be considered an appealing objective market for photovoltaic systems. However, the initial investment in solar energy systems can be very expensive for families and impede any future adoption. Because of the advantages of these systems and the fact that they help provide energy without requiring large public capital investments, governments have offered monetary incentives to encourage the adoption of solar power by households. These strategies include financial assistance that could decrease the initial expense, feed-in tariffs which permit the home owner to generate income, low-premium loans, and tax breaks. As a rule, the target clients of solar energy systems are families who are receptive to this innovation or are likely to buy and utilize these systems (Bashiri and Alizadeh, 2018). To recognize likely clients and adoption factors, the examination carried out by Bashiri and Alizadeh (2018) utilized segmentation and psychological factors.

Generally, low energy costs and high initial investment in PV hardware do not encourage the adoption of solar power. Although it is important to advise individuals about sustainable power developments, little has been done to promote PVs in oil-rich countries such as Iran. In addition, air pollution and the urban lifestyle of people in Tehran have raised numerous concerns which can be reduced by the deployment of solar energy. To deal with these issues, the government has

offered monetary incentives to encourage the use of sustainable innovations in Iran, motivating early adopters (Bashiri and Alizadeh, 2018).

The study conducted by Shah Rukh Shakeel and Arto Rajala (2020) found several determinants of solar PV adoption. They are “demographic, personal, social, technical, economic and external factors” (Shakeel and Rajala 2020). The demographic factors relate to “age, gender, education, occupation, income, marital status, house size, house type, number of residents, ownership status and condition of building”. Individuals’ awareness of and concern about the natural environment comprise some of personal factors as do the “level of motivation, expectations, perceived benefits, knowledge about the technology, willingness to adopt, intentions and perceived behavioural control” (Shakeel and Rajala 2020).

Several social factors can impact the decision to adopt PVs. Individuals may have neighbours who have installed PVs, and this influence is strengthened by the “visibility and observability of the technology” (Shakeel and Rajala 2020). The technical aspects of the technology may also influence the decision to adopt PVs, particularly given the complexity of the system. Some individuals want to be clear about the way it works, whether it is simple to use, its compatibility with an existing system, and its advantages and associated risks. Moreover, they want to know about after-sales service and maintenance costs. Unsurprisingly, economic considerations constitute the most important factor that influences the decision to adopt PV technology. People take into account the up-front cost and high overall expense, financing options, the long-term return on investment and the reduction in energy bills, when considering adoption. The external factors include the market price of energy, subsidies, council regulations related to rooftop installations, and the incentives encouraging the adoption of solar energy (Shakeel and Rajala 2020).

Globally, the change to a low-outflow energy future is well under way and users, including households, are becoming a critical part of this transformation. People are investing in clean energy by installing rooftop PVs and playing a more dynamic role in power generation. The term used to depict this kind of client is "prosumer", that is, one who both produces and consumes power. Despite the importance of households becoming prosumers, the existing research has not specifically looked at the marketing aspects of promoting the uptake of rooftop solar (Paragon Media Pty Ltd, 2021).

Before examining existing research on the adoption of rooftop solar in Australia, the section to follow focusses on models which help understand the diffusion of new technology. It also links this to progress made in the area of behaviour marketing. These two aspects form the conceptual framework for the current study.

2.3 Technology adoption theories and behaviour marketing

There are many theories and models that have been developed to explain the adoption of new technology. Following Rogers' seminal work on diffusion of innovation in the 1960s (Rogers, 2003), many particular technological fields have used this theory – from consumer goods to agriculture, pharmaceuticals and information technology (IT). More recently, the spread of residential solar PVs has also been analysed from the perspective of diffusion of innovation (e.g. Alipour et al., 2021). The diffusion of innovation theory clusters adopters into five groups assuming a normal distribution, namely innovators (the first 2.5% of the adopting population), early adopters (the following 13.5%), early majority (the next 34%), late majority (the sedsequent 34%) and laggards (the remaining 16%). Its focus is mainly descriptive with statistical models used to represent the processing occurring within social and industrial environment without analysing the factors that trigger or influence the adoption processes.

Consequently, other theories and models have emerged – some extension of others, to explain why people make decisions and adopt new technologies. They are summarised well by Taherdoost (2018) and Figure 2.1 shows the theories that help explain different aspects of the adoption of rooftop solar PVs by households. These theories are often complementary and view the process not only statistically, but also from a sociological, psychological and marketing perspective. The Technological Acceptance Model (TAM) forms the basis of the conceptual framework for this study as it aims to understand the motivation behind an actual adoption. As all theories shed light on adoption from a different perspective, they are briefly explained below followed by an overview of the importance of behaviour marketing which has the potential to influence the components of TAM.

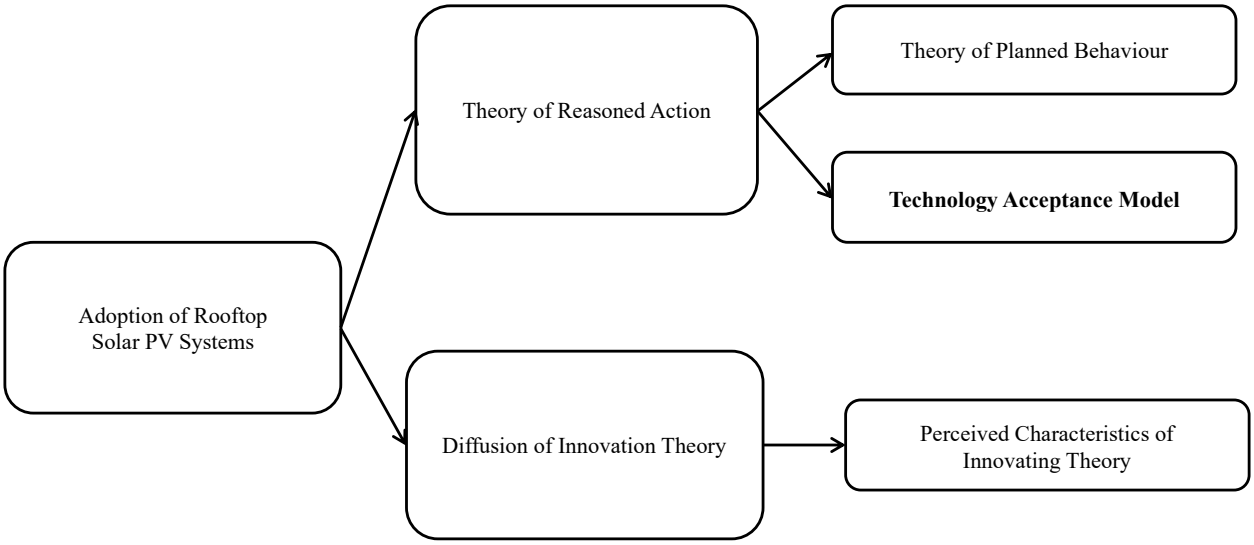

Figure 2.1 Theories Related to the Adoption of Rooftop Solar PV Systems (adapted from Taherdoost, 2018)

The two groups of theories presented in Figure 2.1 examine different settings of the adoption process with the bottom concepts analysing the social and industry environment while the top focusses on individual decision making. In many cases, it may be difficult to strictly theoretically separate or disentangle the particular factors influencing a household's decision and

therefore this study provides empirical evidence based on a survey conducted in Western Australia. It is the first such investigation in this particular geographical setting.

- Diffusion of Innovations Theory – this theory introduces four factors – time, communication channels, characteristics of the innovation and social system, which shape the spread of a new technology. Consequently, people and businesses respond differently with some, namely the innovators and early adopters, being fast in making the decision to adopt, while others (early majority, late majority and laggards) taking longer to join the trend. They all go through decision steps from intention to implementation, using communication channels among members of a similar social system over a period of time;
- Perceived Characteristics of Innovating Theory – being an extension of the diffusion of innovation theory, this model identifies three additional features, namely image, voluntariness and behaviour (Agarwal and Prasad, 1997; Taherdoost, 2018). It emphasises that the adoption decision is taken voluntarily but image and observable behaviour have important influence.
- Theory of Reasoned Action – initially developed by Fishbein and Azjen (1975) for sociological and psychological studies, this theory has been used for research in many other areas, including information technology (Taherdoost, 2018). It focusses on human behaviour described through cognitive mechanisms, namely attitudes – favourable or unfavourable, social norms – supportive or unhelpful, and intentions – based on individual decisions to do something or not to do it. The theory assumes that a particular human behaviour is optional, but individuals are well-organised and act coherently.

- Theory of Planned Behaviour – perceived behavioural control is a new variable added to extend the theory of reasoned action. This behavioural control may be related to the accessibility to resources, availability of expertise, attitude or perceived importance and may reflects subjective and social norms. The theory has been applied in health-related behaviour (e.g. Albarracin et al., 2001) as well to decisions related to the natural environment (Koger and Winter, 2010).
- Technology Acceptance Model (TAM) – this model derived from the Theory of Reasoned Action, describes three factors for motivating customers to adopt a new technology including "perceived usefulness, perceived ease of use, and attitude toward use" (Taherdoost, 2018, 962). Despite some limitations related to internal motivation and social impact on the decision to adopt, this model is considered one of the most widely used in the field of technology acceptance (Wu, 2009). It is similarly used in this study to discov and gather evidence behind households' decisions to adopt solar PVs. According to Wu (2009), TAM allows for the holistic nature of the relationship between motivation and behaviour in technology acceptance to be revealed.

In addition to the technology adoption theories that impact decisions at a personal/household level, it is also important to understand how marketing can influence behaviour. Behavioural marketing is a tool to activate purchasing activities. It brings together marketing and behavioural science to encourage certain desired actions by consumers. In addition to pursuing narrow commercial interests, behaviour marketing can be, for example, with the aim to encourage more sustainable consumption (White et al., 2019) or to achieve other broader societal benefits (French and Gordon, 2019).

When information about current technology adopters is available, this allows to build a more realistic profile of potential users and tailor marketing messages better. In addition to market segmentation, e.g. based on income or age, behavioural segmentation can also be used to emphasise particular values. According to Chou et al. (2020), a marketing mix towards environmentally better products can stimulate attitudes and decisions which encourage green consumerism. A better understanding of current adopters of rooftop solar PV systems can provide insights as to what such a marketing mix should be and also how to segment the market to achieve the most impact.

2.4 Adoption of PVs in Australia

The ascent of the prosumer is especially noticeable in Australia where there is abundant daylight and housetop solar panels have been accepted. Over 30% of Australian families have installed PVs as of 2021, and this percentage is higher in some particular areas of the country. For instance, around 40% of households in Queensland and South Australia have rooftop PVs (Paragon Media Pty Ltd, 2021).

Australia's household level PV adoption is among the highest in the world: more than 20% of Australian houses had adopted PVs back in 2018 (OECD 2016; Australian PV Institute 2018). These adoptions are counted for 68% of the overall capacity (Australian PV Institute 2018). Across Australia, more than 2.5 million housetop PVs have been installed, making the country a worldwide pioneer in terms of the number of systems per family, compared with 1.8 million rooftop PVs in Germany and 2 million in the US (1 million of which are in California). Per capita, Germany and the US have significantly fewer PV systems than Australia (Paragon Media Pty Ltd, 2021).

Households have been persuaded to adopt PVs primarily because they can reduce their power bills and receive payment for any excess power that they generate, although concern for the environment is a factor for some. In the future, consumers will be increasingly concerned about energy generation and will look to solar power, batteries and electric vehicles that are more sustainable than the current options. It is predicted that solar PVs capacity will double over the course of the following 20 years in Australia, from generating10GW in 2020 to 20GW in 2040 (Paragon Media Pty Ltd, 2021). This would consolidate Australia's position as the worldwide leader of decentralized power. Despite these optimistic predictions, the adoption of rooftop solar in Western Australia lags behind the other Australian states and it seems that there is need for a concerted effort, including through marketing, to speed up the diffusion of this technology.

Australia became acquainted with the first PVs in 1990, but this technology became more mainstream from 2009. Various factors have led to the quick reception of PVs in Australia including: increases in electricity prices, decreased cost of solar PVs, widespread acknowledgement and acceptance, the improvement of numerous PV grids, and government strategies which encourage the adoption of PVs (Outhred and Retnanestri, 2015). According to Outhred and Retnanestri (2015), “Australian policy measures at Federal and State levels that supported distributed grid-connected PV systems in 2013 included feed-in tariffs (FiTs), green electricity schemes, renewable portfolio standards, investment funds, net metering, green mortgages, sustainable building requirements and utility programs.” Some of these strategies have been more compelling and have prompted the quick advancement of dispersed frameworks, including rooftop solar PV systems. The PV-associated incentives which facilitated the process of adoption include feed-in tariffs determined by the respective Australian state and territory governments and the Renewable Energy Target (RET) set by the Federal Government.

According to Outhred and Retnanestri (2015), in Australia's capital city Canberra, "the Federal Government's Solar Flagship program supported the 102 MW and 53 MW PV systems and the Large-Scale Solar Auction run by the Australian Capital Territory (ACT) awarded 20-year FiTs to the 20 MW, 13 MW and 10 MW PV systems." However, these systems are larger than the rooftop installations for households.

State and territory governments declared FiTs for PV frameworks associated with the main power grids between 2008 and 2010, with a few plans proposing up to 60 c/kWh for all energy generated. Because of the take-up being far more popular than governments expected, these plans have now been either terminated or extensively decreased to an incentive as low as 8 c/kWh (Outhred and Retnanestri, 2015). In certain states, FiTs are now discretionary and dependent on power retailers or power utilities, and some adoption network organizations currently limit the installation of smaller PV frameworks because of over-voltage limitations. This is not the case in Western Australia where the State-owned power utility allows household systems to be linked to the main electricity grid. The Australian Government's RET comprises two sections – the Large-scale Renewable Energy Target (LRET) and Small-scale Renewable Energy Scheme (SRES). Wind farms have been the best innovation under the LRET, while solar PV systems and solar water heating units have been the best developments under the SRES. The SRES gives an in-advance capital appropriation to grid-associated PV frameworks of 100 kW or less by means of a game plan that involves the buyer (Outhred and Retnanestri, 2015). At first, the arrangement designated multiple times the quantity of considered endorsements for the main 1.5 kW limit. Notwithstanding, the solar credit multiplier was subsequently decreased and finally terminated at the end of 2012. In February 2014, a Board was appointed by the Federal Government to audit the RET. It makes reference to closing the LRET to new members or

diminishing its objective, and either promptly shutting or quickly eliminating the SRES and, in the latter case, reducing the greatest qualified rating for the SRES to 10 kW. There is solid political resistance to these measures as the future part of network-associated PVs has become socially challenged. The SRES and the FiTs were drivers of the rapid take-up of PV frameworks and, furthermore, a tendency to adopt larger systems pursuing economies of scale. Currently, the normal PV framework size has reached about 4.5 kW. However, future patterns are unclear because of changes or the termination of the FiTs, uncertainty about the fate of the SRES, and progressive limitations on network association. Paradoxically, there seems to be developing revenue in the utilization of PV systems for the principal power supply frameworks to replace diesel and other fossil fuel for private, local area and mine site energy supplies. However, any "off-network" share will be more modest than the grid-associated primary market (Outhred and Retnanestri, 2015).

The adequacy of rooftop solar panels in lessening the pressure on demand during summer months is limited, mostly because of misalignment of the circumstances of sun-based PV yield and peak network interest. An interesting case was the Smart Grid, Smart City initiative (http://www.smartgridsmartcity.com.au) which *"*was a $100 million Australian government-funded project, conducted by a consortium led by Ausgrid (the largest NSW electricity distributor, formerly called EnergyAustralia) between 2010 and 2014 that involved approximately 30,000 households and tested a range of smart grid technologies, interval metering and advanced tariffs as well as distributed resources including PV systems and batteries. It gathered information about the benefits and costs of implementing these technologies in an Australian setting" (Outhred and Retnanestri, 2015). This consortium suggested the introduction of season/time period of utilization or dynamic private taxes and net FiTs to prevent

families from installing oversized PV systems and to position them towards the west to improve late-evening generation (Outhred and Retnanestri, 2015).

The analysis by Outhred and Retnanestri (2015) recommended more focus on regions where the rooftop PV penetration is high or should be high; furthermore, attention should be paid to the impacts that energy generation at the neighbourhood level might have on the main grid. This is predominantly because of the distinction in planning between rooftop solar systems and peak periods of demand, especially in locations with higher late-evening demand where most of the photovoltaic systems have been introduced. With the increased take-up of this technology, fundamentally determined by household acceptance, network suppliers need to be prepared to adjust to anticipated greater demand.

Currently in Australia, there is increasing interest in adding energy storage to grid-associated PV frameworks, utilizing lithium-particle batteries. This is stimulating further changes in the regulations and guidelines to improve energy plans and monitor the likelihood of risks. The primary goal of adding energy storage to PV framework generation is to align it with household load, which generally is the highest during early or late evening. However, adding energy storage increases the cost, complexity, space requirements and fire risks (Outhred and Retnanestri, 2015). Hence, battery storage is emerging as a possible option for households in Australia, although with very limited uptake. Currently the high cost of these batteries is preventing better uptake which is considered a barrier for adoption (Solar Choice Pty Ltd, 2021).

To decrease the risk associated with the installation of low-quality PV systems, Australia's Clean Energy Council (CEC) oversees the accreditation and work of the installers of independent and grid-related frameworks, including grid-associated battery storage (Clean Energy Council, 2018). The CEC has established a set of principles for solar PV retailers and keeps a list of

approved PV modules and inverters that satisfy the Australian Guidelines for solar panels. Only PV frameworks that use approved components and are supplied by certified installers qualify for small-scale technology certificates (STCs) under the SRES. These measures, however, have not been adequate to ensure that there would be no issues with particular PV framework implementation (Outhred and Retnanestri, 2015). Hence, Australian households need to be aware and vigilant regarding the reputation of businesses installing rooftop solar systems, and should carefully examine the system's warranty period, its elements and the installation process.

A 2010 analysis of solar systems carried out in Newington, New South Wales found that around 21% of the PV frameworks were non-operational with most (around 92 %) being due to inverter failure (Outhred and Retnanestri, 2015). Despite this, many suppliers continued to install inferior products. There were several factors contributing to this situation, one of which concernsthe responsibility for rooftop solar related to whether the house is owner-occupied or rented. With the average length of house ownership in Australia being about 9 years, the situation becomes even more complex when a property with rooftop solar is being sold. It is difficult for the solar PV system to attract higher price because of uncertainties about the FiTs given that, for example, a 5% per year drop in the FiT was observed in Queensland between 2010 and 2013 (Outhred and Retnanestri, 2015).

With the adoption of solar systems continuing to increase in Australia, it is likely that the energy utilities will reduce the FiTs which in turn may affect households' decisions to adopt this technology. Whether rooftop solar will add value to a property is difficult to predict. A study by Ma, Polyakov and Pandit (2015) shows that owners who expect to sell their properties relatively soon are reluctant to install PV frameworks. On the other hand, their analysis indicates a 2.3–3.2 % property value premium related to the presence of rooftop solar which shows that owners

would recover their investment when a house is sold. Policymakers can utilize this data to encourage the adoption of PVs by households (Ma, Polyakov and Pandit, 2015).

Although solar PVs are not the most proficient or economic means of producing power, they provide "ecological advantages, energy security, innovation overflow, scale economy and formation of green positions" (Ma, Polyakov and Pandit, 2015). Australia has an abundance of sunlight, giving it a great potential in the generation of solar energy. In 2012, the country became the seventh PV market globally and by 2019 the total number of rooftop systems on homes and businesses was 2.3 million with 269,000 systems added in 2019 alone (Australian Energy Council, 2021). At the same time, the possibility for increases in the retail electricity prices and the drop in the cost of PV systems have stimulated interest in rooftop solar. The public power authorities have also put incentives in place encouraging individuals to embrace PVs, such as the Photovoltaic Rebate Program (PVRP), the Solar Homes and Communities Plan (SHCP) and the Solar Credit (SC) programs and State-run FiTs (Ma, Polyakov and Pandit, 2015). In another study conducted in Australia, Best, Burke and Nishitateno (2019) explored the factors encouraging the household adoption of PVs. It was found that wealth has a positive effect on adoption. Also, it was found that owners of larger homes are more willing to adopt PVs. People who live in apartments or renters tend to adopt less, and older houses have fewer solar panels installed. People with higher incomes had more intention to install rooftop PVs. Not surprisingly, the study found that limited finances is a very common obstacle to the adoption of PVs.

In 2020, the COVID-19 pandemic affected Australia’s economy and individual households. Notwithstanding this, by September 2020, more PVs had been installed than for the first nine months compared to previous years, almost eclipsing the number installed for the entire 2019, and showing a record growth for almost all Australian states. Prior to the outbreak of the

COVID-19 pandemic, the Australian PV market was already experiencing a yearly increase of 40%. Evidently, the pandemic did not impede the rapid growth of the Australian PV industry. With a few exceptions due to periodic outbreaks of COVID-19 in some states or regions, the rate of adoption of solar Australia-wide increased at approximately the same rate as in the previous few years (End of Year Forecast for the Australian PV Solar Market, 2020; Sunwiz - Solar Energy Consultants, 2021). Households remained the biggest players in the adoption of solar PVs.

The COVID pandemic accelerated small-scale technology certificate (STC) creation, encouraging solar uptake. In the summer of 2019-2020, Australia also experienced extensive bushfires in several states. This raised interest in self-sufficiency and the need to safeguard the environment. Although COVID-19 slowed down the adoption of solar in May 2020, it resumed rapidly with people working from home and wanting to be self-sufficient in terms of producing their own electricity and growing their own food. There have been speculations that the increase in the sales of solar PVs was due to people working more hours from home, an employment trend expected to persist (End of Year Forecast for the Australian PV Solar Market, 2020; Sunwiz - Solar Energy Consultants, 2021).

However, there are factors that cannot be controlled by individuals or businesses. Since COVID-19 has had a drastic effect on many supply chains, it has limited the quantities and types of necessary components being imported in Australia. Local restrictions imposed to contain the spread of the virus impact installation in some regions at different times (End of Year Forecast for the Australian PV Solar Market, 2020; Sunwiz - Solar Energy Consultants, 2021). During the various lockdowns, people spent less on dining out, but the electricity consumed during their enforced time at home increased their electricity bills. Hence, it is expected that the adoption of

solar will continue to increase. Due to the pandemic and changes in employment patterns, more people are spending time working from home and this will inevitably increase their energy bills which will make people see solar panels as being 'recession-proof' and giving them more financial security. Furthermore, federal and state governments are planning strategies that will include monetary incentives for rooftop solar (End of Year Forecast for the Australian PV Solar Market, 2020; Sunwiz - Solar Energy Consultants, 2021).

Even with strong public interest and government support for utilizing Australia's natural asset – an abundance of sunshine – there is still little data to show why individuals decide to embrace PV technology, particularly in a state like Western Australia. The COVID-19 pandemic did not impact Western Australia to the extent it did in the other states. It is safe to assume that people's attitudes towards rooftop solar PVs have not changed that drastically. What are the main factors that encourage people to install rooftop solar systems in western Australia? Is it the cost, decrease in electricity bills or concerns about the natural environment? What are the obstacles? Are wealth and cost the main factors? For example, current literature suggests that the cost of a house indicates the wealth of a household and solar installations are more common on more expensive properties (Best, Burke and Nishitateno, 2019). What is driving adoption in Western Australia?

2.5 Adoption of PVs in Western Australia

As of December 31, 2020, Western Australia had 366,187 rooftop home solar PV systems with a collective capacity of 1.62 GW (Peacock Media Group, 2021). It is estimated that 28.8% of the Western Australian households have solar PVs with projections that this will increase to a total capacity of 2.6 GW by 2030 (Ho, 2020). An array of factors has contributed to this adoption but

to the best of the researcher's knowledge, to date no study has investigated the factors that have influenced Western Australians the most.

The state of Western Australia is vast, offering a lot of potential for the use of solar PVs not only by households in the large metropolitan area of the city of Perth but also in business districts and in remote and rural areas. For example, the large rooftop areas of commercial buildings could be used to generate a considerable amount of power. Commercial solar operations already exist in Greenough (50km south-east of Geraldton), around Carnarvon and Kalbarri. Solar-powered structures, supplemented by battery storage and wind power are appropriate for remote areas, including mining camps, remote stations, Aboriginal communities and tourist destinations. In 2012, the Australian Energy Resources Assessment Report (2012) arranged by the Geoscience Australia and the Economics Branch of the Department of the Environment and Energy predicted that solar PV would be unequivocally the least expensive type of new-form power generation by 2030. This was an underestimate, with the price of solar PV currently representing one of the cheapest energy options for Australia – $78/MWh compared to $134/MWh for coal and $74–90/MWh for gas (The Climate Council, 2018).

While the rest of Western Australia is slowly moving towards solar-based energy supplies, the State's households have made a significant progress. They are also contributing towards the State's net zero policy by 2050 (Government of Western Australia, 2020). This policy aims to further increase the uptake of rooftop solar to reach at least one in two households in the next ten years. At least one more investment will be needed to contribute to the State's net zero policy by 2050 because the lifetime of PV panels, due to the aging of PV cells, is from 10 to 30 years with serious degradation of efficiency after 10 years. The return of investment depends on metering policies, which are often influenced by politics, and varies between 5, 7 to 10 years.

Understanding what drives adoption decisions can facilitate this transition to net zero. It can also help inform similar changes in other parts of the world. The West Australian Wholesale Energy Market (WEM) will undergo major changes with the State Government's Energy Transformation Taskforce unveiling plans for a strategy aimed at fully integrating renewable energy – from all sources – into the power system. This Taskforce has proposed plans to maximise the benefits derived from renewable energy and improve the security and reliability of Western Australia's power system and the operation of the WEM (Carroll, 2021). How are Western Australians responding to these policies and what drives the adoption of rooftop solar?

2.6 Factors influencing adoption of new technologies

The factors that influence people to adopt new technologies vary from psychological and economic to demographic with political, social and market forces also impacting on households' decisions. Countless strategies and hypotheses have been proposed regarding the likelihood of people opting for sustainable power sources, including solar PVs. Bergek and Mignon (2017) concluded that despite numerous factors that can influence choices, adoption motivation could be unique for potential sustainable power adopters.

Other studies, however, have found particular patterns despite most of the knowledge being fragmented. For example, Sommerfeld et al. (2017) concluded that home ownership, being more than fifty-five years old, living in homes with multiple rooms and the type of home were the simplest factors explaining the likelihood of PV adoption in Australia. In the case of Greece, Sardianou et al. (2013) used a binary probit regression model and concluded that middle-aged and highly educated people are probably more willing to adopt renewable energy while gender

and marital status did not play a role. From a financial perspective, tax deduction was the best option which worked better than energy subsidy (Sardianou and Genoudi, 2013).

Ecological concerns can also be a major factor. However, a study by Fleiß et al. (2017) found that the main motivation for choosing solar energy in Australia was the financial benefit, rather than concern for the natural environment. Another study used a decision model to determine inclinations for changes in motivators and to anticipate purchaser decisions for embracing solar panels under future arrangements based only on financial incentives (Zander et al., 2019). Factors in the model included degree of power utilization, rising power costs, diminishing expenses for higher capacity solar frameworks, pay-off periods with and without government subsidies. The results showed that 66% of the respondents would install a photovoltaic framework while 22% would not do so by any means (Zander et al., 2019). There were three groups among the potential adopters, namely: those who have already used solar PVs and exploited the FiT conditions; those who wanted monetary incentives (33%) and those, mainly younger people, who were not motivated by government subsidies but by the economic benefits from the systems' pay-off according to their electricity consumption, rising electricity prices and the decreasing cost of storage systems (Zander et al., 2019). The findings that not all households are expected to eventually adopt rooftop solar do not support the mainstream innovation diffusion theory (e.g. Rogers, 2003) which assumes that eventually everybody will become an adopter. Factors such as lived experiences, energy alternatives and individual characteristics may result in a larger section of the population not switching to rooftop solar. Although these results pertained to Australia, they may also apply to other high-GDP countries and specific Australian states.

As PV systems have already penetrated the broad household market in many countries, such as Australia, information about their performance can influence future uptake. The absence of adequate information can prevent or slow down the adoption of any innovation, and its potential can be easily disregarded. During the early stages of rooftop solar adoption, Rundle et al. (2008) found that the lack of adequate information about sustainable power sources was one of the obstacles preventing their diffusion and their improvement. It was asserted that the cost of photovoltaic systems was not the sole barrier to their deployment; inadequate information about costs, ecological issues and benefits of these frameworks led to non-financial expenses for clients. It was found that the absence of adequate information about expenses and technological advancements explained the lack of enthusiasm for purchasing solar PV systems (Rundle et al. 2008). Simpson and Clifton (2017) found that most PV adopters in Australia have considered solar energy for its monetary advantages, although they wanted more detailed information about its advantages and operation. It seems that financial incentives for promoting solar PVs adoption are more beneficial for more deprived groups of society (Simpson and Clifton, 2017).

In spite of the fact that innovation enthusiasts and those who are concerned about the environment are willing to adopt solar energy, the absence of monetary incentives and specialized support prevents them from adopting this technology (Simpson and Clifton, 2017). Numerous studies have examined the factors that deter the adoption of solar energy. Qureshi et al. (2017) found that households choose solar PVs so as not to suffer from power shortages in Pakistan. However, the cost of solar and the lack of government incentives were significant barriers, while concern for the environment was a big driver.

The increase in the number of households adopting solar energy will help to minimise carbon emissions and other harmful pollutants. However, household adoption of solar power can go

through periods of slowed growth. The study conducted in US by Wolske, Stern and Dietz (2017) proposes a hypothetical structure for exploring the psychological and social determinants of household interest in solar energy. It draws on three theories to try to explain people's desire to adopt this technology, namely diffusion of innovations, theory of planned behaviour and value-belief-norm theory. The researchers analysed information from 904 non-adopter home owners. By and large, the study found that households perceived photovoltaics in multiple ways, namely for their environmental advantages, as a consumer benefit and as a progressive technology. The authors conclude that an integrated approach should take into consideration people's personal characteristics and inclinations, since those who see direct consumer benefits are more likely to approach installation companies (Wolske, Stern and Dietz, 2017). In this regard, the researchers offered appropriate suggestions to policymakers and advertisers (Wolske, Stern and Dietz, 2017). For examples, using appropriate strategies, advertisers could focus on purchasers who are early adopters or on individuals who feel ethically committed to contributing to environmental change.

Furthermore, the findings suggest that potential adopters need affirmation – from reliable sources – of the advantages of rooftop solar PVs for the individual. This is reflected in the social interest in conversing with an installer and trust in the business. Important sources might be neighbours with solar PVs, or they may be external, such as government departments or not-for-profit associations. Boosting the adoption of rooftop solar is important, but so is having systems that are easy to use and not too complex (Wolske, Stern and Dietz, 2017).

Finally, consistent with past research, the outcomes show the benefit of utilizing existing informal communities to promote rooftop solar. Seeing solar panels on others' homes, obtaining advice from others and being interested in friends' PV systems, were all critical indicators of

interest in conversing with an installer (Wolske, Stern and Dietz, 2017). Some installers, for instance, have worked with existing clients to organise meetings with friends and neighbours at the client's home to find information about new systems and to hear from satisfied clients in the area. In some neighborhoods, group buying and “solarize campaigns”, where homeowners obtain cheaper solar panels by purchasing together with others locally, can be an effective way of diffusing this technology (Wolske, Stern and Dietz, 2017).

Shifting the generation of energy from petroleum derivatives to sustainable sources can help to decrease emissions that pollute the atmosphere and deplete the ozone layer, thereby safeguarding the environment. The governments of numerous nations, including Australia, have offered generous monetary incentives to encourage families to accept roof photovoltaic solar panels which provide a sustainable source of energy.

As this review of literature indicates, there is a long list of factors that can sway households to adopt, or not to, rooftop solar PVs. To the best of this researcher’s knowledge, no study to date has examined the factors influencing the adoption of photovoltaics by households in Western Australia; hence the choice of this particular research topic for this MPhil thesis. Understanding the specifics of a particular geographic setting is important to promote a transition to renewable energy and respond to Western Australia’s climate change strategies.

Chapter 3. Methodology

This chapter outlines the research methodology adopted in the study and then describes the sample used to collect primary data about Western Australian households. Some limitations of the study are also presented.

3.1 Research question and aims

The main research question for this study is:

> What are the main factors that influence decisions regarding the adoption of solar PV panels by Western Australian households and what are appropriate marketing strategies to increase the penetration of rooftop solar PV in Western Australia?

This research question is subdivided into two parts as follows:

RQ1- What are the main factors that influence the decision regarding the adoption of solar PV panels by residential consumers in Western Australia?

RQ2- How can the penetrating ratio of solar PV panels be increased through the implementation of appropriate marketing strategies?

Although the adoption of solar PVs in Western Australia has been rapid and widespread (Brighter Energy Future, 2020), there is limited understanding of the factors that have encouraged households to embrace this new technology at an unprecedented rate. The primary aims of this Master of Philosophy study are:

• To collect empirical evidence about the factors influencing households' decisions to adopt rooftop solar PV panels in Western Australia;

• To identify the factors that have the highest impact on such decisions in order to inform appropriate marketing strategies that could help to increase the penetration ratio of solar PV panels.

Although the findings from the research are based on Western Australian evidence, they have the potential to be applied to other settings. Importantly, a snapshot of Western Australia in 2019 will indicate the drivers of decisions to adopt solar energy technology, which in turn could accelerate this adoption in a political environment that encourages net zero emissions in response to the challenges of climate change.

3.2 Methodological approach

The methodology that was applied in Zhang et al. (2012) is adopted for this study which is, also, exploratory. It is based on the mixed-methods research approach (Shorten and Smith, 2017) and includes both quantitative and qualitative methods for the collection, analysis and interpretation of the data. The methodology uses both primary and secondary sources for the data collection, and comprises a literature review, questionnaire survey, and structured face-to-face interviews with members of households who have adopted photovoltaic systems.

The research plan comprised three stages. First, a literature review was conducted to identify the common incentives and motives driving the adoption of PVs by households in different countries and other states of Australia, as well as the obstacles that impede adoption. The literature review presented in Chapter 2 was based entirely on secondary sources such as journal articles, published reports, and information available online. It helped identify what is already known about the adoption of household solar PVs and any existing knowledge gaps (Creswell, 2009). The literature review indicated that, in this regard, little is known about the behaviour of Western Australian households. Many of the previous studies were valuable in providing

background information, but differences in climate, climate policies, and social and cultural dissimilarities made it necessary to investigate the Western Australian case.

In the second stage, a survey questionnaire was designed to capture respondents' views and ideas regarding the motivations and the barriers influencing the uptake of solar PVs by households in Western Australia. Based on the literature review, which identified the Technology Acceptance Model (TAM) as most relevant to the study, an initial list was compiled of the motivators and barriers, and was verified by several experts who were consulted about the structure of the survey. This helped inform the design of the survey for the collection of empirical primary data. Hence, the questionnaire contained questions designed to discern the importance of any barriers and motivators involved. Finally, a representative sample of adopters and non-adopters of PVs in the residential sector of Western Australia were asked to rank the motivators and barriers according to their correlation with the construct "Adoption of PVs" by using statistical tools, such as Qualtrics data analysis tools.

Permission to carry out the study was obtained from Curtin University's Human Research Ethics Committee. Only adults, that is people older than 18, participated in the survey. The survey was conducted by phone and online in early 2019.

3.3 Survey description

For the survey, 110 Western Australian residents were randomly selected, representing the broader population at a 95% confidence level and a confidence interval of 9. Every household had an equal chance of being selected for the sample. Residents in remote areas were not involved as there is no grid in these regions and the situation is quite different. To ensure the reliability of results, an adequate number of survey participants was recruited. Although better statistical representation could have been achieved with a larger survey sample, the nature of the

study is exploratory and therefore did not depend entirely on the quantitative evidence. The aim of the study was to achieve understanding based on both the quantitative survey data and the qualitative insights derived from the interviews. This is also in line with the positive and normative approaches in economics (Young, 1997), the combination of which should be used in decision-making, including the development of marketing strategies.

All respondents answered the 27 items in the questionnaire (see Appendix A). The questions were designed to assess and rank the factors that lead to the adoption of PVs in Western Australia (WA), and were based on the outcomes from the literature review and insights from interviews with adopters. They were chosen from the validated questionnaires and surveys that exist in the literature and therefore it was not necessary to conduct a reliability measure and report (Cronbach's alpha). Table 3.1 lists the sources from where the validated survey questions were chosen.

The questions were grouped as representing financial, environmental and social factors potentially influencing the adoption of rooftop solar panels. They helped answer the two parts of the main research question. In the structure of the questionnaire, the first three questions were for the purpose of screening, the following six questions collected basic demographic information, related to income, education, household size, type of dwelling, ownership and residential suburb, and the remaining items were multiple choice questions requiring respondents to tick one of the options. The key constructs, related questionnaire items and the research question addressed are shown in Table 3.2.

Table 3.1 Sources with Validated Questions Related to Renewable Energy

Owner/Source	Website address
QuestionPro	https://www.questionpro.com/survey-templates/solar-energy-power-survey-questions-template/
Scribd	https://www.scribd.com/document/168532102/Questionnaire-Renewable-Energy
OPALCO	https://www.opalco.com/wp-content/uploads/2017/08/2017-Community-Solar-Survey-Questions.pdf
3rd International Conference on Renewable Energy Research and Applications	https://www.researchgate.net/publication/281943473_A_survey_on_public_awareness_towards_renewable_energy_in_Turkey
FreeOnlineSurveys	https://freeonlinesurveys.com/s/Wixv2RMd#/0
Laboratory for Energy and the Environment, Massachusetts Institute of Technology (MIT)	https://sequestration.mit.edu/pdf/LFEE_2005-001_WP.pdf
Hart Research Associates	https://cdn.americanprogress.org/wp-content/uploads/2015/01/FI11457-CAP-Energy-Environment-Survey.pdf
Mercom Communications India	https://mercomindia.com/wp-content/uploads/2018/01/Survey_MercomIndiaSurveyRenewables.pdf
Prosumers for the Energy Union (PROSEU)	https://zenodo.org/record/3238181#.YZl-hS0Rp0s

Table 3.2 Structure of the Research Questionnaire

Research question	**Key Construct**	**Questionnaire items**
RQ1	Financial	Q10,Q11,Q13,Q14,Q15
RQ1	Environmental	Q16,Q17,Q18
RQ1	Social	Q23,Q24,Q25
RQ2	Marketing	Q26.Q27

3.4 Analysis of results

The answers to each question were analysed statistically and also graphed using Qualtrics' statistic tools. This allowed to see to what extent each of the factors is correlated with the adoption of PVs and also to inform possible marketing strategies as appropriate to be used for increasing the adoption of rooftop solar in WA.

The analytic statistical tools available in Qualtrics were used to analyze the survey data, and were useful for visualizing and graphically summarizing the answers. These results were presented clearly and enabled conclusions to be reached from the data gathered in regard to Western Australia. It was easy to categorise the factors influencing adoption and to see their implications for marketing strategies.

3.5 Limitations of the study

As with any case study, the interview questions and the items in the survey questionnaire were designed specifically for the specific, in this case Western Australian, context. Therefore, the results and conclusions based on the collected data cannot be easily generalized to other states and territories of Australia or other regions without further localizations and adjustments being made according to particular regional parameters.

Another limitation is the time factor. The survey was conducted in 2019 when there was still less awareness about the immediate impacts of climate change on Western Australia. The bushfires, drought and floods which affected vast areas of this state, and Australia as a whole during 2019-2020 and 2021, most likely would have increased people's willingness to do something about climate change. For example, the annual survey *The Climate of the Nation* conducted by the Australia Institute showed a 3% increase in the level of support for renewable energy between 2019 and 2020 (Australia Institute, 2019 and 2020).

Notwithstanding these limitations, it is useful to have information based on participants' first-hand experience of adopting solar power in Western Australian households, and the factors that have persuaded them to install rooftop solar panels. This is the first study to have gathered this important data which can subsequently be used to formulate strategies that will encourage households in Western Australia to meet their energy needs with PV panels.

Chapter 4. Results: Factors Affecting Adoption of PVs in Western Australia

At the start of the study, 25 structured face-to-face interviews were conducted with adopters of residential PV to investigate the main factors that lead to the adoption of rooftop solar systems. This allowed to canvass the main factors that have influenced these households' decision. These adopters were asked validated questions taken from the literature to investigate motivators and barriers for the adoption. The results show a range of factors, including environmental, economic and social considerations.

A survey was then conducted in Western Australia to find the factors influencing the broader adoption of PVs. The survey sample comprised 110 respondents from WA who completed all 27 items in the questionnaire. To the best of our knowledge, no similar survey has been conducted previously in this state. The factors that influence people's decisions are categorized as economic, social, environmental and marketing.

4.1 Sample description

The 2019 survey conducted in WA collected data from 110 participants who have solar PVs installed on their rooftops. In 2016, Australia's latest Population Census reported 1,073,723 dwellings in Western Australia (idcommunity, 2021). The survey sample covered 0.01% of the households in WA and was representative at the 95% confidence level with a 9.34 confidence interval (The Survey System, 2012).

Sixty-six of the respondents (60%) were females (see Figure 4.1). Sixty (54.55%) of the respondents were between 30 and 64 years of age, 35.45 % were less 30 years old, and 10 % were over 64 (see Figure 4.2).

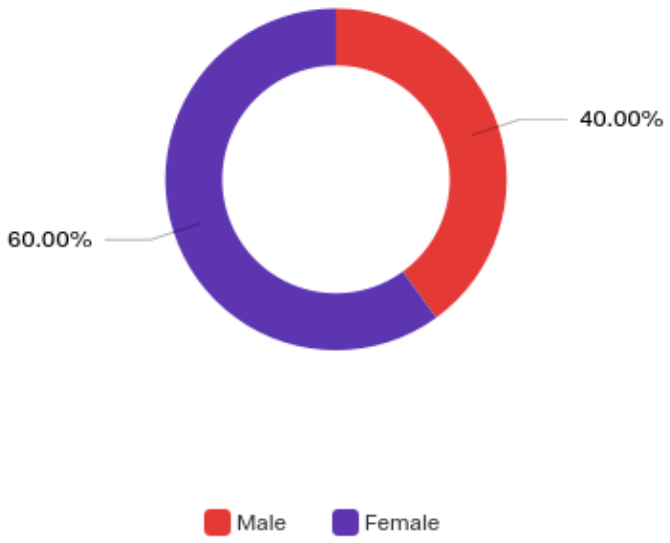

Figure 4.1 Gender Distribution

In terms of education, 45 (40.91%) respondents have secondary education. Only three (2.73%) had not gone beyond primary school, 62 (56.36%) respondents have tertiary qualifications: 26 (23.64%) have a diploma, 22 (20%) have a degree and 14 (12.73%) have a postgraduate degree (see Figure 4.3). The majority of the respondents had a tertiary education, indicating that most of the adopters are relatively well-educated. The largest section of participants (40%) have a gross household income between $38,699 and $744,00, while the remaining 60% are in the higher-income bracket, with 23.64% having a gross income of between $74,400 and $126,500, and 15.45% earning above $126,500. Although the sample was randomly selected, it appears that the main adopters of PV in WA are middle-class people (see Figure 4.4).

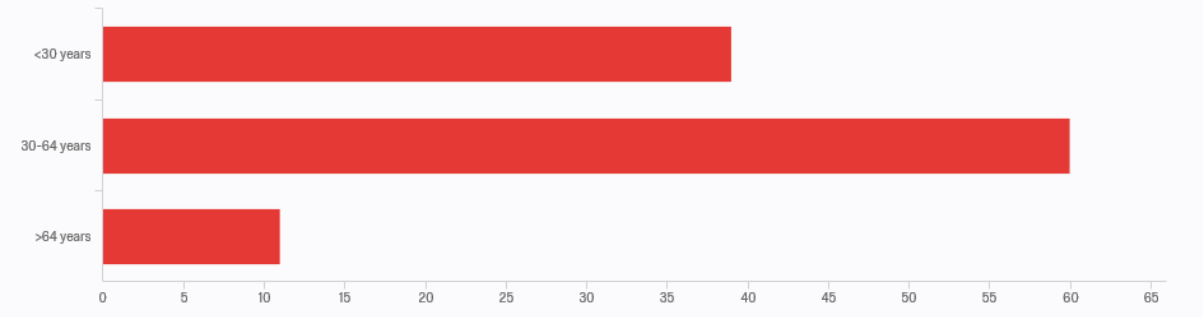

Figure 4.2 Age Distribution

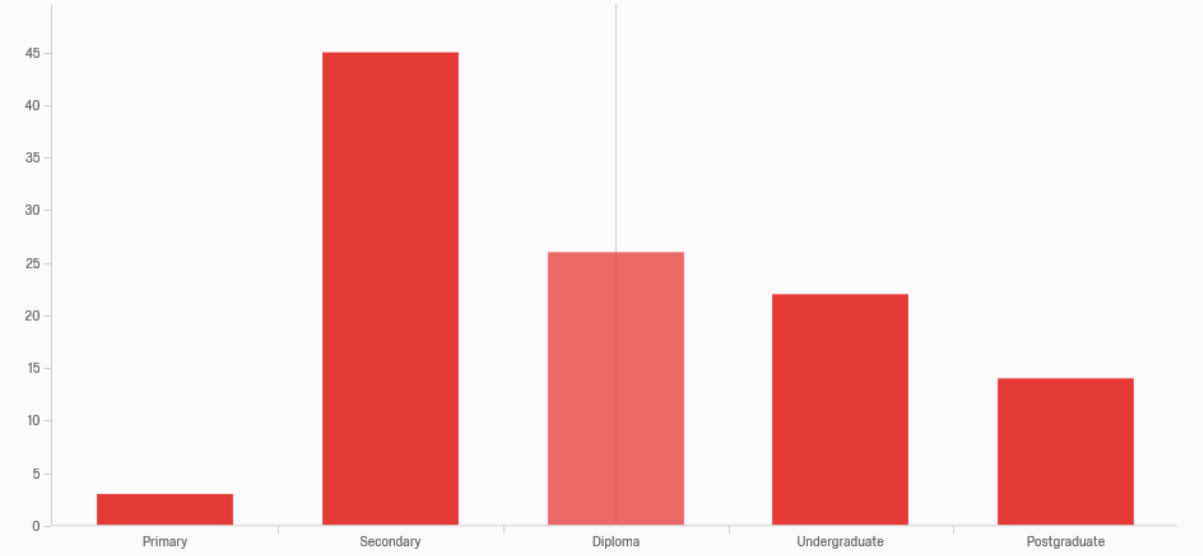

Figure 4.3 Education

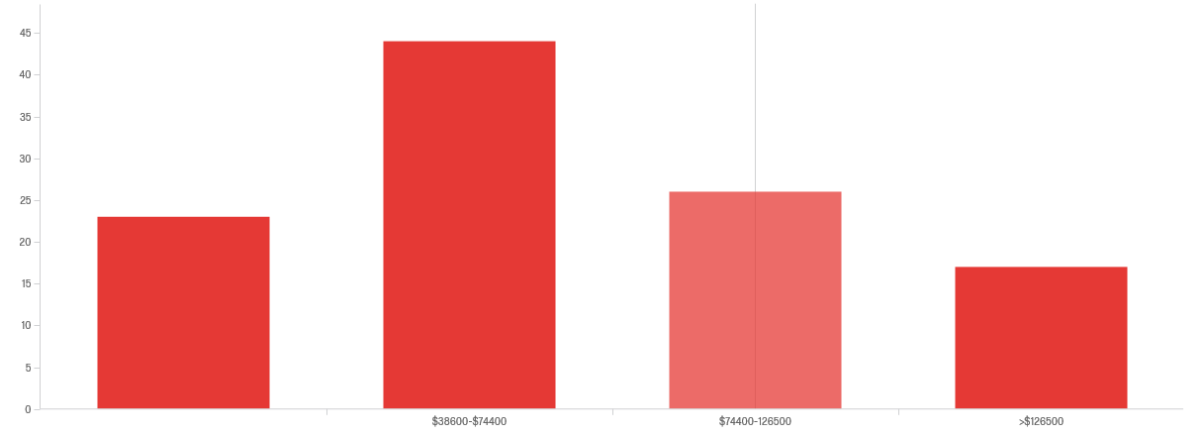

Figure 4.4 Gross Household Income

Most (59.09%) of the respondents were from households of two to four people, 15.45 % were larger households comprising more than four people and 25.45% were single-person households (see Figure 4.5). This is in line with the average household size in Western Australia which is 2.52 persons (Community Profile, n.d.). The majority of respondents (94.55%) lived in a house rather than a unit, townhouse and apartment (see Figure 4.6). Furthermore, the majority of the respondents, namely 78.18%, are owners and the remaining 21.82% are tenants (see Figure 4.7). It appears that mostly middle-sized families adopt PVs, and the majority of them are house-owners.

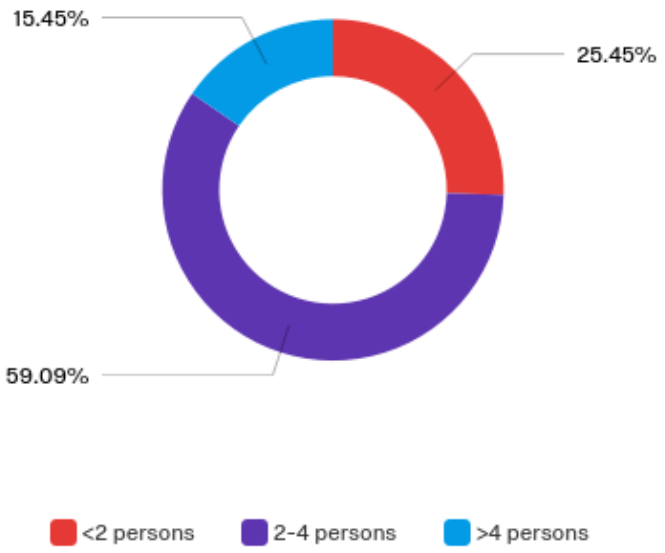

Figure 4.5 Household Size

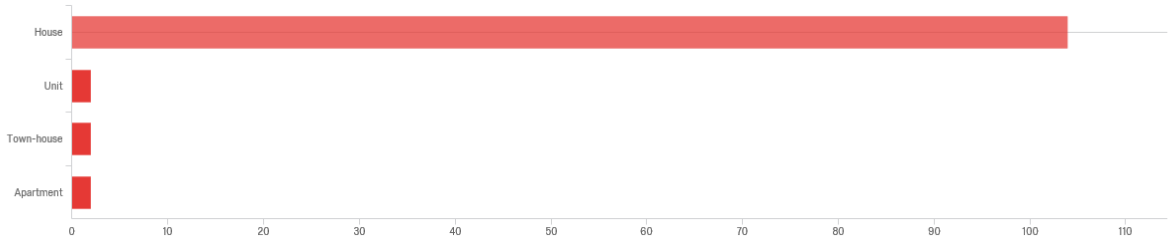

Figure 4.6 Dwelling Type

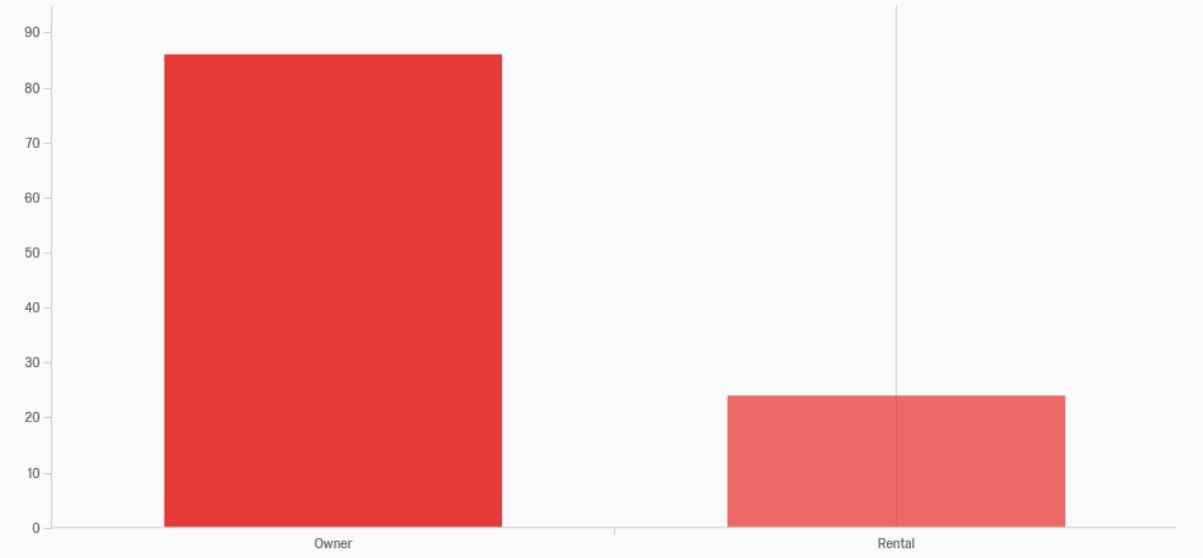

Figure 4.7 Ownership

4.2 Reasons for adopting rooftop solar PVs

The items in the main section of the questionnaire were intended to capture people's reasons for the adoption of rooftop solar PV panels. These questions were based on the three pillars of sustainability: society, economy and environment. Overall, the economic reasons dominated the decision for adopting and using rooftop solar PVs, followed by environmental factors. Social reasons were not as pronounced and expressed mainly as a desire for a decentralised energy supply and less dependence on the current power utility. Marketing efforts and popularisation of the PV technology through the media channels were also included in the group of social

influences. A further factor which was covered by the questionnaire was linked to familiarity with the technology. These reasons are discussed in more detail below.

4.2.1 Economic reasons

Economic reasons, including current and future energy prices, are the main reason for households adopting PVs. Most (57.27%) respondents strongly agree that they have installed PV panels to reduce their energy bills (see Figure 4.8). Similarly, 52.73% strongly agree that they have PV panels because they are concerned about future electricity price rises, with a further 30% also agreeing with this statement (see Figure 4.9).

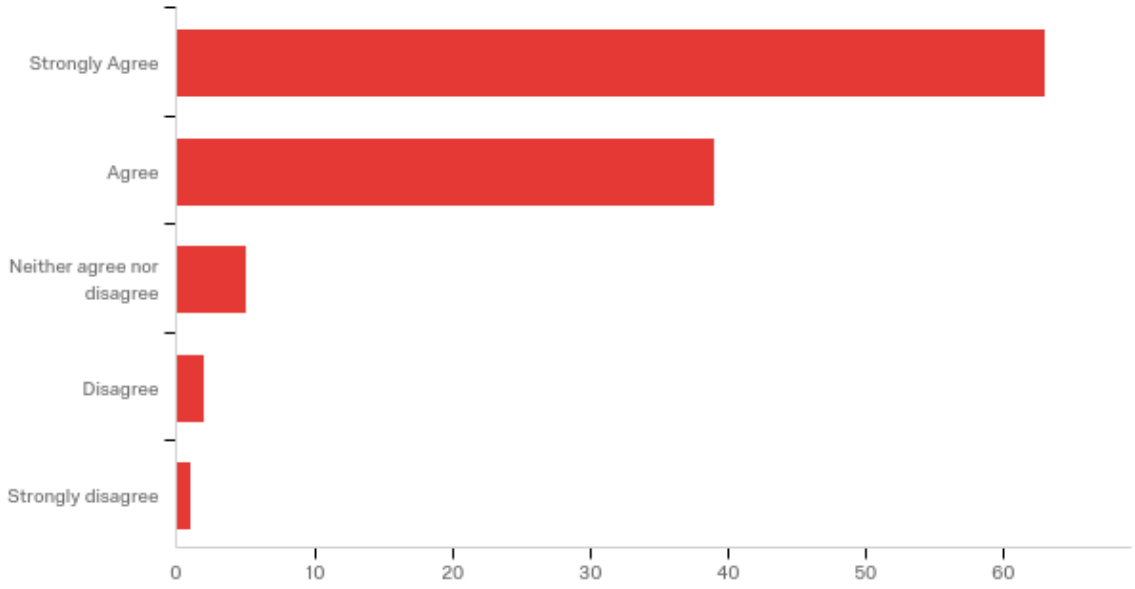

Figure 4.8 Solar PVs Adopted to Reduce Energy Bills

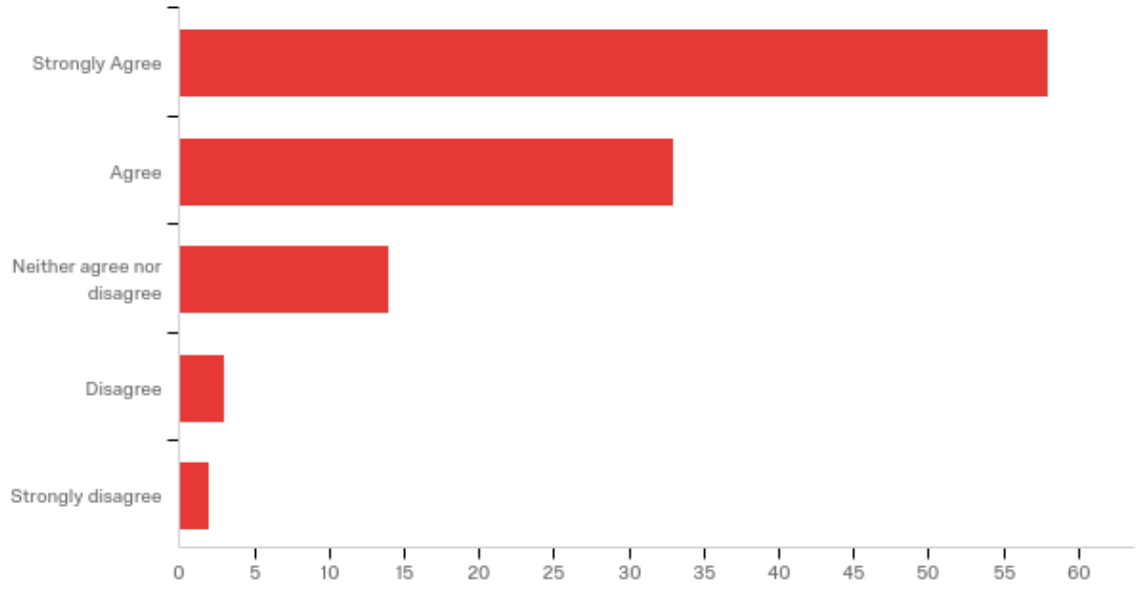

Figure 4.9 Concerns about Future Energy Price Rises

Financial issues are also a very important factor for people. Adopting PVs as a good financial investment or to supplement their income through a positive energy balance was a view with which 26.63% strongly agreed and 40.91% agreed (see Figure 4.10). Increase in property value or reduction in rental expenses are also listed by the majority of the respondents as reasons for selecting PVs; 20% strongly agreed with this statement, and 35.45% agreed (see Figure 4.11).

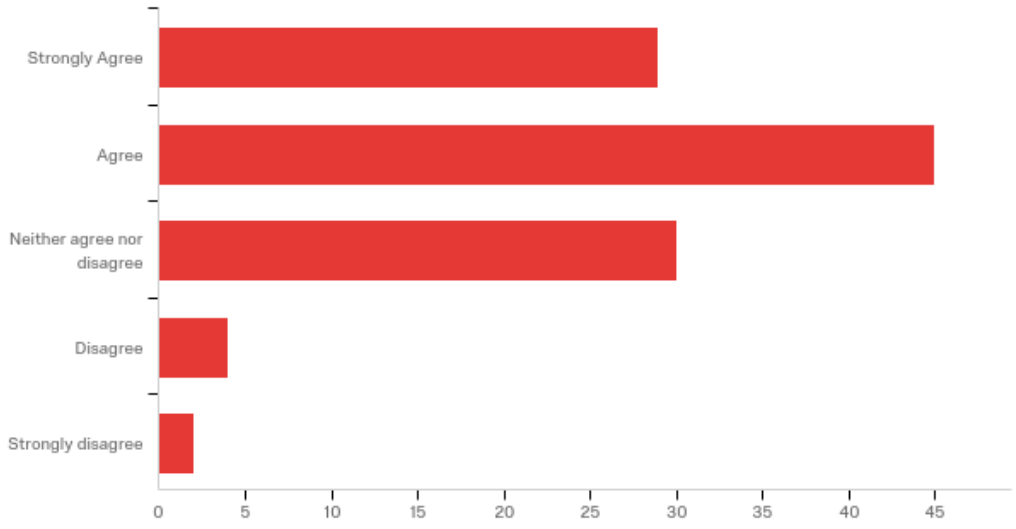

Figure 4.10 PVs a Good Financial Investment

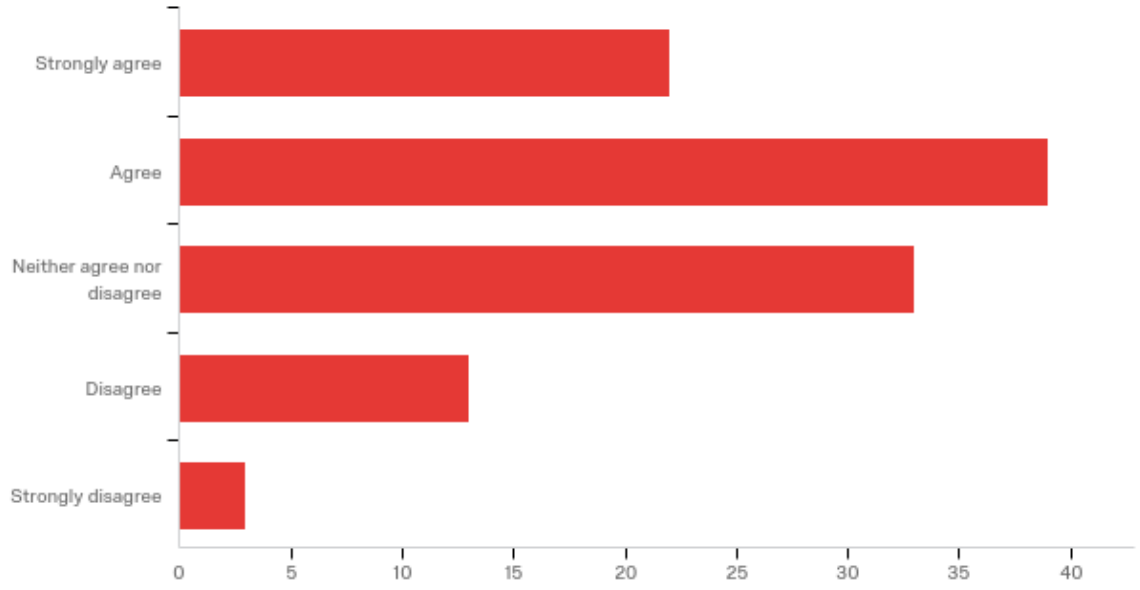

Figure 4.11 Increase in Property Value or Reduction in Rent

Economic incentives, such as the availability of a government rebate for costs at the time of decision-making, have influenced the adoption of PVs for 51.82% of the sample (see Figure 4.12). It is also interesting to note that the remaining households did not consider this to be an important factor.

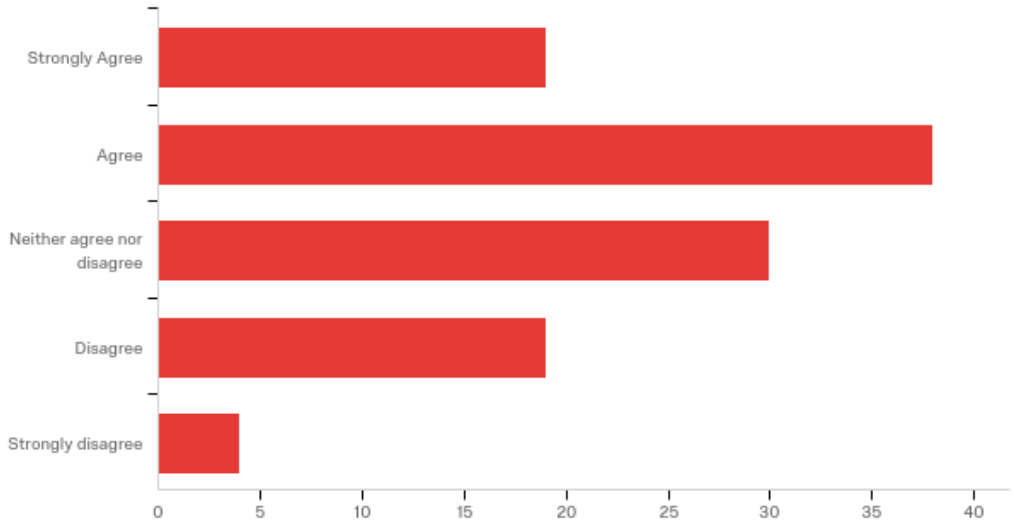

Figure 4.12 Economic Incentives

4.2.2 Environmental reasons

Of the respondents, 45.45% agree that they use PV because they are aware that natural resources are limited, while 27.27%, strongly agree. This indicates that people are concerned about their natural environment (see Figure 4.13).

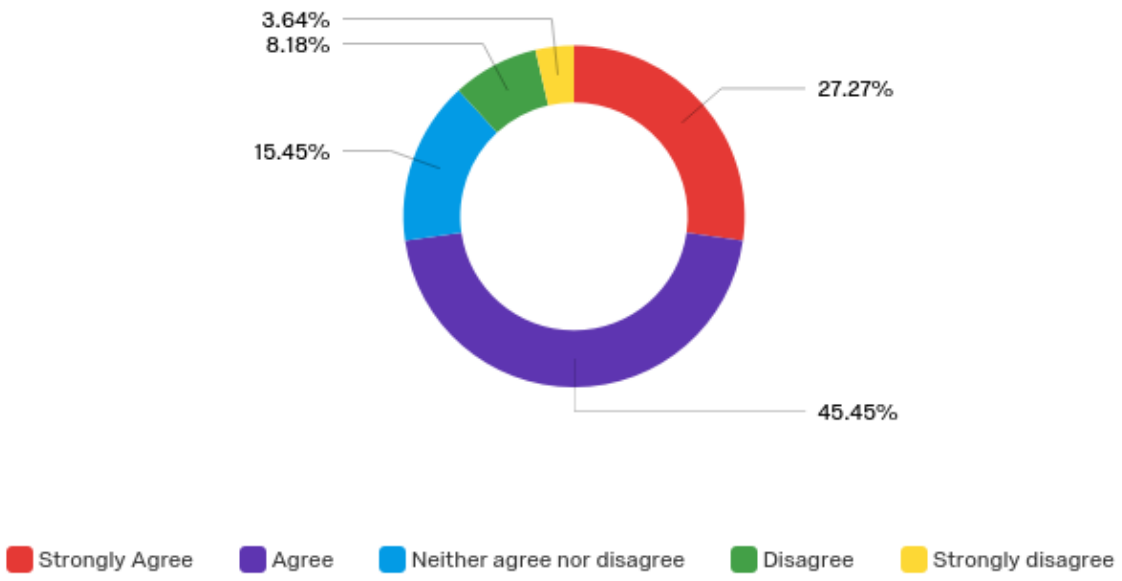

Figure 4.13 Concerned about the Natural Environment

Most respondents agree that they have PVs because they are concerned about climate change and global warming. As shown in Table 4.1, only three people strongly disagree.

Table 4.1 Concerned about Climate Change and Global Warming

#	AWA.FIELD	SIMPLETABLEWIDGET.CHOICE_COUNT	
1	Strongly Agree	29.09%	32
2	Agree	39.09%	43
3	Neither agree nor disagree	22.73%	25
4	Disagree	6.36%	7
5	Strongly disagree	2.73%	3
			110

SIMPLETABLEWIDGET.SHOWING_ROWS_OF

Most respondents (74.46%) agree that they have PVs because they want to contribute to a better natural environment (see Table 4.2). The share of people who disagree with this statement is very small at 7.27% with nobody strongly disagreeing.

Table 4.2 Contribution to a Better Natural environment

#	AWA.FIELD	SIMPLETABLEWIDGET.CHOICE_COUNT	
1	Strongly Agree	31.82%	35
2	Agree	43.64%	48
3	Neither agree nor disagree	17.27%	19
4	Disagree	7.27%	8
5	Strongly disagree	0.00%	0
			110

SIMPLETABLEWIDGET.SHOWING_ROWS_OF

The majority (40.91%) of respondents agree that they have PVs because they are familiar with the renewable energy sources (see Figure 4.14). Many respondents (30%) agree that they have installed or selected a house with rooftop solar PVs because they have product knowledge and experience, and they are aware of how photovoltaic systems operate and the benefits from

using them. Only 6.36% strongly disagree and 21.82% disagree on this subject (See Figure 4.15). The remaining 27.27% of the participants were ambivalent in regard to technology knowledge.

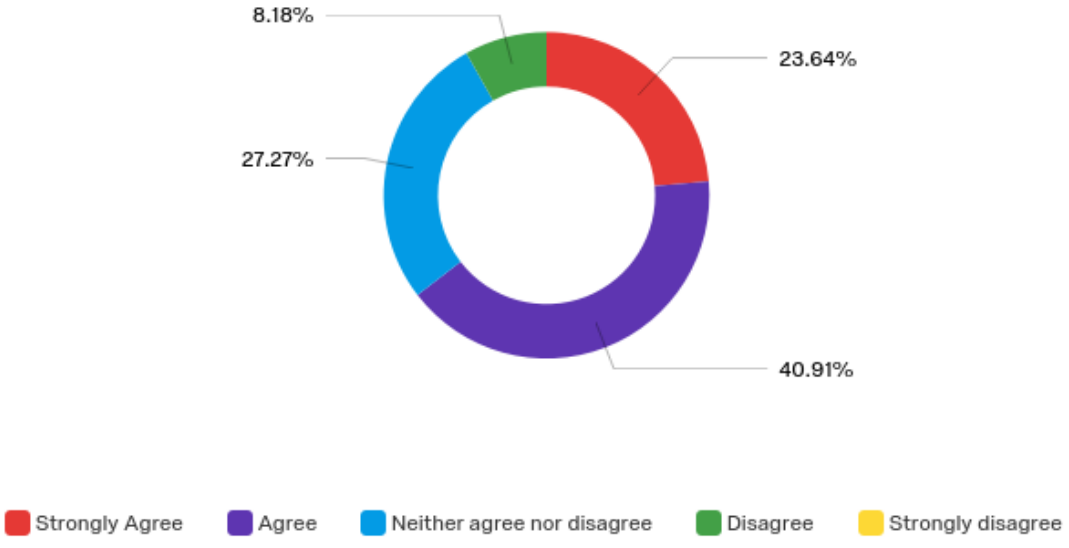

Figure 4.14 Familiarity with Renewable Energy Sources

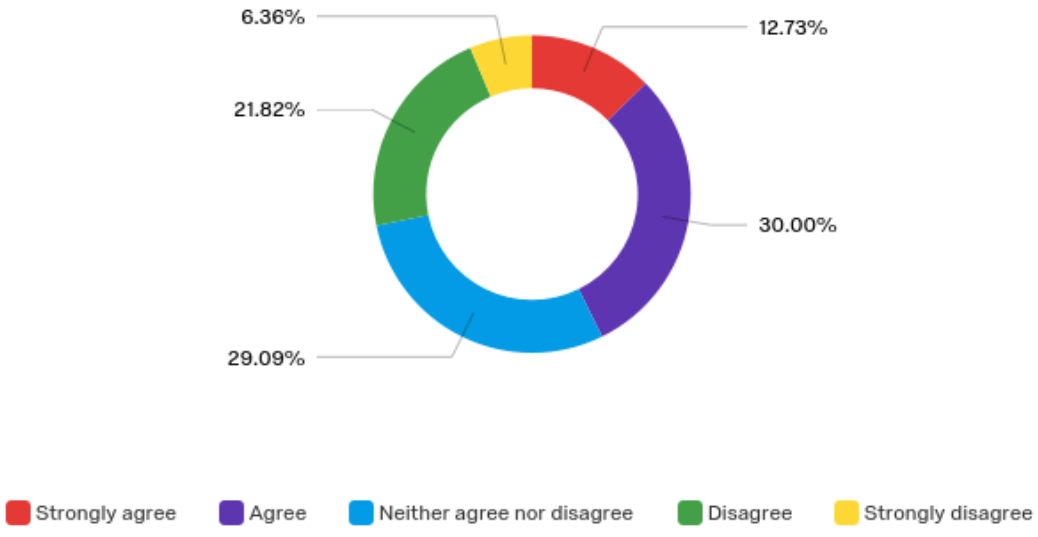

Figure 4.15 Awareness of Photovoltaic Systems

Experience is another factor that the survey asked people to consider. The largest share of the respondents, namely 38.82%, disagree with the statement that they have installed or selected a house with rooftop solar PVs because they had this in their previous house. As Table 4.3 shows, only 20% of the population sample agree on this subject (see Table 4.3). This means that a large number of respondents are experiencing the benefits of rooftop solar for the first time.

Table 4.3 Adoption of PVs because of having it in the Previous House

#	AWA.FIELD	SIMPLETABLEWIDGET.CHOICE_COUNT	
1	Strongly Agree	14.12%	12
2	Agree	20.00%	17
3	Neither agree nor disagree	14.12%	12
4	Disagree	38.82%	33
5	Strongly disagree	12.94%	11
			85

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A significant number (44.55%) of respondents agree that they have installed rooftop solar PVs or selected a house with such a system because they see this as the green energy technology of the future. A further 27.27% strongly agree with this view (see Figure 4.16). Overall, the majority (72%) of respondents agree that they have PVs because they see rooftop solar as the green energy technology of the future.

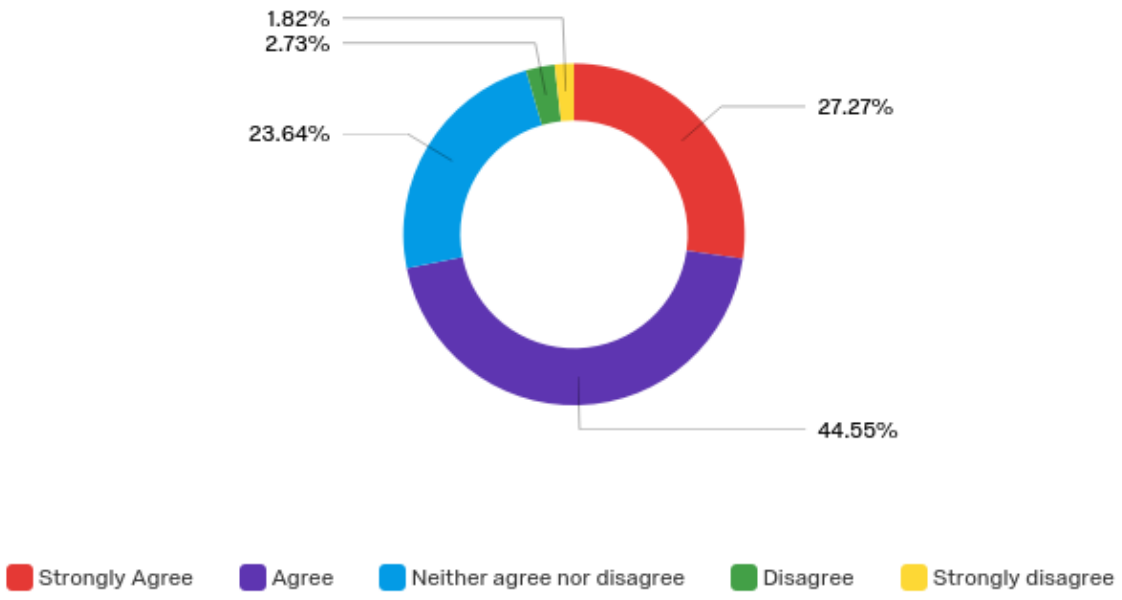

Figure 4.16 Green Technology of Future

A significant number (39.09%) of respondents agree that they have installed, or selected a dwelling with rooftop solar PVs because of conversations with friends and other owners. A further 11.82 % strongly agree with this statement, and only 7.27% strongly disagree (see Table 4.4).

Table 4.4 Selecting a Dwelling with PVs because of Conversations with Other Owners and Friends

#	AWA.FIELD	SIMPLETABLEWIDGET.CHOICE_COUNT	
1	Strongly Agree	11.82%	13
2	Agree	39.09%	43
3	Neither agree nor disagree	25.45%	28
4	Disagree	16.36%	18
5	Strongly disagree	7.27%	8
			110

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Most of the respondents disagree that they have solar PVs because they have been influenced by the mass media: 34.45% disagree and 9.09% strongly disagree with this statement. Less than a quarter (23.63%) of respondents agree or strongly agree that they have been influenced by the mass media (see Figure 4.17).

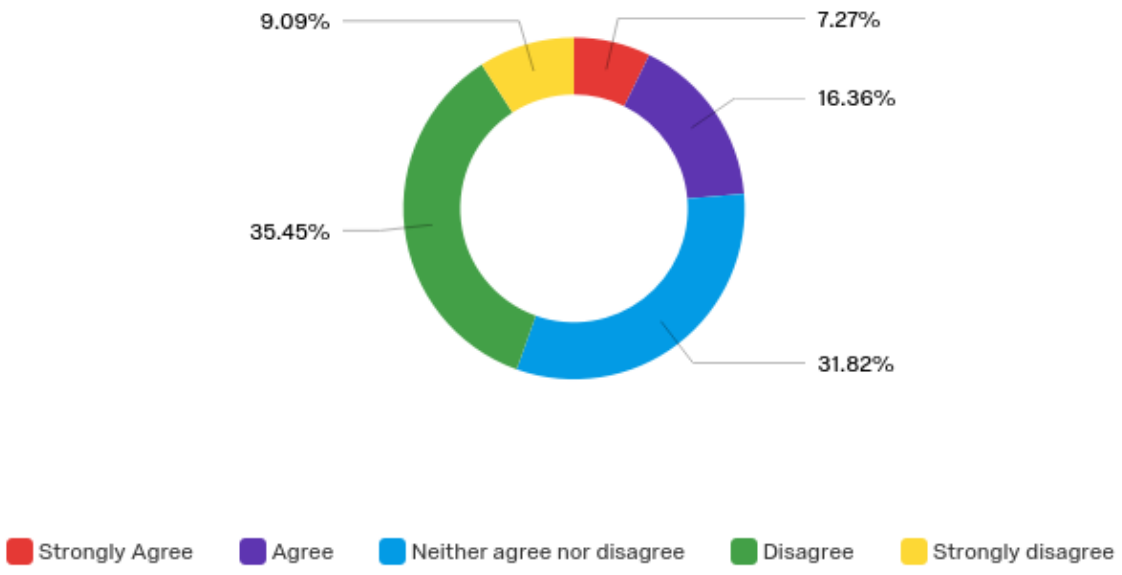

Figure 4.17 Media Influence

4.2.3 Social reasons

Another social factor that was investigated during the survey was the influence of marketing on people's decisions regarding solar panels. The majority of the respondents disagree that they have installed solar PVs as a result of advertising by visitors who came to their property (see Table 4.5 and Figure 4.18).

Table 4.5 Advertising by visitors

#	AWA.FIELD	SIMPLETABLEWIDGET.CHOICE_COUNT	
1	Strongly Agree	8.18%	9
2	Agree	10.00%	11
3	Neither agree nor disagree	33.64%	37
4	Disagree	27.27%	30
5	Strongly disagree	20.91%	23
			110

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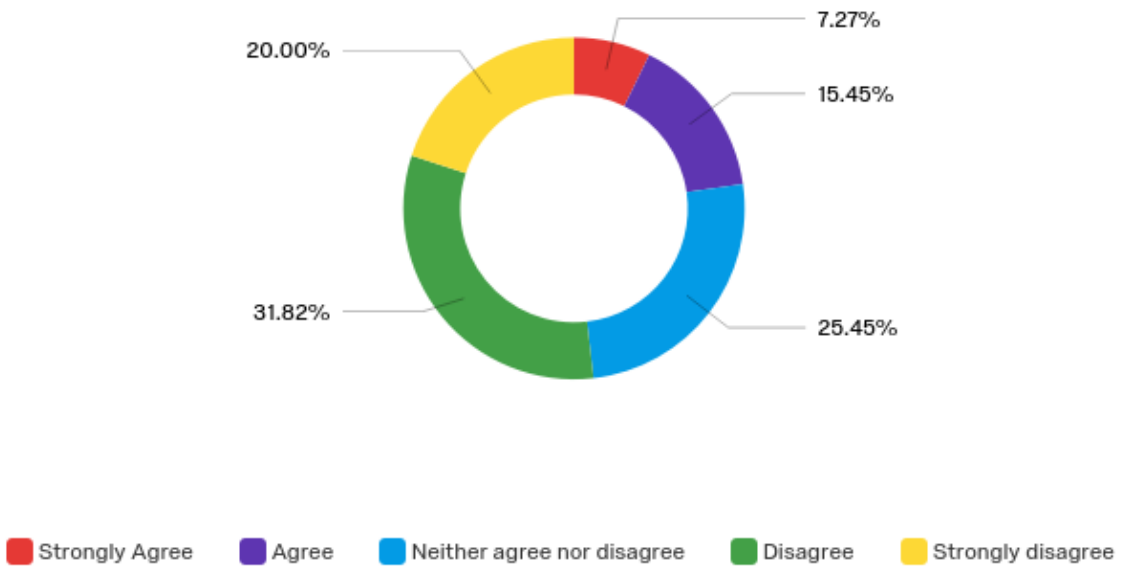

Figure 4.18 Advertising by Visitors

4.2.4 Technological factors

It is interesting to note that after-sales services and warranty were not a big factor in households' decisions to install solar PVs: 36.37% agree, 34.55% disagree and 29.09% did not having a particular opinion (see Figure 4.19). Hence, opinions are quite divided on this issue.

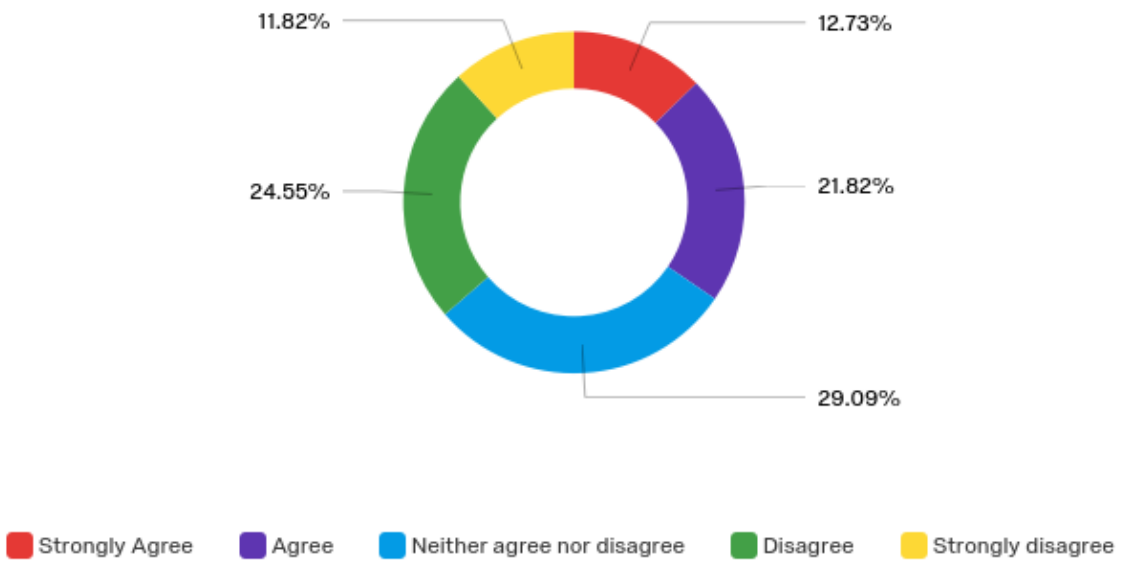

Figure 4.19 After-sales Services and Warranty

4.3 Conclusion

As the data shows, in Western Australia, financial and environmental factors are the strongest influencers of people's decision to adopt PVs. People adopt PVs because they want to save money and to help safeguard the natural environment. Also, word-of-mouth and the influence of others increase the likelihood that people will adopt PVs. This shows that from a marketing perspective the sellers have to focus on financial and environmental aspects when designing successful strategies for the marketing of photovoltaic cells. Also, the better educated people are,

the more willing are they to cooperate in building a better natural environment. Therefore, it is to the advantage of PV providers that they inform people that it is both beneficial to them and to the environment to adopt PVs. The marketing of PVs is basically concerned with educating people. Many people who have not yet adopted PVs might not be aware of the benefits that this technology can bring to them and to the biophysical environment.

Chapter 5. Discussion: Relevance and Importance of Adoption Factors

In this chapter, first we review previous studies related to our findings from the Western Australia survey. Then our results are interpreted, discussed and compared to findings in similar studies conducted previously in other regions. Based on the interpretation of the results, policy implications are discussed and strategies are proposed. The limitations of the study are then stated. Finally, directions for future research are suggested.

5.1 Literature Review

A 2020 study in New York examined the adoption of solar technology by households. The researchers used an online survey questionnaire asking respondents to rate the factors motivating them to adopt PV (do Nascimento et al., 2020). The results of the survey showed that, basically, people were motivated to adopt PVs because they wanted to see a positive impact on the natural environment. The second motivating factor was the desire to reduce energy bills, which is essentially an economic consideration. These results are similar to those obtained in our research conducted in Western Australia which shows that economic and environmental factors are the main motivators for the adoption of PVs by households. It should be noted that when the factors leading to the adoption of PVs need to be ranked according to their influence on decision-making, economic considerations are not the primary motivator. In fact, both environmental and economic factors are equally important to adopters (do Nascimento et al., 2020).

In another study conducted in Sweden in 2011, researchers found that people are interested in adopting PV systems because of environmental considerations and their desire to have a green lifestyle (Palm and Tengvard, 2011). The results from this Swedish study showed that investing in PV systems and buying them was expensive, hence, economic factors impeded the adoption of

rooftop solar PVs. For a large section of the Swedish population, both financial and institutional barriers needed to be reduced to enable them to adopt PVs. Again, we see the interplay between environmental and economic factors with the former being motivators and the latter being barriers to adoption (Palm and Tengvard, 2011).

Circumstances vary across countries and regions because of different specific conditions for PVs adoption, so it is appropriate to draw parallels between Western Australia and other developed parts of the world. However, insights can be obtained from less developed areas, particularly when it comes to socially and economically weaker sections of Australian society. For example, a study conducted in Brazil in 2020 reveals that reduction of costs and improved financial circumstances make PV adoption more attractive and influence buyers' decision (do Nascimento et al., 2020). This may also indicate that people in Brazil or developing countries with less access to and lower levels of education are less concerned about the natural environment, often resulting in less purchasing power. The Brazilian study shows that economic issues take centre stage and are more important to the country's residents. Economic issues in reality are overwhelmingly more important for the Brazilian population contrary than protecting the natural environment – a common situation in the developing world. Hence, the Brazilian study can be applied to other underdeveloped countries or regions in the world where PVs are still emerging.

There are gaps in the studies conducted so far on PV adoption, particularly when it comes to having a comprehensive understanding of the environmental effects of the PV systems. Such assessments are scarce since the impacts of PVs on the environment have not been studied fully, and the current literature does not offer adequate information on this topic. Also, the impacts of factors such as land requirement and appropriate pattern distribution on the performance of the

PV systems require further investigation. Additionally, there is not enough information about the effectiveness of PVs in reducing GHG emissions and the ways by which the carbon footprint of rooftop solar can be decreased. Furthermore, future research needs to investigate the effects of different parts of the PV cells that release hazardous materials, and the potential and feasible recycling methods (Tawalbeh et al., 2021) These are all areas of investigation from which any marketing strategies can benefit, particularly if future studies produce valuable outcomes.

5.2 Interpretations

The results presented in Chapter 4 reveal several interesting findings regarding the importance of gender, household characteristics, financial and environmental considerations and social factors that can influence the adoption of domestic solar PV systems. Each of these factors is discussed below.

5.2.1 Gender

The Perth study showed that females are more willing to adopt domestic PVs. Sixty percent of the respondents (66 individuals) were female, suggesting that women were more interested in adopting PVs, and that decisions about domestic rooftop solar are gender-related. In a similar study conducted in New York in 2020, women were also more likely to make decisions to adopt PVs, driven mainly by environmental factors and their concerns about safeguarding the natural environment (Schelly and Letzelter, 2020).

5.2.2 Household characteristics

In the surveyed sample, the level of education appears to play a major role in influencing the adoption of solar PVs. Of the 110 respondents, three (2.73%) people had completed only their primary education, and 45 (40.91%) have a secondary school education. Of the remaining 62

(56.36%) respondents, 26 (23.64%) have a diploma, 22 (20%) have an undergraduate degree and 14 (12.73%) have a postgraduate degree. Essentially, the majority of the adopters are relatively well-educated and have a tertiary qualification. Also, PVs appear to be the technology of choice for people with middle incomes and secondary education – 45 of the 110 adopters who represent the largest section of the sample are within the middle-income range of $38,600 to $74,400. Furthermore, the results show that 2 to 4 people families adopt PVs. Most (59.09%) of the households consist of 2 to 4 people; only 15.45 % have larger households of more than four people. Furthermore, most (94.55%) of the respondents lived in a house rather than in a unit, townhouse or apartment. The majority of the respondents, namely 78.18%, are owners with the remaining 21.82% being renters. This is similar to the results of the study in New York where socioeconomic variables including household income, home value, and education were aligned with solar adoption (Schelly and Letzelter, 2020).

These insights have implications that can help to develop appropriate marketing strategies to promote and increase the adoption of PVs at both the local (WA) and global level. For instance, because the results show that PVs are the technology of choice for people with middle income and secondary education and households of 2-4 people, any marketing campaigns and programs should target this segment of the market.

5.2.3 Financial considerations

The results show that economic and financial factors are important considerations that determine whether people in Western Australia are willing to adopt PVs. Economic reasons, including current and future energy prices, are the main reason for households adopting PVs. Most of the respondents, namely 57.27%, strongly agree that they have installed PV panels to reduce their energy bills. In a similar study in New York, the survey results show that environmental and

economic factors are both equally important to the adopters of PV technology at a residential level. Although these two factors are basically equally important for the respondents, it is also worth noting that women are more likely to be motivated by environmental factors. In the New York study, the factor that ranked third as a motivator was trust in the solar installer, an issue which merits further study in the context of Western Australia and other regions (Schelly and Letzelter, 2020).

Hence, the focus of any marketing strategies and marketing campaigns should be on the economic and financial circumstances of households. Basically, financial issues can be the most important factor as a motivator or as a barrier to the adoption of PVs. People tend to adopt PVs to save money on their electricity bills, and this was confirmed by the majority (57.27%) of the WA respondents. Financial issues are also a very important factor for people who see the adoption of PVs as a good investment or a way to supplement their income through a positive energy balance; 67.54% of the WA respondents agreed, with 26.63% strongly agreeing. Similarly, 52.73% strongly agree that they have installed PV panels because they are concerned about future electricity price rises, and a further 30% also agreed with this statement. Increase in property value or reduction in rental expenses are listed as reasons for selecting PVs by the majority of the respondents – 55.45% of the respondents agreed with this statement, with 20% strongly agreeing. For 51.82% of the respondents, economic incentives, such as the government rebate to alleviate costs offered at the time of decision-making, influenced their decision to install PV panels.

Households can save significant amounts on energy bills by adopting PVs. However, the policy environment can be quite dynamic with government incentives changing. This is particularly relevant to Western Australia where the electricity utility is owned by the State

Government. The circumstances regarding financial decisions made by WA households may change although there is generally a continuity of policy priorities. Since 31 August 2020, a year after the survey was conducted, new residential solar power systems installed in Western Australia are not eligible for the Renewable Energy Buyback Scheme (REBS) or a solar feed-in tariff of 7.135 cents per kilowatt-hour. Instead, they are remunerated by the "Distributed Energy Buyback Scheme (DEBS) that pays:

- 3 cents for each kilowatt-hour of solar electricity fed into the grid for most of the day, and
- 10 cents for each kilowatt-hour exported from 3:00 pm in the afternoon until 9:00 in the evening" (Brakels, 2021).

The increased rate of 10 cents per kilowatt-hour applies when the energy demand by households is the highest. Although this benefits the overall running of the grid, it may affect the ability of households to generate additional income. The new rebate amounts might affect the rate of PV adoption, which can be the topic of future research (Brakels, 2021).

5.2.4 Environmental considerations

In Western Australia, after financial factors, environmental issues constitute the second most important factor influencing the adoption of PVs. Most (68% or 75) of the respondents agreed that they have solar PVs because they are concerned about climate change and global warming. Only three (2.7%) participants strongly disagreed. Most (74.46%) respondents agreed that they have PVs because they want to contribute to a better natural environment. These findings suggest that marketing strategies should also incorporate environmental factors and make people more environmentally aware. Media and the education system have a key role in making people

environmentally aware, and encouraging the adoption of renewable energy options should be part of their mandate.

5.2.5 Social factors

The results show that social factors, such as media influence and advertising, or friends and others visiting their home, were the least important factors. As in other areas related to socially and environmentally responsible behaviour (e.g., Saunders & Goddard, 2002; Couldry, 2012), the impact of the mass media is not obvious and can only be reinforced if backed up by education and other government policies. Another possible reason for the media having little influence on decision-making related to rooftop solar is that the Western Australian mass media have not actively engaged with this topic and, in fact, on many occasions they continue to spread doubt and uncertainty on issues such as climate change (Taylor, 2014). This means that specific marketing strategies can play a role in educating households by emphasizing the financial and environmental benefits of installing rooftop solar PVs.

5.3 Future Research Directions

This study could be followed by local studies in other parts of Western Australia and in other Australian states so that successful marketing strategies can be applied to encourage the adoption of PVs in each region. More research should be done in each region to determine the specific factors that should be considered when designing marketing strategies. Australia is a developed country; therefore, the results of this study which was conducted in Western Australia might be different from those obtained for less developed regions. Although the results of the current research cannot be generalized, there are valuable parallels that can be drawn regarding the importance of economic mechanisms and environmental concerns in the adoption of solar PVs. These issues provide fertile ground for future research.

To increase the adoption of PVs in Western Australia, financial and environmental factors must be taken into consideration. Moreover, education about the benefits of solar PVs should start in high schools, if not earlier, and the issue of sustainability should be incorporated into every school curriculum. Future research could investigate the impact of education on people's willingness to adopt a green lifestyle in adulthood.

Also, the study results indicated that economic incentives are crucial. If governments set up schemes whereby households can receive loans to buy and install PVs, the adoption rate would increase. Another possible field of research could involve the analysis of the types of incentives and their duration. Because the feed-in-tariffs in Western Australia were changed in August, this could be a disincentive for the adoption of PVs and this issue merits future investigation.

The role of education should not be underestimated. People need to understand the environmental consequences of their decisions and to learn to care about the natural environment. By adopting renewable energy, people should know that they are contributing to the overall wellbeing of the natural environment which must be preserved for future generations. Hence, sustainability should become a priority and a core social value.

Chapter 6. Conclusions, Implications and Limitations

In this study, we determined the factors that influence the adoption of rooftop solar photovoltaics in Western Australia, using a mixed-method approach comprising quantitative and qualitative research. This study primarily addressed the following research questions:

RQ1- What are the main factors that influence the decision regarding the adoption of solar PV panels by residential consumers in WA?

RQ2- How can the penetrating ratio of solar PV panels be increased through the implementation of appropriate marketing strategies?

Data was gathered from participants in Western Australia and surveys were conducted through Qualtrics to find out the main factors that lead to the adoption of PVs in residential areas. A survey was carried out in 2019 of 110 households that had installed rooftop solar PVs.

As the data shows, financial and environmental considerations are the strongest factors that encourage people to adopt PVs in WA. People adopt PVs because they want to save money on their electricity bills and to help safeguard the natural environment. Furthermore, word-of-mouth and the influence of other people increase the likelihood of PV adoption. This indicates that from a marketing perspective, sellers have to focus on the financial and environmental benefits when designing successful plans for promoting the uptake of photovoltaic cells.

6.1 Financial Factors

Financial and economic considerations, including current and future energy prices, are the main reason for households adopting PVs. More than half of the respondents, namely 57.27%, strongly agreed and 35.45% agreed that they have installed PV panels to reduce their energy bills. Therefore, focusing on the financial benefits that can be acquired by people who adopt PVs

can be a good marketing strategy. People can be encouraged to adopt PVs for their households if they believe that this can improve their financial situation.

6.2 Environmental Factors

A large number of respondents, namely 45.45%, agreed that they use PV because they are aware that natural resources are limited, while 27.27% strongly agree. This indicates that people are concerned about their natural environment.

Most (68.18%) of the respondents strongly agreed or agreed that they installed PVs because they are concerned about climate change and global warming. Only three people strongly disagreed with this statement.

Most respondents (74.46%) agreed that they have PVs because they want to contribute to a better natural environment. Therefore, another effective marketing strategy could involve informing people about the ways in which PVs can benefit and safeguard the natural environment.

The results of this study show that the more educated people are those who are more willing to contribute to building a better natural environment by installing PVs. Therefore, it is the responsibility of PV providers to raise people's awareness of the benefits of PVs for them and for the environment. Hence, the marketing of PVs is basically a matter of educating the public, as many people are still unaware of the financial and environment benefits of PVs.

There are other factors that may impact on people's decision for adoption of PVs, such as unaffordability, people renting, not enough sunshine exposure. The study shows that at the moment there are three financial benefits: (1) upfront financial support provided by the commonwealth government; (2) electricity savings on the household consumption; and (3)

payback incentives if the household provides electricity to the main grid between 3 pm and 9 pm (Household Renewable Energy Overview, 2021).

The West Australian Wholesale Energy Market (WEM) is expected to undergo a major revolution with the State Government's Energy Transformation Taskforce launching strategies for a restructure which will connect renewable energy – in all its forms – into the power system. The "taskforce, established in 2019, has been responsible for developing constrained-access arrangements which will maximise the benefits of renewable energy and facilitate more equitable and efficient use of capacity on the Western Power network"(Carroll, 2021). Western Australia's energy network is one of the first schemes to include battery storage and electric vehicles. In order to redesign the power generation system, a major target to achieve is making the photovoltaics much more widespread in Western Australia which needs efficient marketing strategies for encouraging households to adopt PVs.

6.3 Policy Implications

The results derived from this study suggest that more incentives should be offered, and people should be made more aware of the benefits of adopting PVs. Although financial issues are the main motivator for households installing PVs, environmental awareness and encouraging people to contribute to a better natural environment by using renewable energy are also very important.

Young consumers should be of particular interest as they will be longer affected by climate change. As shown in the study by Perera and Hewege (2018), young adults are concerned about the natural environment. They also pursue emotional benefits by showing green conscious behavior. However, young adults tend to reject or disregard the negative implications related to climate change, including its potential local influence, and can be suspicious of

governmental actions (Perera and Hewege, 2018). This shows the particular challenges that marketers face in the marketing of green products, such as rooftop solar PV systems. Such campaigns should emphasize the positive appeal, enthusiasm and opportunities to engage with action and solutions collectively through adopting renewable energy at the domestic as opposed to any negative connotations (Perera and Hewege, 2018).

Developing climate change awareness-building programs and the role of renewable energy in preventing tipping points is highly recommended. However, it is essential not to present climate change as an overwhelming problem to avoid discouraging young people to participate in such programs. Given the positive correlation between hopefulness and young adults' reply to climate change-related issues (Perera and Hewege, 2018), accentuating authorized implications, such as rooftop solar, and demonstrative benefits can extend the market potential for green technologies.

People need to be educated about the more sustainable PV alternatives, including the use of battery storage, as this could motivate them to install rooftop solar systems. They can be educated by information campaigns and through social media and advertisements. Sustainability education in the current curricula should line up with the main purposes, goals and the content of adopting such green technologies and transitioning to a net zero economy. Green jobs related to installation and maintenance as well as further improvements of rooftop solar systems can also be part of educational curricula maintaining the focus on gaining critical and analytical expertise (Perera and Hewege, 2016). Specifically, sustainability and renewable energy options should be included in school curricula in Western Australia.

Already, the climate policy of Western Australia is encouraging a transition to renewables by having strategies and programs intended to increase the adoption of PVs. These initiatives include:

- installing community batteries to strengthen the electricity network and help households to maximise the benefits of rooftop solar without paying the up-front cost of their own battery system;
- conducting leading-edge trials of how to orchestrate rooftop solar with batteries and electric vehicles, such as a new program to create virtual power plants based on new battery systems that the Government-owned utility will install in selected schools;
- a Solar Schools Program to increase the State Government's use of renewable energy by installing solar systems on school rooftops (Western Australian Climate Change Policy | Western Australian Government, 2021).

The aim of these policies is to make renewable energy part of the WA culture so that, eventually, people will automatically choose more sustainable alternatives. This aim cannot be achieved unless the whole economic wellbeing of the society improves so that people can afford to install PVs. Moreover, information about PVs should be easily accessible, and people need to be encouraged and adequately informed by the media about the benefits of adopting PVs.

6.4 Limitations of the Study

The results derived from the study pertain to Western Australia, and any generalization to other regions needs to be done with caution. Further localized research and further verification of the results are needed as there may be other factors influencing the adoption of PVs, such as different policy environments and incentives. Also, because the feed-in-tariffs changed in August

2020, the situation could change in the future which might affect the findings of a similar study conducted in Western Australia in future.

6.5 Implications

Also, the results obtained in this study can inform the design of marketing strategies that will increase the uptake of PVs in, for example, African and Gulf countries where the use of solar photovoltaics is less popular. The penetration rate of PVs in Western Australia is very good. Hence, we can conclude that the factors that encouraged the adoption of PVs in WA can be more emphasized in places with a similar geography and sun radiation to promote this environmentally-friendly technology.

As described in the results chapter (Chapter 4), we can conclude that PVs are the technology of choice of educated, middle-income families or individuals. Education plays a key role in people's decision to adopt PVs. Hence, marketing strategies and marketing campaigns in Western Australia should be designed so that they target people with middle income and middle level of education. People with high income who can easily afford the investment in rooftop solar PVs need education and green economy awareness should be targeted.

Also, the government should offer incentives to encourage the adoption of PVs because this technology can reduce the generation of electricity by traditional means, and people will be less reliant on the State government for the generation of electricity. If there were strong government support for PVs, this could encourage more people to adopt this technology. In this regard, the government and the public are interdependent. If the government encourages and assists people to adopt PVs, people will also support the government by adopting PVs in Western Australia.

If we generalize our results to other countries, we can conclude that in countries with higher GDPs people are more willing to adopt PVs. Hence, the economic wellbeing of the society has a direct relationship with the adoption of PVs. Additionally, the more people know and are concerned about their natural environment, the more willing they will be to safeguard it. Therefore, it is the responsibility of governments to educate people about the necessity to contribute to a better natural environment.

Photovoltaic systems are a sustainable technology for the production of electricity. They should be used to replace the traditional system of electricity generation in places that have the conditions (such as ample sunlight and appropriate dwellings) that make the installation of PVs feasible. This matter only can be achieved by cooperation between people and governments as is seen in Western Australia where there is a steady increase in the uptake of PV technology by households and government support.

6.6 Future Research

There are many further aspects of diffusion of rooftop solar PVs that can be studied in the future. Below are some main research areas.

• Conduct multiple regression analysis to find any significant relationships among the constructs used in this study.

• Analyse marketing strategies used – in future, it would be useful to design a study to analyse the marketing strategies that have been applied successfully, and which could complement this current research.

• Compare the residential sector with industrial/government premises – a study can be designed in the future which compares PV adoption in the residential sector with its adoption by industry and government departments.

• Analyse households which have not adopted solar PVs – it would be useful to investigate those households which have not adopted solar PVs and to investigate the reasons for people's reluctance to do so.

The Western Australian study offered some insights. However, more work needs to be done to understand the real impacts and contribution of rooftop solar PVs in the transition to better energy solutions in the current global environment and climate emergency.

Shortly after the survey stage of the study was completed, Western Australia was impacted by COVID-19. Although there were very few cases of local and community transmission and the State's economy continued to perform very strongly, the pandemic changed people's perceptions and attitudes towards risk. The impact that COVID-19 had on the rate of PV adoption could be a worthwhile topic for future research.

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APPENDIX A

Survey Questions of Photovoltaic (PV) Systems Adoption in WA Published iQ Score: Great
Screener Block Options Screener 1
I have received information regarding this research and had an opportunity to ask questions. I believe I understand the purpose, extent and possible risks of my involvement in this project and I voluntarily consent to take part.

Yes, I consent
No, I do not consent

Condition: No, I do not consent Is Selected. Skip To: End of Block.

Screener 2 What is your residential postcode?
Screener 3 What features does your roof have?
Solar Panels
Roof Paint
Metal Roofing
Stone-coated steel
Asphalt Shingles
Slate
Rubber Slate
Clay and concrete tiles
Green roofs
Other

Condition: Solar Panels Is Not Selected. Skip To: End of Block.

Add Block Default Question Block Block Options

Q2 Demographic Factors: Gender:

Male
Female

Q3 Age:
<30 years
30-64 years
>64 years

Q4 Highest education level:
Primary
Secondary
Diploma
Undergraduate
Postgraduate

Q5 Household Annual Gross Income:
<$38600
$38600-$74400
$74400-126500
>$126500

Q6 Household size:
<2 persons
2-4 persons
>4 persons

Q7 Type of Dwelling:
House
Unit
Town-house
Apartment

Q8 Ownership:
Owner
Rental

Q9 Suburb in WA:

Q10
I installed, or I selected this house with, rooftop solar PVs for the following economic factors:

To reduce my energy bills.

Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q11
I installed, or I selected this house with, rooftop solar PVs for the following economic factors:

Because I am concerned about future electricity price rises

Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q12
I installed, or I selected this house with, rooftop solar PVs for the following economic factors:

PV is a good financial investment or to substitute my income through positive energy balance

Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q13
I installed, or I selected this house with, rooftop solar PVs for the following economic factors:

To be less reliant on electricity suppliers

Strongly Agree
Agree
Neither agree nor disagree
Disagree

Strongly disagree

Q14
I installed, or I selected this house with, rooftop solar PVs for the following economic factors:

To increase the value of the property or reduce the renting expenses

Strongly agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q15
I installed, or I selected this house with, rooftop solar PVs for the following economic factors:

Because there was a government rebate which reduced the cost of solar PVs

Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q16
I installed, or I selected this house with, rooftop solar PVs for the following environmental considerations:

I am aware that natural resources are limited

Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q17
I installed, or I selected this house with, rooftop solar PVs for the following environmental considerations:

I am concerned about climate change and global warming

Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q18
I installed, or I selected this house with, rooftop solar PVs for the following environmental considerations:

I want to contribute to a beer natural environment

Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q19
I installed, or I selected this house with, rooftop solar PVs for the following product knowledge and experience factors:

I am familiar with renewable energy sources

Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q20
I installed, or I selected this house with, rooftop solar PVs for the following product knowledge and experience factors:

I am aware of how photovoltaic systems operate and the benefits from using them

Strongly agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q21
I installed, or I selected this house with, rooftop solar PVs for the following product knowledge and experience factors:

I used rooftop solar PVs in my previous house

Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree
× Not applicable

Q22
I installed, or I selected this house with, rooftop solar PVs for the following product knowledge and experience factors:

I see PVs as the green energy technology of the future

Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q23
I installed, or I selected this house with, rooftop solar PVs for the following social influence factors:

23) Conversations with other owners and friends

Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q24
I installed, or I selected this house with, rooftop solar PVs for the following social influence factors:

Media influence

Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q25I installed, or I selected this house with, rooftop solar PVs for the following social influence factors: The way I am perceived by others
Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q26
I installed, or I selected this house with, rooftop solar PVs for the following marketing factors:

Advertising by visitors who came to my property

Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

Q27
I installed, or I selected this house with, rooftop solar PVs for the following marketing factors:

After sales service and warranty

Strongly Agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

End of Survey

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