Analyzing the Potential Use of Solar Photovoltaic Systems by Commercial Businesses in the Moreland Municipality

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An Interdisciplinary Qualifying Project Submitted to the Faculty of WORCESTER POLYTECHNIC INSTITITUE in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science

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ABSTRACT

This project was conducted for the Moreland Energy Foundation Ltd. (MEFL) of Moreland, a suburb of Melbourne, Australia. The goal of this project was to learn about business opinions and demographics, determine the total physical solar potential of a target neighborhood, and identify key enablers and barriers for commercial solar photovoltaic installation. To obtain this information we used surveys, interviews, and analysis of data through mapping software. The data will be used as a key component of MEFL's Zero Carbon Evolution strategy to lower carbon emissions in Moreland by 20% by 2020. Our findings determined which business zones and which industries were most effective to target, and identifies key issues that MEFL should investigate further for large-scale solar implementation.

EXECUTIVE SUMMARY

Introduction

The use of alternative energies has become an increasingly viable option throughout the world as a strategy to combat high energy prices and climate change. Globally, 75% of human-induced carbon dioxide emissions from 1980-2000 were due to fossil fuels combustion (J.T. Houghton et al., 2001). More specifically in Australia, electricity prices have recently risen substantially—over 40% on average between 2005-2010. The solar photovoltaic (PV) industry has become increasingly popular; uptake has increased by an average of 56.3% annually over the past ten years across Australia ("Australian Energy Statistics," n.d.). However, given the more recent reduction in government support through feed-in tariffs and the Renewable Energy Target (RET), uptake has plateaued, and even decreased in some areas. In the city of Moreland, approximately 6% of residences have a solar PV system, and even fewer businesses have systems despite the business sector consuming a much larger amount of electricity.

Goals and Objectives

The goal of this project was to assist the Moreland Energy Foundation Ltd. (MEFL) in the expansion of solar PV usage by Moreland businesses by researching and analyzing factors that influence solar PV uptake as well as the demographic makeup of the commercial community.

We achieved this goal by accomplishing three main objectives:

1. Determine the opinions of businesses in Moreland regarding solar PV
2. Gather information in order to understand the composition and geographic distribution of industry in Moreland
3. Determine the physical solar potential of Moreland businesses by analyzing a suburb of Moreland and extrapolating these findings to represent all of Moreland.

Methods

To gain a general understanding of how businesses viewed solar PV and why they had or had not installed solar panels, we surveyed the business population of Moreland through an online survey. We designed the survey to be quick, easy, and confidential so businesses would be more inclined to respond. We were then going to use our data to establish trends in the businesses based on industry and suburb. However, our survey received fewer responses than

expected due to an overall low response rate. To overcome this challenge, we decided instead to conduct case studies on the respondents who gave enough data for a solar analysis of their business. Some of the businesses that responded were willing to interview with us to give us more details on their views of solar. These interviews, as well as interviews with Clair Perry of Sydney Road Brunswick Traders Association and Rory Allen of Energy Matters (a local solar panel installation company), gave us great insight into the incentives and barriers around installing solar PV systems.

Having learned as many business opinions as possible, we started researching the composition and geographic distribution of businesses in Moreland. To do this, we analyzed city planning maps to locate industrial, commercial, and mixed use zones where businesses might be located. We furthermore analyzed the industry distribution of businesses using census data to determine where certain types of businesses are located.

We then began looking at the solar capacity of Moreland businesses to see which suburbs and industries presented the highest potential capacity. Using satellite imaging software called NearMap we were able to accurately measure the roof space of businesses in the suburb of Coburg North. We identified a selection of businesses by industry and determined the average number of solar panels that could be installed on individual rooftops. Using data on the industrial composition of each suburb of Moreland, and assuming that businesses of the same industry in other suburbs would have the same average roof space, we extrapolated from our sample pool to estimate the solar capacity of every suburb by industry. Based on the extrapolated data, we then determined the total solar capacity for businesses in Moreland, as well as key regions and industries to target.

Findings

Through surveys, interviews, and data analysis we distinguished five key findings related to commercial solar uptake.

Business Zoning

Through our mapping exercise, we determined that Coburg and Coburg North are the suburbs within Moreland with the highest concentration of business zones. This is beneficial because it is important to target areas where there are either a large number of businesses or where businesses take up the majority of the land area.

Physical Solar Potential

Our solar capacity analysis estimated that Moreland businesses have a maximum physical solar potential of 446 megawatts (MW), or 586 gigawatt-hours per year (GWh/yr). This potential could provide 103% of Moreland's energy usage. We also found that Brunswick, Coburg, and Glenroy-Hadfield were the three suburbs with the highest physical potential. Transport, Postal, & Warehousing, Retail Trade, and Accommodations & Food Services were the three industries with highest physical potential. Within the region of Coburg North analyzed, we found Gaffney St and Charles St to have the highest capacity, both with average business capacity estimates over 130 kW.

Survey Results

We found that while the business opinions determined by the survey results were valuable, the survey itself proved to be an inefficient tool of engagement with businesses. We anticipated a 2-10% response rate from the 1,800 businesses we could potentially reach; however, due to the distribution error, we were only able to reach 495 businesses, and of these received a 2.0% response rate. Yet, we were still able to determine some business opinions. The two largest barriers observed were property ownership, as discussed below, and high upfront cost. The largest incentive to installing solar was reduced energy costs.

Diversity as a Barrier

Diversity presents barriers to implementation of alternative energies because of language barriers. We found that some parts of Moreland have a high concentration of non-native English speakers who do not always have enough understanding of the language to comfortably talk about a complex topic like solar PV. The barriers resulting from diversity were most prevalent in Brunswick, which has a large immigrant population.

Property Ownership

We found that property ownership is one of the largest barriers to installation as many businesses do not own their property. It is uncommon for landlords to have relationships or even direct communication with their tenants, which leaves many businesses feeling like changes to the building are not in the scope of their lease. Another barrier presented to leased properties is the presence of an Owner's Corporation. We found that commercial, retail, industrial, or mixed-

use property with shared space is managed by a Corporation, so additional approval is needed for a business to install solar panels on shared property such as a roof.

Recommendations

Target Coburg and North Coburg

Due to the high concentration of industrial and commercial areas of Coburg and North Coburg, we recommend MEFL begin encouraging solar uptake in these areas. The high concentration of commercial areas in these suburbs provides MEFL with a location to target many businesses.

Continue Solar Potential Analysis

Due to the fact that not all business types in Moreland were represented through our NearMap solar capacity assessment, we recommend MEFL continue this assessment in order to gather information from all business types. Following this, MEFL can recalculate the total physical solar potential to Moreland as a whole using the average number of panels per business in each individual industry and the numbers of businesses in each industry for the individual suburbs of Moreland.

Property Energy Ratings

There are currently no widely used standards for a regulated disclosure of property energy ratings. We recommend MEFL encourage a pre-existing standard, or create their own with the help of the Moreland City Council, to allow businesses and landlords to assess their energy practices to a regulated standard. A standard like this would allow landlords to increase the advertising potential of their buildings. This would be their incentive to install solar, as they currently have no real financial incentive to install a solar system themselves; however, classification through such a standard could allow landlords to raise rent due to the building's lower electricity costs.

Conduct Case Studies of Landlords and Businesses

Upon learning how helpful our case studies were to our findings, we recommend MEFL to conduct case studies about landlords and businesses that currently have solar PV installed. We would have liked to gather more information from landlords for our project, as we believe the interaction between landlords and business owners are a large barrier in the implementation of

solar. Case studies of landlords can provide insight as to why they do or do not want solar and can allow MEFL to learn how to encourage them to install solar in the future. Additionally, MEFL should conduct more case studies of businesses with solar, because the information these businesses can provide as to how and why they installed can be valuable information in motivating similar businesses to install.

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1 INTRODUCTION

The change in the global climate has been described as being caused primarily by human actions, specifically exponential population growth and overconsumption of natural resources such as fossil fuels (Vitousek, 1994). Carbon dioxide concentrations have increased by over 30% since pre-industrial times, with half of this increase since 1965, and the global mean surface temperatures have increased 0.6°C since the late 19th Century (0.2-0.3°C over the past 40 years) (Thomas R. Karl & Kevin E. Trenberth, 2003). Considering approximately 75% of human-induced carbon dioxide emissions in the past 20 years are due to fossil fuel combustion, and gas prices are set to triple in the next decade, it is clear that people need to reduce their consumption and shift their reliance to resources that are both renewable and less impactful on the environment (J.T. Houghton et al., 2001; "Why We Need the RET," n.d.)

While climate change is a global problem, it often falls on individual countries to respond to this crisis. Australia has responded to the call for more renewable energy sources by putting increased attention on solar photovoltaic (PV) systems. Australia receives the highest amount of solar radiation on the planet, making solar PV systems an ideal alternative energy source (Gies, 2003). Solar PV use has seen a climb in numbers in the past decade in Australia; however, it has recently begun to drop due to reduced government incentives.

In an effort to encourage community-wide sustainability, the Moreland City Council established the Moreland Energy Foundation Ltd. (MEFL) in 2000. MEFL works to assist Moreland, a municipality in Melbourne, Australia, to increase their uptake of solar energy. The goal of the Moreland Energy Foundation is to bring Moreland to a zero carbon emissions state by encouraging a reduction in overall energy usage as well as the installation of renewable energy sources, primarily solar PV. Organizations like MEFL have helped to increase solar uptake in Australia by an average of 56% annually over the past 10 years ("Australian Energy Statistics," n.d.). As a source for alternative energy, solar PV is very well suited for an urban municipality such as Moreland. Wind energy is also very popular and viable in Australia; however, it requires large land space and is most economic on large scales, and is therefore not applicable to individual residents or business owners in an urban setting. Hence, MEFL continues to encourage solar technology amongst the residents in the Moreland community.

While residential uptake of solar PV has seen significant growth in the Moreland area, only a handful of businesses use solar PV. Due to the high number of businesses with a storefront in Moreland (over 4,000 buildings) and the large quantity of electricity a single businesses uses, increasing the number of businesses that use solar PV would greatly help to reduce Moreland's carbon emissions (Bruce Thompson, Andrew Guthrie, Kristen Wood, & Matthew Sullivan, 2014). Fortunately, the overall cost for a solar PV system has decreased in recent years and it is now possible for a small company to afford this technology rather than it being exclusive to large enterprises and energy utility companies.

The Moreland City Council and MEFL are working together on a new strategy called Zero Carbon Evolution (ZCE); ZCE plans to reduce the carbon emissions of Moreland by 20% by the year 2020. ZCE will help businesses save money and reduce each of their respective energy costs by utilizing alternative energy.

The goal of this project was to assist the MEFL in the expansion of solar PV usage by Moreland businesses by researching and analyzing factors that influence solar PV uptake as well as the demographic makeup of the commercial community. The project concluded with recommendations for further action to be undertaken by MEFL in their Zero Carbon Evolution strategy. In order to complete this project goal, we developed the following objectives:

1. Determine the opinions of businesses in Moreland regarding solar PV
2. Gather information in order to understand the composition and geographic distribution of industry in Moreland
3. Determine the physical solar potential of Moreland businesses by analyzing a suburb of Moreland and extrapolating these findings to represent all of Moreland.

In order to be most efficient in targeting businesses for solar PV uptake MEFL will utilize the information from our research to first work with those businesses that have the least amount of barriers to installation and with whom the strategy applies. Simultaneously, they will work with those businesses with more challenging barriers to resolve the issues so that solar PV uptake may become more feasible for these businesses as well.

Although MEFL's goal is to help the Moreland community reach a state of zero carbon emissions, they are aware that businesses are primarily motivated by financial incentives compared to environmental implications. For this reason, our research focused on the financial impacts, incentives, and barriers for solar PV, as opposed to the environmental impacts. While

the environmental impacts were the focus, motivating businesses through financial gains was the best way to reach zero carbon emissions for the Moreland business community.

In Chapter 2 we discuss social, political, economic, and technical aspects which influence or are influenced by solar PV technology. We also examine the current state of the Australian energy sector and provide information on solar PV, both generally and specific to Australia. The politics that play a role in solar PV are discussed, as well as information about our sponsor. In Chapter 3 we explain the steps we took to gather information for our project deliverables. The end product is useful data and recommendations that will help MEFL implement their ZCE engagement strategy in encouraging businesses to install solar PV. In Chapter 4 we discuss the findings and recommendations of our research and present our conclusion for this project.

2 BACKGROUND

2.1 Current State of the Australian Energy Sector

2.1.1 Rising Energy Costs

Across Australia, electricity prices have risen sharply in the past few years and are projected to continue growing in the current market; electricity costs have risen 46% on average nationally in the past decade (Novak, 2010). To combat these growing energy prices, Australians must find new ways to reduce and supplement their energy needs. Already, efforts have been made in both of these areas, but have yet to curb energy prices to a suitable level. This has caused many people to seek more alternative energy sources such as solar photovoltaic (PV) systems (AEMO Media, 2013).

Reducing energy consumption is the easiest way for people to reduce energy bills. Energy conservation has become a common and encouraged practice in Australia in recent years. From 2009 to 2014 there was an average annual decrease in energy consumption by 1.8% per capita (AEMO Media, 2013). These reductions have been made through habitual changes such as unplugging unused electrical devices, using less hot water, using fans instead of air conditioners, as well as implementing improved home installation and hardware changes like efficient refrigeration and heating appliances and low energy light bulbs ("Reducing Your Energy Consumption," n.d.). Despite this national effort to reduce energy consumption, Australians are still facing continually increasing electricity bills and are looking to further reduce their energy costs by supplementing their energy supply.

Solar energy is providing those who install PV panels with a great way to reduce their energy bill. There has been a 23.6% increase in solar PV installation in Australia, resulting in a 2.9% decrease in large scale energy supplier grid consumption in 2013-2014 (AEMO Media, 2013). This is because installing solar PV panels reduces power bills an average of 65% (Andrew Blakers, Glen Morris, Giles Parkinson, Penny Parle, & Paul Riley, 2014). However, the large upfront cost of installing solar panels is preventing many who would be interested from actually investing.

As a result there are many government and non-governmental organization efforts to help eliminate this cost barrier so that more people can more easily install solar panels (Hunt, Kurisko, MacDowell, & Pietri, 2013). The government support comes in the form of the

Renewable Energy Target (RET) which is further explained in the Politics section of this chapter. However, much of the government funding that is being provided is at risk of being removed due to the changing political field. Leaders among the solar PV industry have stated that if the government subsidies are withdrawn, the solar PV industry will most certainly collapse. The fear of the existing government subsidies being removed has caused the stock prices of several major PV companies to plummet recently. Government officials are saying that the renewable energy installations have already exceeded their predicted targets and that the subsidies are costing the government too much to continue supporting ("RET changes," 2014). Ironically, it is projected that reducing the Renewable Energy Target would actually increase electricity costs for consumers as well as increase energy supply companies profits by AU$10 billion by 2030 ("TCI," 2014).

Solar PV provides a potential solution to the larger energy cost problem in Australia. With solar technology seeing rapid advances due to increased viability, it is likely that solar will continue to become even more efficient and affordable for small scale installation ("Cheaper Solar Panels," 2014). Given that renewable energy sources only contribute 1.7% of Australia's energy production, they will not likely replace large scale power suppliers for the foreseeable future; however, ignoring solar PV's potential will result in rising energy costs with no viable alternatives for small scale residential or business installations ("Australian Energy Statistics," n.d.).

2.1.2 Energy Industry and its Environmental Impacts

Fossil Fuels

Across the world, the modern energy industry is based around natural resources, primarily coal and crude oil. Neither of these sources are sustainable or renewable, nor can they be replenished quickly enough to meet current demand. Andrew Blakers of the Australian National University reports that if 1200 Megawatts (MW) of alternative energy sources, such as solar panels and wind turbines, are installed each year between 2014 and 2050, the Australian energy supply will be fully transformed (Andrew Blakers et al., 2014).

Changes to the Economy

Switching from nonrenewable resources, such as coal, to renewable resources, such as solar, will be a large undertaking for Australia. According to the World Coal Association, an

association of major international coal producers, Australia produces 69% of its electricity from coal, making it the fifth most coal-dependent nation in the world ("Coal Facts 2014," 2014). As a nation, 41.7% of Australia's economy is based on exports of non-renewable energy sources; of these exports, 30% comes directly from the export of coal (Australian Government Department of Foreign Affairs and Trade, 2013). When fossil fuel resources run out, there will be a large economic downturn if Australia continues to rely on exporting natural resources. At the same time, alternative energy sources currently present a danger to the fossil fuel market. "Solar and other renewables put downward pressure on wholesale electricity prices because the input cost are free, so even during peak demand their production costs are low and fixed" (Andrew Blakers et al., 2014). Lowering the demand of fossil fuels will reduce the amount of money Australian providers will receive for their exports. According to the aforementioned facts, Australia's fossil fuel-dependent economy is unsustainable in a future with lower demand for fossil fuels. It is estimated that coal and other fossil fuels will be fully depleted by the year 2050 (Andrew Blakers et al., 2014). Australia's economy will face difficult changes if it does not reduce its dependency on non-renewable resources. Development of sustainable and environmentally friendly energy sources will provide long term relief and support for the Australian economy.

2.2 Current State of the Solar Photovoltaic Industry

2.2.1 Solar Photovoltaic System Configurations

Solar PV systems convert solar radiation from the sun into electricity, while producing no output emissions, including carbon. These systems are usually in one of two configurations, standalone and grid tied. Both standalone and grid tied systems can be beneficial, but the ideal system choice is often based on geographic location and local utility services.

If electricity produced by a standalone system is not immediately used, it is stored in batteries for use at a later time. This typically means electricity is stored in the batteries when the sun shines during the day, and is drained from the batteries at night when more electricity is used. These systems are generally found in more remote areas that are farther from the grid and can be less easily connected to it. In this case, if there is no power stored in the batteries and the solar system is not producing electricity, there is no electricity that can be consumed at that moment (Noone, 2013).

The second type of solar PV system is grid tied, where the system connects into the local power utility's transmission lines. Under this configuration, the electricity produced by the solar panels is not stored, but added to the grid if not consumed immediately onsite. If there is additional electricity demand than what the onsite solar PV system can supply, the building will draw power from the grid. All electricity is consumed from the grid if the system is not generating any itself (Noone, 2013).

Any system that is tied into the grid is charged for the electricity it takes from the grid in one of two ways. The first option is net metering. The second method of payment is gross metering where the utility company pays the system owner for all the electricity their system produced, and the system owner pays the utility company for all the electricity they consumed from the grid. Net metering is the method most commonly used in Victoria (Noone, 2013).

2.2.2 Types of Solar Panels

There are two major types of solar panels: crystalline structured and amorphous. The crystalline panels are more efficient than the amorphous panels, and therefore produce more electricity, but are also more expensive (Pode & Diouf, 2011). Crystalline solar panels are approximately 12-17% efficient, depending on the quality of the panel and whether the panel is of monocrystalline or polycrystalline structure, while amorphous panels range between 6% and 8% efficiency (Pode & Diouf, 2011). Therefore, amorphous panels need more physical space to produce the same amount of electricity as crystalline panels, which becomes a critical point when roof space is discussed. Another major difference in the two types of panels is that crystalline panels need direct sunlight to produce electricity, while amorphous panels only need a source of light to produce electricity ("Solar Panels - Frequently Asked Questions," n.d.). In short, there are different options when considering solar panels, based on the desired system output, cost, and other factors.

2.2.3 The Importance of Orientation and Tilt of Solar Panels

In order to obtain the maximum possible amount of electricity generated from solar panels, orientation and the angle at which the panels are fixed needs to be considered. In the Southern Hemisphere, panels absorb the most amount of sunlight when they face North. When panels are angled 45^{o} off of North, they reduce in output by about 8%; and when panels are angled 90^{o} from North (East or West facing) the system loses about 30% in output energy

("Solar Panels - Frequently Asked Questions," n.d.). South facing solar panels are not a practical orientation in the Southern Hemisphere.

After considering a system's orientation, the angle at which the panels are mounted relative to the ground is another key factor in maximizing efficiency. The general rule of thumb is that the panels should be fixed to approximately the same angle of latitude at which they are located, plus or minus ten degrees. This alignment will allow them to absorb the maximum amount of energy throughout the year. The angle needs to be considered because nearby obstructions to solar systems could warrant changing the angle if the obstructions block sunlight for a portion of each day. Occasionally roofs are angled within the goal range, but when the roof is flat or not within the desired range, frames can be added to correct this angle as to maximize the system's output. Figure 1 displays the efficiency a solar system would have based on its orientation and tilt angle for the Sydney, Australia area, which is located at about 34^{o} south in latitude.

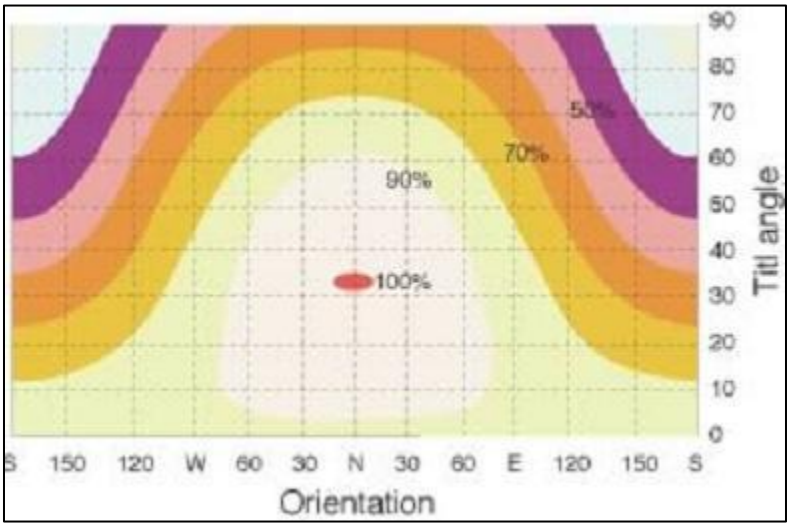

Figure 1 - Efficiency of Solar PV in Sydney based on its Orientation and Tilt Angle[1]

2.2.4 Solar Viability

While solar energy sounds like a renewable and clean solution to global warming, carbon emissions, and rising energy costs, is it a viable option? Solar energy in Australia is more than feasible. As stated in *Your Home*, an Australian government guide to environmentally sustainable homes, "Sufficient sunlight falls on Australia to supply the nation's total energy

[1] Harburn, J. (2010, January 7). Solar Panel Tilt and Orientation in Australia [company]. Retrieved September 13, 2014, from http://www.solarchoice.net.au/blog/solar-panel-tilt-and-orientation-in-australia/

needs many times over" (McGee, 2013). This is supported by looking at Figure 2 below, which shows the average solar radiation for the years 1990 to 2004. The darkest spots represent the most solar radiation, showing that Australia is the only landmass with a substantial area of the darkest color covering nearly the entire country.

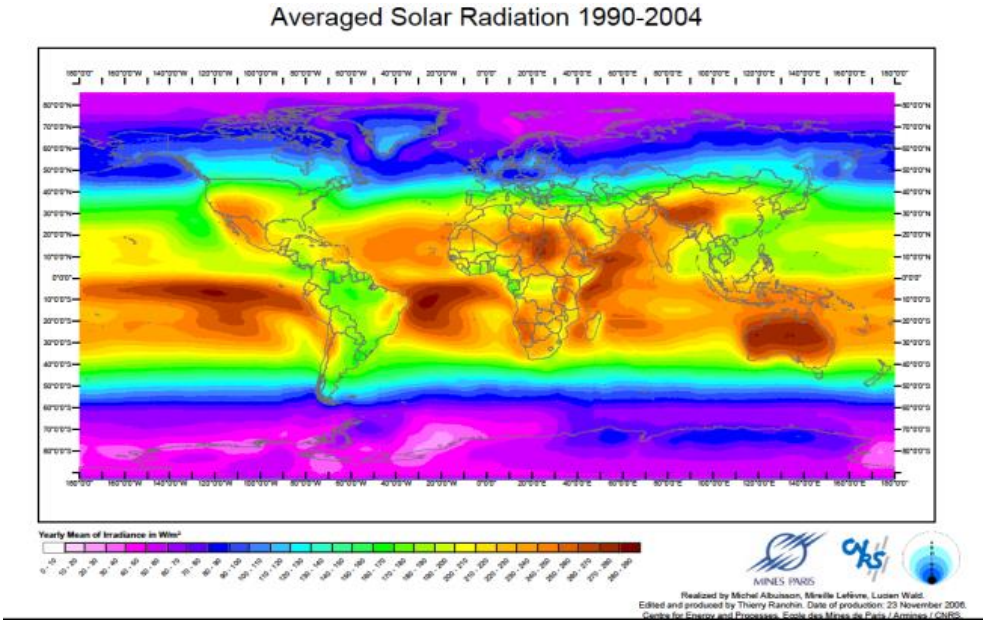

Figure 2 - Average Solar Radiation 1990-2004[2]

The amount of solar radiation a location receives depends on a few things. First is the latitude: the closer to the equator, the more solar radiation a location will receive. Elevation also plays a large part, as an increase in 300 meters in altitude result in a 4% increase in solar intensity (Gies, 2003). Additionally, Australia receives more solar radiation than most places on the globe because it is in the Southern Hemisphere. During their respective summers, the Southern Hemisphere is closer to the sun than the Northern Hemisphere, resulting in an increase of 7% sun intensity (Gies, 2003). The cleaner air in the Southern Hemisphere has less air pollution than the Northern Hemisphere, also resulting in higher sun intensity. These two factors account for 15% more sun intensity in the Southern Hemisphere than equivalent latitude locations in the Northern Hemisphere; moreover, the ultraviolet radiation (UVR) levels are higher in the Southern Hemisphere than the Northern Hemisphere, as demonstrated in Appendix B. The significance is that there is indeed a large potential for solar PV systems in Australia. Australia is well suited for the implementation of this renewable energy source. Our project's

[2] Isirdo, M. (2013, October 8). Australia - where the Sun hits the hardest. Retrieved from http://thestarlightwalker.wordpress.com/2013/10/08/australia-where-the-sun-hits-the-hardest/

aim was to help the Moreland Energy Foundation (MEFL) in their quest of making Moreland a zero carbon emission community, and the use of solar energy is a very practical way to achieve this.

2.2.5 Social

The increasing viability of solar energy makes it a solution to rising energy costs and concerns of global warming and carbon emissions. However, how do people view the technology and what it has to offer? In Australia, a large percentage of the population—over 75%—thinks favorably of renewable energy sources (Andrew Blakers et al., 2014). Solar and renewable energy also plays a role in Australia's politics. As stated by Senators Milne and Ludlam, "Solar is popular and supported by the masses, everyone wants solar." They also mention that solar essentially buys votes from the Australian population in electorates because it is so popular. However, not all agree with the advantages of renewable energy. For example, the Australian Prime Minister Tony Abbott was accused of being, "…blind to the economic and environmental benefits of the RET" according to Mark Butler, the Shadow Environment Minister (Andrew Blakers et al., 2014). One important reason there is disagreement regarding the RET and government support of renewables is cost. That leads into the last point of the current state of solar PV systems: how much money they cost, and moreover, how much money a solar PV system can save over its lifetime.

2.2.6 Financial

The cost of a solar PV system depends on many variables, the most obvious of which are desired size and number of panels. The type and quality of the components, as well as installation costs, are also unavoidable expenses. In addition, the types and amounts of government rebates and tariffs that are available will greatly affect the total out-of-pocket expenses of the system. Additional costs that some systems may have to include are from removal of trees or other shade producing objects and existing infrastructure upgrades for older buildings ("Guide to installing solar PV for business and industry," 2014). While costs vary based on the aforementioned characteristics, Table 1 displays cost estimates of different sized systems for some of Australia's major cities, taking government rebates into account
("Guide to installing solar PV for business and industry," 2014)

System Size	Price Range
10 kW	AU$10,390 - AU$20,940
30 kW	AU$37,750 - AU$54,840
50 kW	AU$65,000 - AU$89,115
100 kW	AU$107,900 - AU$186,525

Table 1 - Estimated Solar PV System Prices ("Guide to installing solar PV for business and industry," 2014)

One characteristic people are often concerned about when installing solar PV is the large upfront cost. However, over time, the system pays for itself and then begins saving money that would have been otherwise spent on electricity costs. If just half of a business' electricity is provided by a solar PV system, the payback period would be around 10 years or less ("Solar Panels - Frequently Asked Questions," n.d.). Payback times are always fluctuating though, largely due to the fact that as overall energy costs rise, the system is saving the system owner more money and the payback time will be shorter ("Solar Panels - Frequently Asked Questions," n.d.). Another estimate is that commercial solar PV systems can pay for themselves in seven to ten years, depending on whether or not the RET will be repealed[3] (see Politics) (Dick Warburton, Dr Brian Fisher, Shirley In't Veld, & Matt Zema, 2014).

2.2.7 Moreland Business Sector

Since MEFL has already targeted the residential sector of Moreland, they wish to target the next population that can implement solar power – businesses. Businesses tend to consume more electricity than residents, so it is a valuable sector to target. MEFL has little information about the businesses in Moreland compared to what they wish to know. However, they do have some basic information about businesses in the community. As of 2013, there were over 11,000 businesses in Moreland. The business community is comprised of approximately 16% Construction, 12% Professional, Scientific and Technical Services, 11% Transport, Postal, and Warehousing, 10% Rental, Hiring, and Real Estate Services, 8% Retail Trade, and 43% other (Australian Bureau of Statistics, 2014). This information is useful as we wish the outcome of our project to take the business type into consideration when evaluating its solar PV feasibility. This breakdown of business types helps us understand the types of businesses we will be targeting, and further understand the characteristics of our target population.

[3] As discussed in the Politics section, the RET is under government review and portions may possibly be eliminated.

MEFL wishes to understand how to make installing solar power more appealing to businesses, which is one of the things we aim to help them discover with this project. One attitude of business owners which MEFL is aware of is that businesses are primarily motivated by saving money. Most businesses are less motivated by the environmental impacts of renewable energy than they are by the potential financial savings that these sources of energy can provide ("Zero Carbon Moreland," 2014).

It is also recognized by MEFL that they need to provide businesses with simple and limited options for solar energy, since businesses are time and resource limited and cannot look extensively into this energy source themselves ("Zero Carbon Evolution," n.d.). According to MEFL's research, businesses are concerned about the assurance of a return on their investment, and the time frame in which they will be paid back since many are renting or leasing property from a landlord that may or may not reimburse, or even allow, for the installation of solar PV ("Zero Carbon Evolution," n.d.).

Between 70% and 90% of businesses in Moreland lease their business location (Bruce Thompson et al., 2014). This adds another degree of difficulty when looking to install solar panels because not only does the business need to want to install, but the landlord also has to permit the installation. Furthermore, most leases are set for five years or less, which is less than or equal to the minimum payback time of solar panels. Ideally a business with a five year lease would just break even with this investment at the end of their lease. If a business with solar panels then moves they must either pay to have the panels moved or find a way to recover the cost of installation and leave them behind. These three factors make many businesses hesitant to install solar panels because even if they decide they want to, they may find that their landlord will not allow it. Considering so many businesses in Moreland lease their business location, it is important that we investigate options on how MEFL may be able to overcome these barriers.

2.3 Politics

When tackling an issue like climate change and modifying the energy sector, responsibility inherently falls on the government. Policy and funding dictate how the energy industry operates in addition to how citizens consume the energy. In recent history, Australia has struggled with two major pieces of environmental legislation; one being the RET and the other being the Carbon Tax.

The RET was established by the federal government in 2001 as the Mandatory Renewable Energy Target. It was revised in 2009, named the Renewable Energy Target and with the goal of sourcing 20% of national energy production from renewable sources by 2020 (Dick Warburton et al., 2014; Target, 2014). Essentially, large entities in the energy sector (primarily electricity providers) are required by the RET to provide certificates to the Clean Energy Regulator (CER) as proof of the production of renewable energy. These certificates are purchased by electricity providers directly from household, small business, and community group renewable energy systems (small-scale) as well as from renewable energy power stations (large-scale) (Environment, 2013). Entities regulated under the RET are required to surrender small-scale technology certificates quarterly and large-scale generation certificates annually. The purchase of small-scale certificates means additional profit—and incentive—to households and businesses that implement solar beyond the cost benefit of energy bill reduction.

Not only does the RET promulgate a more diversified energy profile, but it also stimulates the renewable energy industry and provides economic alternatives to consumers. By 2020 the RET is predicted to reduce the average energy bill by 2%, generate over 18,000 jobs, and prevent 34.7 million tons of carbon emissions from being emitted (Andrew Blakers et al., 2014; "Why We Need the RET," n.d.). It is not surprising that 64% of Australians polled in 2014 say the government should definitely keep the RET ("Renewable Energy Target Research," 2014).

However, the scheme has some inherent flaws that jeopardize its future as policy in Australia. While the renewable target is 20%, the collapse in some areas of manufacturing has increased the generation of renewable energy, pushing the 2020 estimate towards 26%. This could cost the nation AU$22 billion in cross-subsidies, due to the fact that the government spent about 5.6% of the government revenue on post-tax subsidies for petroleum, natural gas, and coal (about AU$20 billion) in 2011 ("Energy Subsidy Reform: Lessons and Implications," 2013; Pearson, 2014). In light of these trends, the Ministers for Industry and Environment established an expert panel in February 2014 to review the economic, environmental, and social implications of the RET to determine its cost efficacy ("Terms of Reference," 2014). The panel produced a report in August 2014 with their findings: to reduce the RET and better invest the resources. The government hopes to achieve this by either closing the large-scale program to new entrants and accelerating phase out, or reducing the RET overall, possibly eliminating the small-scale

program, so that the renewables share of national energy production doesn't exceed 20% by 2020 (Dick Warburton et al., 2014; Pearson, 2014). Abolishing the small-scale program would increase the cost of PV systems, therefore increasing payback time by three years, and would decrease the installment rate by 30% and not recover until the early 2020s (Dick Warburton et al., 2014). Alternatively, phase out of the small-scale program could save approximately $2 billion in cross-subsidies that would have been spent in 2015-2030. This option would also change the small scale eligibility requirements from 100 kW systems to 10 kW systems in order to truly target residential systems; a typical 8 m^2 system produces approximately 1 kW (Dick Warburton et al., 2014; "Solar Panels - Frequently Asked Questions," n.d.). The statutory review of the RET must be completed by the Climate Change Authority by the end of 2014 ("2014 Renewable Energy Target Review," 2014). While the future of the RET is uncertain, it is clear that major long-term policy is difficult in an ever-changing market like electricity.

Another policy implemented to more specifically reduce carbon emissions was the Carbon Tax. Established in 2012 and repealed in 2014, the Carbon Tax required eligible facilities (those that emitted more than 25,000 tons of carbon dioxide annually) to offset their reported emissions by surrendering units to the CER ("How the Carbon Tax Works," 2014). With an increased cost to electricity generators and providers, consumers felt the impact with an estimated 10% increase in energy cost, and the renewable energy sector increased in response to higher prices. Like the RET, there was value to the Carbon Tax, yet not enough to outweigh the costs. During its two years of operation, carbon emissions were reduced by 29 million tons (8.2%) across the National Energy Market, emissions intensity decreased by 2-3%, and electricity demand decreased by 1-2% (Frank Jotzo, 2014). However, the tax was repealed because it was believed to have too much cost to consumers without enough environmental benefit (measured by reduced carbon emissions); the Australian Treasury predicts that a Carbon Tax-free 2014-2015 will decrease average living costs by AU$550 ("How the Repeal Will Work," 2014). It can be predicted that without the pressure of the Carbon Tax translated to consumers, there will be less of a demand to reduce electricity bills, and therefore less implementation of small-scale renewable systems like solar.

With the repeal of the Carbon Tax and potential reduction or elimination of the RET, the Direct Action Plan was introduced to Parliament in June 2014 as a means of implementing the Emissions Reduction Fund (ERF). The Carbon Farming Initiative Amendment Bill 2014

establishes the ERF as a replacement to the Carbon Tax by establishing an emissions trading scheme monitored by the CER. Similar to the RET, the ERF will require emission reductions to be traded, bought, or sold to entities, but will allow for a broader range of reduction projects ("Carbon Farming Initiative Amendment Bill 2014," n.d.). According to the Department of the Environment, the ERF "will operate alongside existing programs that are already working to reduce Australia's emissions growth such as the RET and energy efficiency standards on appliances, buildings, and equipment" ("Emissions Reduction Fund," n.d.). It is unclear at this point in the legislative process what impact the ERF will have on small-scale energy producers like businesses.

Even without large, concrete programs like the RET and Carbon Tax, the government still provides incentives to participate in alternative energies, the largest of which are feed-in tariffs. Like net and gross feed metering, there are net and gross feed-in tariffs. Net feed-in tariffs pay returns for any excess power they feed into the grid; gross feed-in tariffs pay per kilowatt-hour (kWh) generated ("Victorian Feed-in Tariff Schemes," 2014). Appendix C summarizes the types of net feed-in tariffs present in Victoria. There is a proposed rate of AU6.2 ₵/kWh to take effect on January 1, 2015, which is reduced from AU7.4 ₵/kWh after the Carbon Tax was repealed ("Victorian Feed-in Tariff Schemes," 2014).

2.4 Moreland Energy Foundation (MEFL)

2.4.1 History

Before the Moreland Energy Foundation, Ltd. (MEFL) existed, the government-owned Brunswick Electricity Supply Department (BESD) provided electricity to the Brunswick area as well as encouraged energy efficiency. However, the electricity supply industry was privatized in the 1990's, resulting in the sale of the BESD. Without the BESD, the local community lacked a focus on energy efficiency and conservation. In response, the Moreland City Council (MCC) created a new body focused on features such as energy conservation and lowering carbon emissions; this new body became MEFL ("Our history," n.d.).

MEFL is a non-profit organization based out of Brunswick, Victoria, Australia. By collaborating with the local community, MEFL works to further energy conservation with the goal of reducing carbon emissions. On MEFL's website they explain that they "…undertake community engagement, do research, consult, provide professional development and advocate on

energy efficiency, renewable energy and related policy and planning issues" (Moreland Energy Foundation Ltd., n.d.).

2.4.2 Previous Initiatives

Since its inception, MEFL has rolled out several major initiatives for the Moreland community. One of these projects that has already been successfully completed is Zero Carbon Moreland (ZCM), which ran from 2008 to 2012. The goal of ZCM was to reach out to businesses and residents of the Moreland community in order to reduce carbon emissions by 20% by 2012 ("Zero Carbon Moreland," 2014). By 2012, ZCM worked with over 4,000 residents and business to lower environmental impact. Through the ZCM program, 110 homes were retrofitted for more efficient heating and cooling (Moreland Energy Foundation Ltd., n.d.).

This community outreach provided a smooth introduction for Positive Charge. Launched in 2013, Positive Charge is the business arm of MEFL. They aim to provide individuals and businesses with information on products such as solar panels, insulation, and windows. Positive Charge also offers the community local workshops on energy conservation techniques and sustainable practices (Positive Charge, 2014).

In June 2014, MEFL launched Zero Carbon Evolution (ZCE) in partnership with MCC (Moreland Energy Foundation Ltd. & Moreland City Council, 2014). Zero Carbon Evolution is similar to Zero Carbon Moreland; however, ZCE has higher goals for the community. By 2020, ZCE plans to reduce Moreland's carbon emissions by 20%, in addition to having solar panels on 1,200 businesses and 60 community buildings. In order to reach this goal, MEFL is going to work directly with businesses in order to simplify their integration of solar power. To assist larger establishments such as schools and sports clubs, MEFL will offer low-interest loans to help the large set-up cost. When considering installing solar panels, the high installation cost is a major barrier. As part of ZCE, MEFL has established the Bulk Buy program in conjunction with Energy Matters, a solar panel installer and supplier. The Bulk Buy offers residents and businesses of Moreland a 10% discount to the upfront installation cost of solar panels as well as an extended warranty (Andrew Guthrie, 2014).

A unique goal of ZCE is to establish the Moreland Community Solar Co-Operative. This will be a large solar PV establishment allowing community members who do not have the proper physical structure for solar panels or the capital for the installation of solar PV to still participate

in the growth and development of solar PV energy. MEFL hopes for these goals to be fulfilled by 2020 (Moreland Energy Foundation Ltd., n.d.).

2.4.3 Our Role

Our role was intertwined with Zero Carbon Evolution; through surveys and interviews of local businesses, we determined what benefits businesses would like to see from solar energy and what is preventing them from installing solar energy now. We created a set of recommendations that outlines the enablers and barriers that businesses face in regard to the integration of solar PV. Our goal was to provide MEFL with this information to help them approach businesses for the installation of solar PV systems as part of the ZCE strategy. Our chosen methods for accomplishing this goal are outlined in Chapter 3.

3 METHODOLOGY

The goal of this project was to assist the Moreland Energy Foundation Ltd. (MEFL) in the expansion of solar photovoltaic (PV) usage by Moreland businesses by researching and analyzing factors that influence solar PV uptake as well as the demographic makeup of the commercial community. The project concluded with recommendations for incorporation into the Zero Carbon Evolution strategy. In order to complete this project goal, we developed the following objectives:

1. Determine the opinions of businesses in Moreland regarding solar PV
2. Gather information in order to understand the composition and geographic distribution of industry in Moreland
3. Determine the physical solar potential of Moreland businesses by analyzing a suburb of Moreland and extrapolating these findings to represent all of Moreland.

3.1 Objective 1: Determine the Opinions of Businesses in Moreland Regarding Solar PV

To gain a better understanding of our target population, we first wanted to learn how solar PV systems were perceived by local businesses so that we could identify any shortcomings or misconceptions in their understanding. The information we gathered from this objective provided basic demographic information for businesses such as their business type, number of full time-equivalent employees, and electricity costs.

3.1.1 Survey

To learn more about Moreland businesses and to obtain information on which to base our recommendations, we conducted a survey of a broad selection of businesses. The survey asked for some of their opinions on solar, such as why they were or were not satisfied with their solar PV system, or why they had or had not yet installed a system. The survey also contained questions which measured businesses' knowledge of the topic, such as the payback time and upfront installation cost, so that we could determine what businesses currently know about solar power.

The online survey of local businesses consisted of 15-26 questions, depending on how the respondent answered some key determinant questions. Each survey respondent followed one of nine independent paths, as the respondent's previous answers would designate the subsequent

questions. The link for the survey was sent out to businesses via email. The businesses' emails were obtained from contact lists created by MEFL from past events, the Sydney Road Brunswick business directory, and the Moreland City Council's business email list. The Moreland City Council (MCC) sent out the survey on our behalf to its business email list as not to give out business contact information without the proper permission. Along with these emails, the survey was added to the front page of MEFL's website and posted on MEFL's and MCC's business Facebook page. The survey was anticipated to reach approximately 1,800 businesses.

A survey was used for this objective because we wished to target as many businesses as possible and we did not have the time or resources to individually interview them all, making the survey an efficient tool to gather data from the large sample pool. Another reason why we chose to use a survey in this application was because the responses to the survey could more easily be analyzed as quantitative data and easily examined to find trends amongst the responses.

Along with technical information, we were looking to understand the financial requirements that business owners want to meet in order to be more drawn to solar PV. It is also important for MEFL, and us, to know if business' expectations of solar PV are accurate. The questions that targeted this information included: what maximum upfront cost they would be willing to pay for the system, what maximum payback time they expect for the system once it has been installed, and what minimum percentage of their current usage they want the system to produce (see Appendix E for the full survey). Understanding these requirements helped us gauge business owners' current understanding of solar PV.

Also within this objective, we wished to learn how many businesses lease their business space, which was asked in the survey. This was important as a large percentage of commercial spaces are leased from landlords, which adds a complexity to installing a solar panel system, further explained in Chapter 4.

Creating the Survey

In an attempt to garner the most responses we could from the survey, we made the survey quick and easy for respondents. We did so by making the survey short and emphasizing the fact that it would only take about five minutes to complete.

While creating the survey, one way we managed to keep it short and simple was by utilizing ranges for some answers so that a respondent didn't have to take time to look up exact information, such as their electricity expenses. Electricity usage and costs often fluctuate as

seasons change, and ranges were an effective way to take some of these variables into account. Additionally, ranges provided a higher level of confidentiality for questions asking about more personal information such as business expenses and savings. See Figure 3 below for an example of a survey question with ranges.

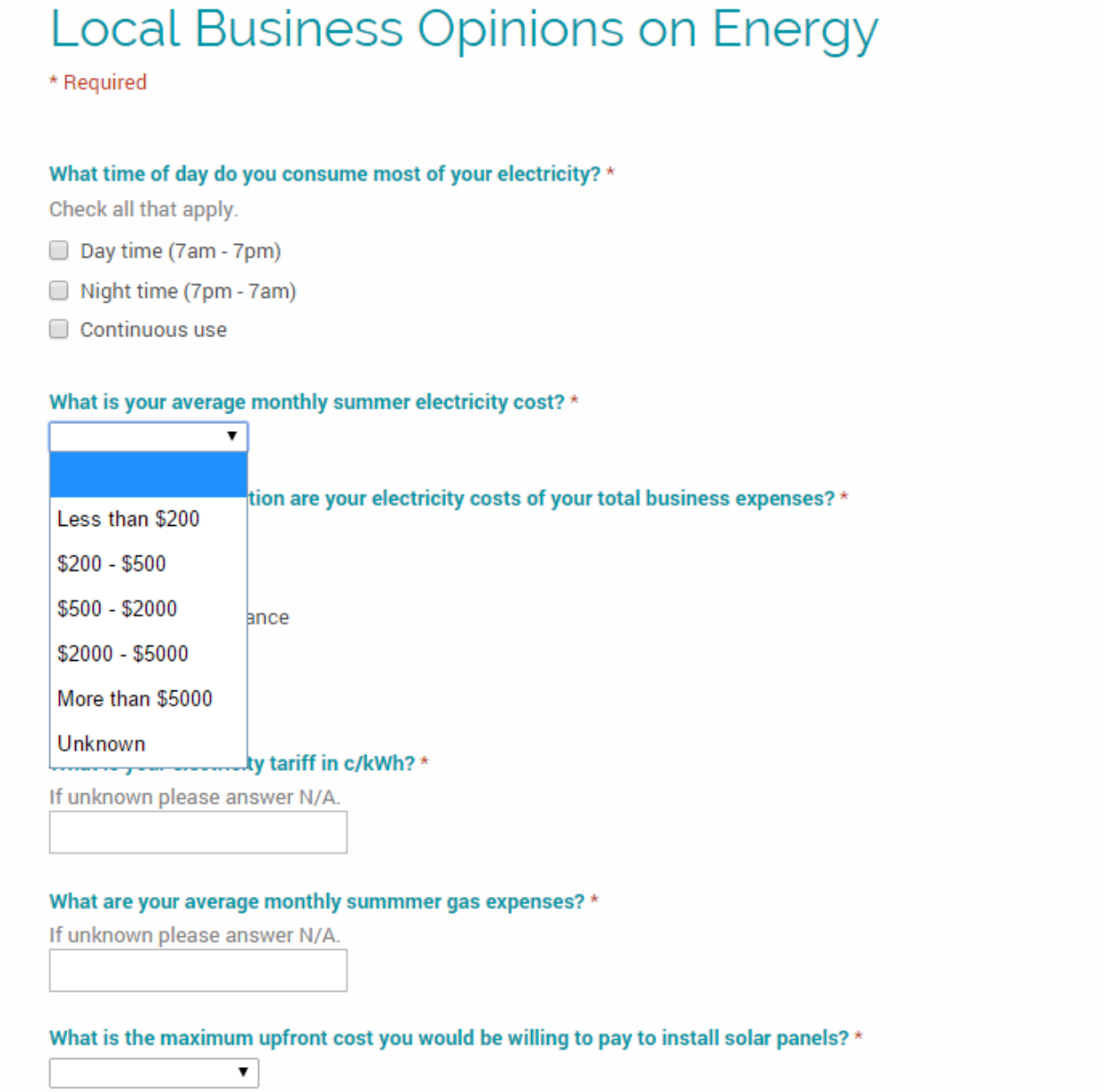

Figure 3 - Example Range Survey Question

3.1.2 Interviews

Interviews with Businesses

Following the distribution of the survey, we conducted semi-structured interviews with a selection of the businesses with whom we surveyed. With this we wished to gain a clearer understanding of the consideration process for installing a solar PV system. We spoke with three businesses who, at the conclusion of their survey, stated that they were willing to interview with us and explain more of their thoughts and opinions on solar. If they indicated they would like to be interviewed, we contacted them and set up an in-person or over-the-phone interview. We created follow-up questions specific to the nine different survey response paths and asked them questions corresponding to the path to which they responded (see Appendix F for the interview questions). The interviews were semi-structured so that there was a conversational aspect and so that the line of questioning could be modified based on the interviewee's answers.

Interviews with Business Consultants

Another important area of interest for us was how landlords can take advantage of solar PV integration. Businesses which lease their building space provide another layer of complication for solar PV installation. Many building leases are written such that the tenant pays for their own electricity usage. Therefore, a landlord would have no incentive for installing solar panels because they would not see the beneficial reduction in utility bills. This leads to complications with payment for a solar PV system and ownership of the system. Businesses that lease may not want to install solar panels on the building because the payback time for the panels may be longer than the business will be occupying the building. If a tenant's lease is not continued and the tenant leaves the building they would then lose their investment. For this reason, understanding the opinions of landlords in relation to solar PV was very important.

We attempted to contact commercial landlords to gather some information from their point of view, similar to the information we collected from businesses. Given that there was no list of landlords available to us through MEFL or MCC, we attempted to contact landlords through real estate agents. As further described in Chapter 4, we found that landlords are difficult to contact directly and most often work through real estate agents. We understood that real estate agents would not want to give out their clients' information so we asked them to forward our contact information and a description of our project to their clients. We received one confirmed referral, but were never contacted by a landlord. The survey and interview questions we prepared

for landlords can be found in Appendix I. Moreover, we spoke with the local Trade Association representative of Sydney Road Brunswick, Claire Perry, and a solar panel installation salesman, Rory Allen, from Energy Matters. Energy Matters is a solar panel installation company which works with MEFL and Positive Charge through ZCE.

The semi-structured format of these interviews also allowed for follow up questions and comments which in many cases led to valuable information from the interviewee. See Appendix G and Appendix H for the prepared questions asked during interviews, not including any follow up questions asked on-the-spot during the interviews.

3.2 Objective 2: Gather Information In Order to Understand the Composition and Geographic Distribution of Industry in Moreland

In order to understand the business composition of Moreland, we used census data provided by the Australian Bureau of Statistics to analyze each district within Moreland for number of businesses per industry. We then used this data to create maps of the distribution of each industry and the top industry for each district in Moreland (see Appendix K).

Using city planning maps, we also determined where commercial, industrial and mixed use zones are located within Moreland. This helps us identify the geographic distribution of each of the represented industries previously identified, so that we might understand what concentration of businesses lies where in Moreland. See Figure 9 in Section 4.1 for the map showing business zoning.

3.3 Objective 3: Determine the Physical Solar Potential of Moreland Businesses By Analyzing a Suburb of Moreland and Extrapolating Findings to Represent All of Moreland

Following our surveys and interviews, we conducted research into where high densities of commercial and/or industrial businesses exist within Moreland, and into what types of businesses were in these areas. Given that Coburg North is heavily industrialized, we wanted to examine the district's industrial sector to measure its potential solar PV capacity. By doing so we learned how much energy could be provided by solar PV installed in this area.

3.3.1 Solar Potential of Coburg North

Analyzing Coburg North provided insight as to how many solar panels could actually be installed in this given area. This helped us understand the solar potential for other industrial areas

within Moreland as well by extrapolating our data. We used a combination of Google Maps and a digital mapping software tool called NearMap to determine the maximum physical potential for solar PV in an industrial and commercial area of Coburg North. Knowing the maximum number of panels an area can support, and therefore the maximum energy that an area can produce, we could estimate reasonable targets for encouraging installation. We could then use that information to extrapolate to similar commercial or industrial areas and estimate that area's maximum potential as well.

First we used Google Maps and Google Street View to create a list of business locations and addresses in Coburg North. From this list, we found these businesses on NearMap and used tools within NearMap to determine the number of solar panels individual commercial roofs could support. NearMap allows users to measure roof space in a variety of ways, and virtually install solar panels on the roof.

To determine the solar capacity of a roof, we first broke them down into three sub sections: flat, slanted North-South, and slanted East-West. Some buildings had multiple roof sections of different types, so we measured the dimensions in meters of these sections individually, and then summed them together to find the total capacity of such buildings. By identifying the type of roof we could determine how the solar panels would theoretically be mounted. While not all of the buildings were exactly square to the coordinate system, all of the buildings were close enough that we could fit them into one of these three categories.

For flat roofs the panels would need to be mounted on angled frames to compensate for the sun's angle to the horizon. Due to the shading produced by the angled panels, we added a 0.6 meter gap for each additional row of solar panels to be mounted so that no panel would be in the shadow of the one in front of it. We virtually mounted the panels with the short facing the North side of the building because the angled frames were designed for the panels to be mounted this way (see Figure 4).

Figure 4 - NearMap Example with both Measurement Methods

With slanted roofs we did not need to add this gap so the panels could be mounted right next to each other. For East-West slanted roofs we could mount the panels on both sides of the roof because they would receive equal sun exposure. For North-South slanted roofs we would only mount the panels on the north side because panels on the south side would receive almost no sun exposure (see Figure 5). Whether East-West or North-South, we would mount the panels such that the short side of the panels ran parallel to the lower edge of the roof.

Figure 5 - North Facing Panels on a Slanted Roof (NearMap)

To determine the usable roof space we would first calculate the number of solar panels that could fit on the roof as if there were no obstructions or shading. Then we subtracted any area that was unusable due to such factors to determine the actual usable roof space (see Figure 6).

We accounted for a number of factors when determining the usable roof space of a building such as:

1. The size of the solar panels, which are about 1.7 meters by 1.0 meter.
2. Whether or not the roof was slanted, and if so, in what direction.
3. Shading caused by obstructions such as trees, antennas, or roof heating and air conditioning units.
4. Obstacles located on the roof that panels cannot be installed over, such as antennas, heating and air conditioning units, and skylights.
5. Locating panels far enough away from the edge of the roof as to not compromise the structural support of the roof.

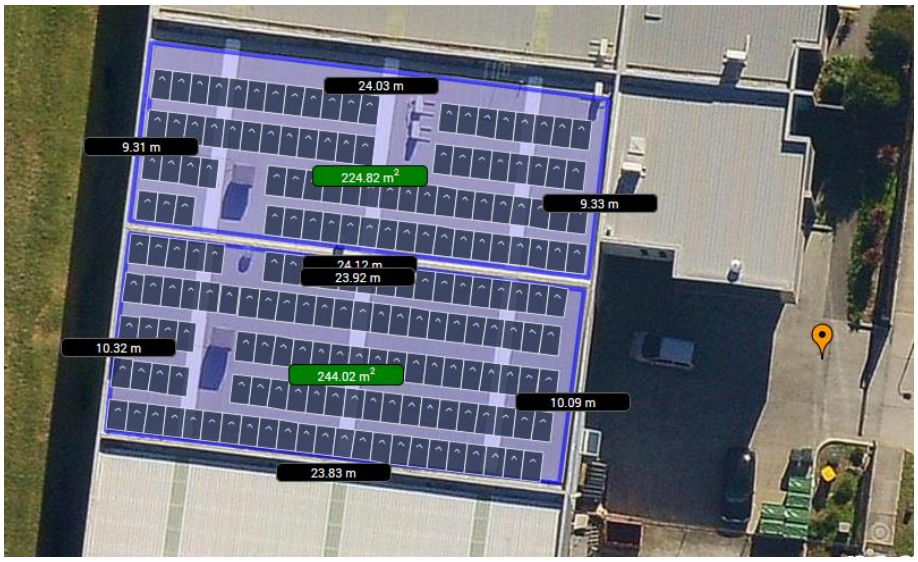

Figure 6 - NearMap Example Avoiding Obstructions

Originally we used the solar panel addition tool to put solar systems on rooftops, and then counted the number of panels that could fit. However, in order to expedite the process, because we knew the dimensions of the panels, we created a key that allowed us to use the dimensions of the roof to estimate the number of solar panels that should be able to fit on a specific roof. An example of both measurement methods can be found below in Figure 4. Figure 6 provides an example of the solar analysis for a building with obstructions on the roof which would prevent the installation of solar panels. The key we used can be found in Appendix L.

Wherever there was an obstruction or shadow due to roof mounted equipment or surrounding objects like tall buildings or trees, we would subtract that area from the total area of the roof space because mounting solar panels there was either impossible or not beneficial (see

Figure 6). NearMap has date records of all photos taken of an area, so using photos from different days and times of day allowed us to see where shadows were cast on the building so we would know not to install panels on these parts of the roof.

3.4 Analysis

3.4.1 Objective 1 Analysis

The results which we found through our surveys and interviews helped us understand how Moreland businesses felt about solar energy. In order to analyze the surveys, we transcribed the resulting information from the survey results into a concise table containing all information for each individual business that responded (see Appendix J for the response summary sheets, made anonymous for this publication). Due to the small number of results, we were only able to observe specific information from businesses by reading and studying these tables compared to using a large-scale analysis method that would allow for generalized trends. Similarly, because of our small number of interviews, reviewing our minutes and summary notes allowed us to gather specific information from our interviewees.

3.4.2 Objective 2 Analysis

Through Moreland city planning maps, we determined where commercial, industrial, and mixed use zones are located. This identified the geographic distribution of each of the represented industries previously identified, so that we could locate the concentrations and types of industries in Moreland. See Figure 9 in Section 4.1 for the map which shows business zoning.

3.4.3 Objective 3 Analysis

Upon completion of the second objective, we processed the solar capacity data in order to analyze any patterns we noticed in the mapping. We started by analyzing the NearMap projections for potential of solar for the Coburg North area on which we focused. We took the potential of each building and organized them by street. We then determined the average number of panels per business analyzed on that particular street. After analyzing all streets studied, we created a shaded scale to be applied to the overlaying map mentioned in Finding 2. Additionally, breaking down this information into average capacities per street allowed us to understand the relative size of businesses on individual streets as compared to surrounding streets, based on the average number of panels.

3.5 Challenges

3.5.1 Objective 1 Challenges

The first major issue we came across in this step was locating enough businesses to survey, as well as experiencing a low response rate of the businesses we successfully reached. One of our emails, sent out by MCC, was distributed with an incorrect URL. This reduced the number of email recipients, providing less potential email responses. In order to compensate for a low response rate, we walked door-to-door speaking to businesses. The door-to-door method in itself was a challenge as people weren't very receptive to us for a variety of different reasons, explained in Chapter 4.

Another challenge came from business owners' lack of knowledge of solar PV. As is explained in Chapter 4, many businesses are not knowledgeable about solar panels and the installation requirements and process. Since not all of the survey respondents were educated on the topic, the data collected was inconsistent. If a business was educated and they answered questions in an educated manner, this provided us with accurate data. However, the less educated survey responses provided us with inaccurate data for the question, but also hinted to the fact that business were uneducated about solar. There was no definite way, however, to determine which responses were educated and which were not, making the analysis of these types of questions difficult.

Contacting landlords to interview also posed a large challenge. The Moreland City Council was unable to provide us with a list of commercial building owners due to privacy measures; therefore we had no master list of landlords to contact. We contacted local real estate agencies asking them to send a message on our behalf to commercial landlords pursuing an interview. Additionally, landlords are rarely present at the business locations they own, which explains one reason why landlords were difficult to contact.

One of our main challenges for interviews was the limited number of businesses that volunteered their time; even when going door-to-door, many businesses did not have time to interview with us.

3.5.2 Objective 2 Challenges

Creating our maps was hindered by the inconsistency with maps available to layer. The main base map of Moreland created and used was based off of satellite data used by MEFL in

Google Earth. However, when overlaying city planning maps, there were minor inconsistencies, which led to finalized maps that were slightly askew. The maps presented in Chapter 4 give a relative idea of the information conveyed; however, they are not completely accurate.

3.5.3 Objective 3 Challenges

While working with NearMap in determining the physical potential of solar installation, there were a few challenges that created the potential for inaccuracies. In the first step of finding the businesses using Google Maps and Google Street View, we found the addresses and business names may be inaccurate at times for a few reasons. First, Google Maps and Google Street View aren't necessarily up-to-date in their imaging, and therefore some buildings and businesses may be different than how they are pictured (see Figure 7). This was shown when in the overhead view of Google Maps there was no building on a particular lot, but in Google Street View there was a building present, as shown in Figure 8. Additionally, the addresses marked by Google are only somewhat accurate and in our submission of business names, addresses, and solar potential. These challenges were present but were not viewed to hinder the results of our total physical capacity. However, they do affect the extrapolation of solar based on industry because businesses were categorized by industry by their storefront in Google Street View. Also, given that NearMap is updated more often, its imaging is more accurate and that is the tool we ultimately used to measure solar potential for our final product.

Figure 7 - Two Google Street View Images of 2 Catherine Street from Different Points

Figure 8 - Two Images of 3 Dawson Street Showing Different Information from Google Maps and Google Street View

When determining usable space for solar panels in NearMap, it was often difficult to determine whether a roof was flat or slanted. We attempted to use Google Maps and Google Street View to see if either of those angles could help distinguish the roof style, but often to no avail. In this circumstance, we looked for the shadow cast by the building to best judge if it was flat or slanted but this was not always a great determining factor. This has potentially impacted our results because the entirety of a flat roof can be used for solar panels, but more space is required per row of panels. Conversely, slanted roofs can only use the North facing side (or the East and West sides for East-West facing roofs), but less space is required per row. For these reasons, depending on the size of the usable area and the number of rows that could be used, the estimates for solar potential may be over or underestimated, varying on building and its individual circumstance.

Additionally, our method of measuring solar potential using dimensions on NearMap was imperfect in itself. NearMap does not have perfect accuracy (within 15 centimeters up to 200 meters), and the process we used of drawing points ourselves to create dimensions added further inaccuracies in measurements ("Are nearmap's PhotoMaps™ accurately...," n.d.). Because of this, and the dimension method being an estimate, all of our solar potential measurements are estimates and may not be representative of the actual potential, but rather a general idea for individual locations and areas as a whole. In order to gauge our accuracy, we calculated the solar potential using both the area and virtual installation methods for 10% of the buildings analyzed. Upon both methods of capacity estimation, we determined the percent error of our area measurement to be 8.2% on the conservative side, meaning our area estimation was found to underestimate the area's physical solar potential. Our methods for determining this are described in Appendix M.

4 FINDINGS, RECOMMENDATIONS, AND CONCLUSIONS

Upon completion of our project, we have discovered a variety of findings that stood out among our data. These findings and the recommendations we have come up with for MEFL are discussed below. Our findings were gathered from our survey, interviews, data analysis, and NearMap solar potential analysis. Our recommendations are based on our findings, as well as other ideas we have come up with while conducting our research throughout the duration of this project.

4.1 Finding 1

Coburg and Coburg North are the suburbs with highest concentration of business zoning within Moreland.

As part of our first tier mapping exercise, we identified areas of commercial, industrial, and mixed use zones to identify areas of focus for solar analysis, as seen in Figure 1 below. From this map, we determined that the areas of highest concentration of business zoning are Brunswick, Coburg, and Coburg North. As described in Finding 4, businesses in Coburg and Coburg North are more receptive to solar, and therefore are higher value targets. Coburg is mostly commercial with some industrial zones, whereas Coburg North is primarily industrial.

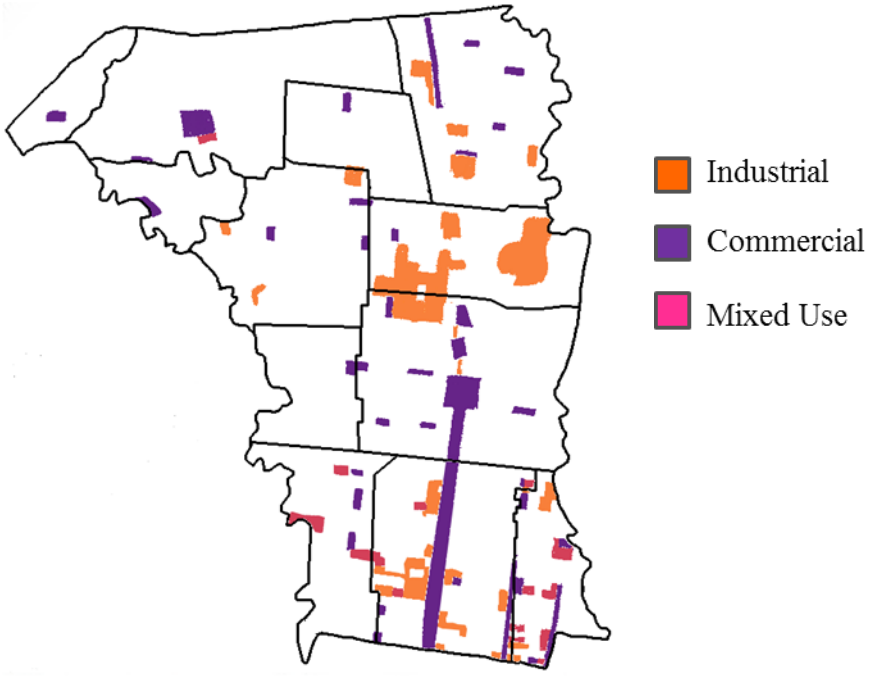

Figure 9 - Tier 1 Map: Zones of Moreland

4.1.1 Recommendation 1

We recommend starting with the industrial area of Coburg North because of its high industrial and commercial concentration. Based on our Figure 9, approximately one fourth of Coburg North is comprised of industrial businesses. This high concentration of businesses in conjunction with Coburg North's aptitude for solar PV makes this suburb the best area to begin implementing Zero Carbon Evolution (ZCE).

4.2 Finding 2

The maximum physical solar potential of Moreland businesses was determined to be approximately 446 MW, or 586 gigawatt-hours per year GWh/yr, and provide 103% of Moreland's energy usage.

Based on our NearMap analysis of Coburg North, we were able to extrapolate the physical solar potential to the remaining suburbs of Moreland. This extrapolation allowed us to determine the total physical solar potential. We also calculated the total energy consumption of Moreland for 2012, which was determined to be 571 GWh/yr. These calculations can be found in Appendix N.

We determined that Brunswick has the highest physical capacity for solar PV (98.8 MW), followed by Coburg (74.9 MW), then Glenroy - Hadfield (68.0 MW). These suburbs represent 22%, 17%, and 15% of Moreland's solar potential, respectively. This data is represented in Figure 10. By analyzing the data from the perspective of industry, we determined that Transport, Postal, & Warehousing and Retail Trade equally represent Moreland's highest physical potential for solar PV (106 MW), followed by Accommodations & Food Services (80 MW). These industries represent 24%, 24%, and 18% of Moreland's physical solar potential based upon industry, respectively. This data is represented in Figure 11.

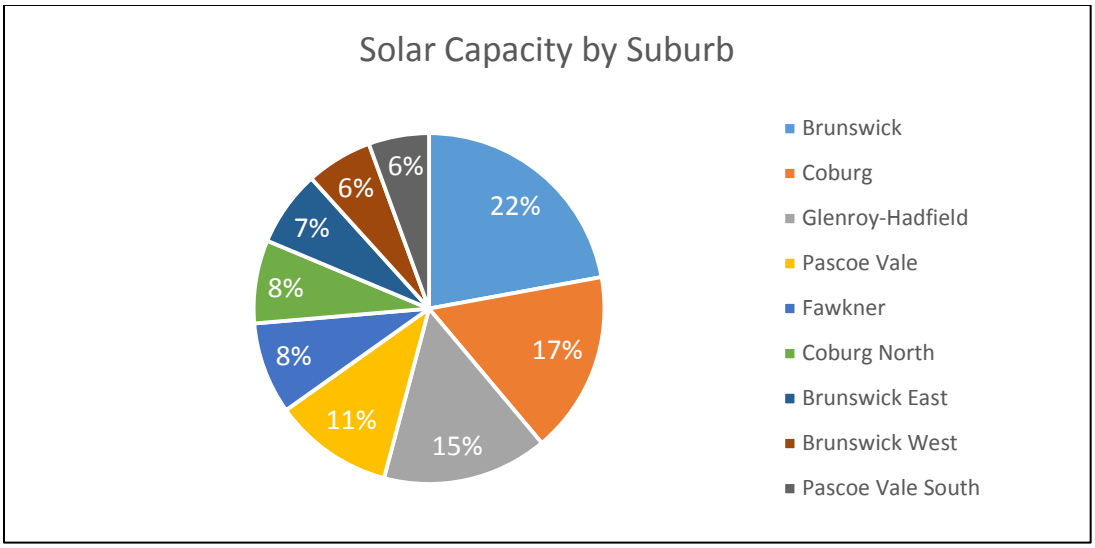

Figure 10 - Moreland Solar Capacity by Suburb

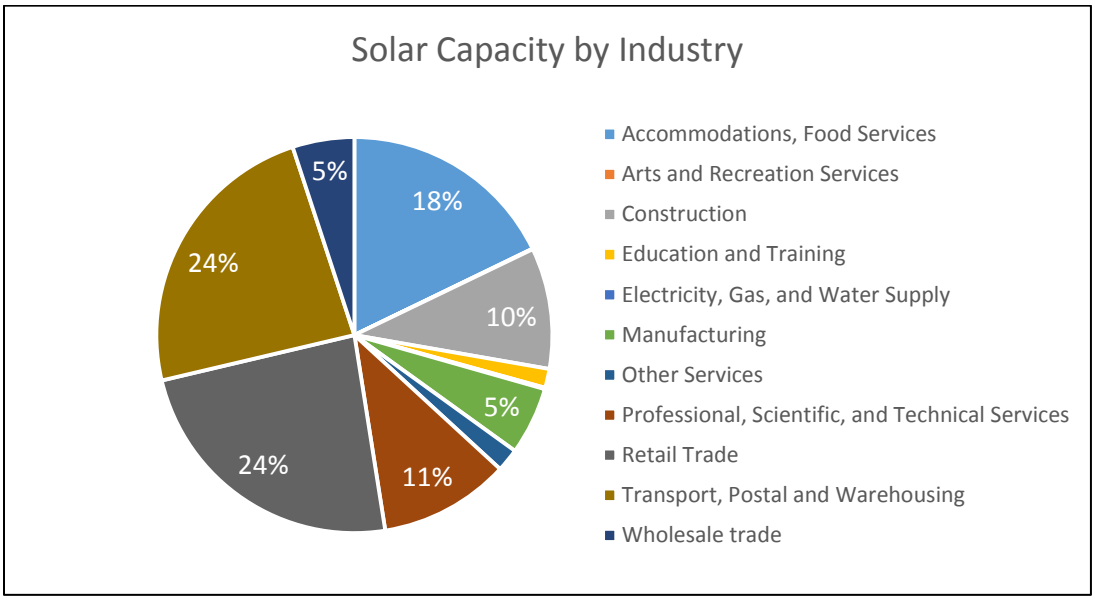

Figure 11 – Moreland Solar Capacity by Industry

Continuing with a similar analysis of an individual suburb we determined the industries with the highest estimated solar capacity. For this example, we chose Coburg over Brunswick because Coburg is known to be more receptive towards alternative energy (as described in Finding 4). In Coburg, the top three industries for physical solar capacity are: Retail Trade (19.8 MW), Transport, Postal & Warehousing (17.5 MW); and Accommodations & Food Services (13.2 MW) (see Figure 12). These industry rankings align with Moreland as a whole as well. Graphical representation of this information for Moreland and all suburbs can be found in Appendix O.

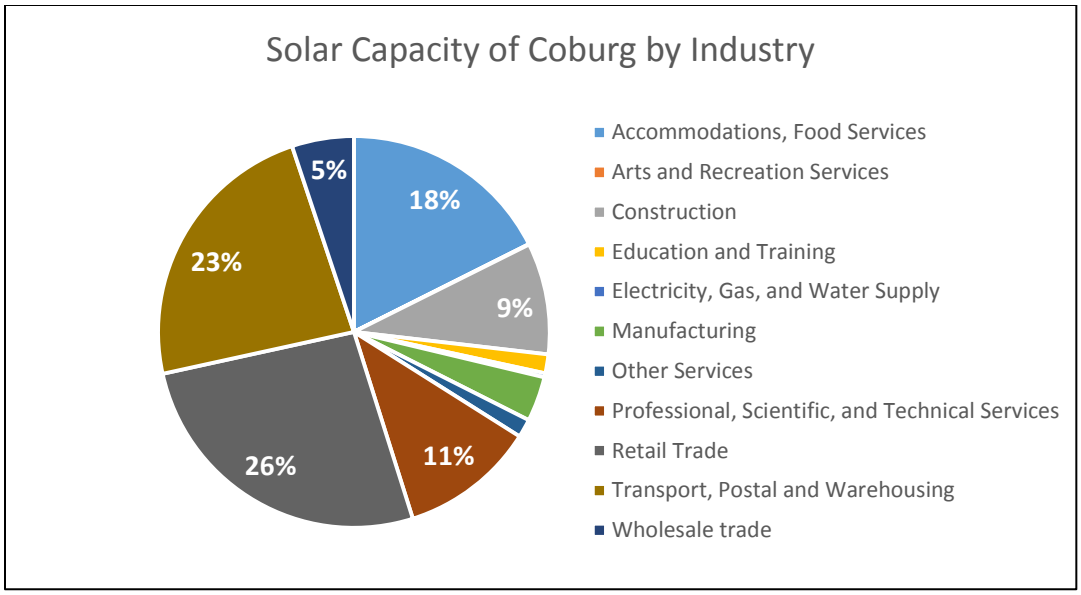

Figure 12 - Solar Capacity of Coburg by Industry

Through our NearMap capacity analysis, we examined 4 km of linear space in Coburg North. Outlined on Figure 13 below are all of the streets that we analyzed. The gradient represents the relative averages of potential solar panel system size per business for each street.

Figure 13 - Tier 2 Map: Coburg North Analysis

We also found that our methods for determining physical capacity were relatively accurate. Using the area measurement tool instead of virtual installation of panels in NearMap was approximately 8% conservative in the number of panels installed.

It is important to acknowledge that our estimations are limited. When comparing our results as a sample of the general data from the Australian Bureau of Statistics, we found that some categories of businesses were misrepresented or not represented at all. Unrepresented industries include major industries like Rental, Hiring, and Real Estate Services, Finance and Insurance Services, and Health Care and Social Assistance (among others). This limitation is extremely important to consider as the represented industries only represent 73% of Moreland businesses.

Additionally, our estimates could face future drawbacks. We included all system sizes in our estimates, the average calculated to be between 38-50 kW. The Small-scale Renewable Energy Scheme of the Renewable Energy Target could potentially be reduced, meaning a cap placed on system size at 10 kW instead of the current 100 kW. Above this cap, the system is considered a renewable power generator under the Large-scale Renewable Energy Target, which has more restrictions and regulations than small-scale systems. While this does not directly reduce the solar potential, it could present another barrier to installation.

4.2.1 Recommendation 2

When looking to extrapolate data from a single suburb onto all of Moreland, it is important to pick a suburb with a large concentration of business that have a similar composition to that of Moreland. Picking such a suburb will mean that each industry in Moreland is well represented in the remaining suburbs. Through extrapolation, each industry can then be accurately represented.

Unfortunately, because not all industries were present in our sample, our solar capacity data only represents 73% of the businesses in Moreland. **Therefore, the solar capacity analysis of Coburg North should be continued in order to accurately represent industry distributions similarly to that of Moreland.** After a sample of Coburg North has been completed, such that it properly represents Moreland, we suggest targeting the suburb which has the highest solar PV capacity.

4.3 Finding 3

The business opinions determined by the survey results were valuable, but surveys proved to be an inefficient tool of engagement with businesses.

Our online survey was intended to reach over 1,800 businesses. From that, we expected a 2-10% response rate. One reason we believe that our response rate was only 2.0% was that while residents will respond to surveys about solar PV because they view energy consumption as a domestic problem, businesses have little concern for solar PV and energy efficient practices. Due to a technical error in our correspondence with the Moreland City Council, our survey reached 495 businesses with a response rate of 2.0%. With over 11,000 businesses in Moreland, the responses we received represented just 0.09% of the business population, and were therefore deemed statistically insignificant. The survey links provided through the MCC and MEFL Facebook pages, as well as on MEFL's website proved ineffective, returning zero responses. According to Claire Perry of the Trade Association of Sydney Road Brunswick, the most efficient way to engage with businesses in the area is to speak with them one-on-one when they are not busy.

The most useful information ascertained from the survey responses was the electricity tariff paid and the average energy bill, which was used to determined how much energy was consumed. This information was also used during our case studies from Finding 8. Additionally, we found that some of the information requested in the survey was unnecessary and unhelpful, such as gas usage because very few businesses use any gas.

Since the purpose of the survey was to gain business opinions, we also considered the information collected from two previous workshops that MEFL hosted. Between the workshops and our survey, over 30 businesses were represented (0.28% of total businesses) and we were able to gather some general business opinions. The two largest barriers that were observed were upfront cost and leased premises. Of the businesses represented, upfront cost prevented two businesses from installing systems, prevented two businesses from considering installing a system, and was the largest challenge overcome by the one business surveyed that had previously installed solar panels. Of the six leased businesses surveyed, five said that not owning their building was the primary reason they had not installed or considered installing a system; multiple businesses expressed similar opinions at the workshops. Another notable barrier was trust; many businesses felt that the solar PV industry is not well established and that there is a

lack of trust with installers and suppliers. The incentives to installing solar included reducing energy costs, implementing better business practices, reducing environmental impact, and increasing a business's market advantage, with the largest being reducing costs.

4.3.1 Recommendation 3

We believe that our survey received such little response because there was little incentive for businesses to contribute. **We recommend that if surveying businesses in the future, MEFL offers an incentive that a business can immediately benefit from**, rather than the promise that their responses will be used to help them save money later on.

4.4 Finding 4

Diversity presents barriers to implementation of alternative energies.

We discovered that a large percentage of businesses operating in Moreland are owned by immigrants. During our door-to-door surveying, we found it difficult to communicate with business owners about energy costs and alternative energies because they were non-native English speakers.

Through our door-to-door conversations with businesses we also discovered that a large portion of the businesses in Brunswick were unreceptive to speaking with us about energy costs or alternative energies. However, through talking to businesses in Coburg North, we discovered they were much more receptive. It was also noted that more businesses had already installed solar panels in Coburg North than in Brunswick. A report recently released by MEFL confirmed these observations, stating that highest penetration of solar in Moreland is in the suburbs of Gowanbrae, Coburg, and Coburg North, and the lowest is in Brunswick, Brunswick East, and Brunswick West (Syed, 2014).

4.5 Finding 5

Among businesses that install solar, the business size and type are key indicators of the size of the system they will install and the motivations for installation.

Business size is often the deciding factor when choosing the size for a solar PV system; smaller businesses typically install 10-30 kW systems, medium businesses tend to install systems up to 100 kW, and larger businesses will often install systems that are 200 kW or larger. These generalizations are due to the physical space of each respective business, as well as the capital a business has available to spend on a solar PV system.

One important business characteristic that we learned from our research was that larger companies often install solar to be environmentally friendly and to look "green" to their customers and within their industries. To these larger, high capital businesses, the upfront cost of large systems, or even multiple systems installed at different locations, is insignificant to their overall bottom line.

For a small and medium enterprise (SME), solar is seen as a long term cost cutting tool. Most often, SMEs are more attracted to saving money than they are about looking environmentally friendly, although this can be a large incentive for certain businesses as well.

Some of the major industries that are currently installing solar PV systems through Energy Matters, a local solar PV installation company, are council and government institutions, private hospitals and the health sector, as well as businesses that work in large refrigeration operations. Regardless of the business type, the goal is to find a balance between a business' energy tariff and the feed-in tariff, as well as their energy usage and time of use, to determine how feasible solar installation is for a given business.

4.5.1 Recommendation 5

We recommend that MEFL investigate regions and industries with high electricity tariffs that would see the most benefit of installing solar panels. These businesses with higher tariffs will have a shorter payback time and therefore may be more likely to install. These targets could provide MEFL with businesses that are ready to install now.

4.6 Finding 6

Key enablers and barriers were determined to be evenly weighted in solar installation factors.

One of the largest reasons businesses are deciding to install solar PV is due to the large rise in energy costs, and the opportunity to save money in the long run. Energy costs have been on the rise across Australia due to the aging utility infrastructure. Distribution networks in Australia are needed to transport electricity long distances from highly populated areas to more remote locations. This large and aging system needs to be maintained and replaced, and the costs of doing so fall upon the utility users in the form of higher electricity tariffs. By installing solar PV, businesses can reduce the amount of electricity they use from the grid, therefore paying less. As electricity costs are projected to keep rising, the key enabler to install solar is to avoid more

expensive electricity in the future by paying a higher upfront cost now. While the advantage varies for each business, many businesses could benefit from installing solar PV, and essentially pre-purchasing electricity now, opposed to later at a higher cost.

For some businesses, particularly larger or corporate style businesses, one of the key barriers is that the thoughts and decisions of installing solar need to be passed up the ranks. While one person in the company may think installing solar is a good option, another, higher up the ladder, may think otherwise. This obstacle usually requires time, as decisions are being discussed internally and then worked out with the installer.

The most common barrier however is often not a barrier at all, but rather a perceived barrier. As described by Rory Allen, people looking to install solar often have preconceptions that in reality tend not to be a problem after all. These may include a system not meeting a customer's expectations, or customers being indecisive on what they want, what they expect, or thinking solar is not a financial investment they have the ability to make. These misconceptions can prevent people from going through with an installation, or even prevent them from looking into solar in the first place. Of the nine survey responses that indicated not having solar installed, and not having looked into it, four cited high upfront costs as a reason for not having looked into solar at all, or not having continued to look into solar.

4.6.1 Recommendation 6

Engaging those with the fewest barriers to installing is an important first step. As more businesses install solar, more business without solar will begin thinking about installing and may think to install themselves. Additionally, further research should be conducted in the area of the key enablers and barriers identified. While we identified some enablers and barriers, we did not have the time to determine how to act on these. Therefore **work must be done to enhance the identified enablers and to reduce the identified barriers**. By doing this MEFL will be better able to apply and act on the factors we identified.

4.7 Finding 7

Property ownership is one of the largest barriers to installation as many businesses do not own their property.

Through our survey results, nearly all respondents stated that not owning their building was the primary barrier to installation. Interviews with Claire Perry from the Trade Association

for Sydney Road Brunswick also added that businesses and landlords very rarely interact directly. Lease negotiations most commonly take place through a third party real estate agent. The lack of a landlord-tenant relationship leaves many businesses feeling like changes to the building are not in the scope of their lease. However, of the businesses that installed solar through Energy Matters over 70% do not own their properties. For these businesses, each landlord viewed the addition of solar panels to be a personal adjustment for which the tenant is responsible

Through our interview with Rory Allen, we found that in his experience, difficulties arose when the landlord attempted to interact with a business owner during the installation process. Instead of the business owner installing PV in a way that best suits the business, the landlord would have different interests and priorities that must be met. While this is a feasible option and has happened as we learned through our interview with Rory Allen, it creates another barrier in itself even if the landlord and tenant do interact.

We found that commercial, retail, industrial, or mixed-use property with common property is often managed by one or more Owner's Corporations (Victorian Government Consumer Affairs Victoria, n.d.). Multiple Owner's Corporations are common in large multi-story buildings, commercial properties, or developments that combine residential and commercial lots. Roof space can be considered common property, and is therefore maintained by the Owner's Corporation(s). Decisions regarding common property are decided by the Corporation, so a business wishing to install solar would have to have the installation approved by the Corporation, either at a meeting or by a paper ballot, making the installation processes more cumbersome for the tenant.

Furthermore, landlords seem unmotivated to install a solar system when there is limited understanding of the financial benefits of installation. One such recovery option would be to increase rent while the tenant sees the benefit of a reduced energy bill. According to Claire Perry, landlords are currently increasing rent without renovating or updating their buildings. The lack of money landlords are willing to spend on general upkeep of their buildings is a further indication of their lack of desire to improve them with solar PV.

However, landlords who are willing to update and improve their buildings have begun to use solar panels as an incentive for a tenant to stay in a building upon renewing the lease. In

order to keep their buildings fully occupied, landlords have been known to install solar systems to incentivize tenants into remaining in the building due to the lower electricity costs.

Solar panels are also being added to new buildings more frequently. As new buildings are being constructed, plans often call for solar panel systems, particularly on larger buildings where the cost of a large solar PV system is insignificant compared to the price of the project as a whole.

4.7.1 Recommendation 7

We found that the vast majority of leased businesses pay their own electricity bill, independent of their landlords. Businesses therefore are the sole beneficiaries as their electricity costs would be directly reduced. If a tenant who installed a system were to leave the building, the landlord would inherit the responsibility of the system because in most cases, it is too expensive for a business to uninstall, transport, and then install their PV system on a new building. However, landlords are unable to market solar PV and any other energy conservation practices completely because there is no regulated disclosure of energy ratings for rental properties. Energy efficiency adds value to a property, which a landlord cannot market adequately without such standards.

Additionally, as stated in Finding 3, large businesses often install solar to reduce their environmental impact, thereby implementing better business practices. Improving public image only works as well as the marketable facts: mainly, a public energy standard which can be accredited to a building.

As previously recommended to MEFL by the last WPI project team, **we recommend that MEFL encourages the implementation of a regulated disclosure of property energy ratings**. A rating system designed for large industrial properties already exists, but may not be appropriate for smaller properties. If this system is not suitable, MEFL should support a system that is and encourage landlords or businesses to get their buildings evaluated. Alternatively, MEFL and MCC could work together to create their own energy rating standard for businesses in Moreland. This will allow landlords and businesses to market as having green strategies. It will also allow tenants to make informed decisions on the amenities of a particular building. Alternatively, MEFL could encourage businesses to certify through globally established standards such as Leadership in Energy and Environmental Design (LEED) Certifications. LEED certifications are easier to obtain for new buildings as larger projects need to be undertaken to

obtain a certification. To encourage this, MEFL should advertise the standard they wish to promote and spur businesses to apply for these standards, or even help them apply. Upon talking to leased businesses they are working with to install solar, MEFL can promote the standard they wish by pitching the idea that the business and landlord of the building will be able to easily advertise their sustainable practices in a standard way that is backed by MCC or an outside organization.

4.8 Finding 8

Applicable case studies provide valuable information that can be incorporated in MEFL's engagement strategy.

Two key ways MEFL engages businesses in discussing installation is to provide statistics supporting the success of solar PV and to present case studies; however, where statistical averages can be hard to relate to, a case study of a similarly sized business within the same industry provides a concrete example of a functional model for implementing solar panels. Seeing that a successful example already exists means that the business won't need to invest significant time researching the installation process and can remain focused on their primary business functions.

We conducted a solar evaluation of three businesses in Moreland to provide a basis that MEFL can use to show to other businesses for use in their future engagement strategy. With these case studies, MEFL can tell these specific stories to similar businesses in order to show how closely related their two circumstances may be. Ideally this would encourage the business owner to see how easy or feasible installing solar for their business may be after seeing these examples. The businesses studied were chosen from our survey responses that contained the needed information to evaluate their particular business. This needed information included the business's electricity tariff and average summer monthly electricity costs, which not all survey respondents included. We analyzed a wholesale trade company, a real estate firm, and a manufacturing business (See Appendix P for all solar assessments). These solar assessments took the businesses electricity usage, tariff, roof space and orientation, an assessor determined system size, and other factors into consideration. After all information was input into the data calculator, the assessment provided the percentage of electricity the system will produce, the time it will take to pay back the system, and the total money that will be saved over ten and twenty years.

The wholesale trade company occupying a one-level body corporate premises could install a 10 kW system, which would provide almost 60% of their electricity costs and be paid off in just over 4.5 years. After ten years, the business would save over AU$35,000, and over AU$75,000 after twenty.

The real estate firm occupying a small storefront of a one-level body corporate premises could install a 3.75 kW system, which would provide 20% of their electricity costs and be paid off in just under 5 years. After ten years, the business would save over AU$12,000, and over AU$25,000 after twenty.

The manufacturing company, which occupies its entire building, could install a 9.5 kW system, which would provide over 20% of their electricity costs and be paid off in just over 8 years. After ten years, the business would save just under AU$20,000, and over AU$40,000 after twenty.

While the example wholesale trade company and the small manufacturing company install systems of almost identical size, the manufacturing company has a lower electricity tariff and therefore would save less money overall.

We also conducted a case study of a business that was in the process of installing solar with MEFL's assistance. This manufacturing company, located in a one-level self-owned building, has the potential to install a 5 kW system, which would provide just under 50% of their electricity costs and be paid off in just under 5 years. After ten years, the business would save almost AU$15,000, and almost AU$31,000 after twenty.

We analyzed this business as we analyzed all others, by using NearMap to determine the maximum physical solar potential. We then conducted the same solar assessment as for the previously mentioned case studies. The difference with this instance however is that knowing that they were in the process of installation, we had information as to what they decided to install in the end, allowing us to compare our methods and results to those that they actually implemented.

Through our NearMap solar estimate, we determined that there was the potential for 95 solar panels, providing 23.75 kW, to be supported by the building. However, after obtaining the electricity usage and tariff information, the solar assessment revealed a much more realistic scenario for this particular business. Through the assessment, we determined that the best system size for this business would be a 20 panel 5 kW system, far from the 96 panel and 23.75 kW

system the roof could physically support. This was an example of how a building is able to physically support a larger solar PV system than what is realistically needed for their electricity usage profile.

At the conclusion of our assessment, we compared our findings to an assessment completed by MEFL for the business. Their assessment suggested a 20 panel, 5 kW, system, confirming that our case study process was accurate.

4.8.1 Recommendation 8

While some landlords have put solar panels on their properties to make the property more appealing and valuable, many still doubt that tenants or prospective tenants would be willing to pay more for a property with solar panels. **We therefore recommend MEFL create a few case studies that could present landlords with a concrete example of a solar PV installation being financially beneficial**. Proving that solar panels could directly benefit a landlord is key to increasing uptake because decreasing the electricity costs of a property does not directly benefit a landlord, but being able to increase rent will.

We also recommend **MEFL conduct case studies of a variety of businesses that currently have solar installed**. If a few businesses from some of the major industries in Moreland are evaluated through a case study, the studies can then be presented to other similar businesses in the community as a firsthand example of how solar has worked in a similar situation.

4.9 Additional Recommendations

4.9.1 Recommendation 9

We recommend that MEFL talk to businesses that are already environmentally focused to encourage them to extend their sustainable practices. Businesses such as farmers markets, organic markets, health food stores, etc. typically already partake in green practices, and may be willing to look into solar if presented with an easy path to installation.

4.9.2 Recommendation 10

MEFL should also attempt to incorporate solar into the building design process for new buildings. To do so, **MEFL should attempt to work with architecture firms, engineering firms, commercial developers, and construction companies.** By working with these groups

MEFL can encourage solar to be installed on new buildings rather than needing to go through a business and/or landlord later on. This also may be an easier pitch as the cost of solar at the time of construction will likely be insignificant as compared to the cost of the entire project.

4.10 Conclusion

The contents of this report are meant for the use of the Moreland Energy Foundation and any other similar foundation encouraging the installation of solar PV systems. The goal of this project was to assist MEFL in learning about the characteristics of businesses in the Moreland area, learn about some common enablers and barriers of installing commercial solar systems, as well as providing MEFL with data on the business makeup within Moreland, including the distribution and breakdown of industries in Moreland and its suburbs.

4.10.1 Long Term Implications

In the long term, we hope that our research, findings, and recommendations can be useful for MEFL, and help them in efficiently targeting businesses to encourage solar installation through their Zero Carbon Evolution (ZCE) strategy. The overall goal of ZCE is to reduce the carbon emissions of Moreland by 20% by 2020, and our hope is that our project is valuable to MEFL to help them in achieving this goal.

4.10.2 Who Will Benefit

The community of Moreland is energy conscious; our work will help business owners join in the energy conservation trend. Currently, many business owners do not think there is a major benefit to installing solar PV for their building. The work in this report will help MEFL, Positive Charge, and MCC work with businesses to expand the use of solar PV.

In addition to working with businesses, our analysis of roof space will benefit another project currently in development at MEFL, Moreland Community Solar. As previously discussed, businesses will most likely install a system large enough to meet their energy usage instead of exceeding this level. The Moreland Community Solar project is looking for businesses with extra roof space to donate so this additional electricity can be used by residents of Moreland. The team working on the Moreland Community Solar project will use the results of our NearMap analysis of Coburg North to find businesses to approach for this project.

Our findings could be used by other communities, foundations, or organizations that are looking to improve their energy conservation. Businesses are an important part of any

community and provide a major target for implementation. Our findings could be used to engage businesses in an informed way.

4.10.3 Questions Our Work Raises That Could be Pursued by Others

Upon completion of our work, we determined a few areas that could benefit from further research. The first of which is to find a way to effectively collect data from businesses. Our survey was not effective, but had it been, it would have provided valuable information. As we did not have time to identify alternative methods, it would be beneficial for other methods to be tested in the future.

As our work identified some of the enablers and barriers to solar PV uptake, additional work would ideally attempt to enhance the enablers and reduce the barriers and their impacts.

Additionally, we mentioned how information from landlords would have improved our understanding of property ownership complications. However, because there is no public listing of landlords in Moreland, we were unable to contact them to gather any information. Future work could determine how to contact landlords directly and gain their opinions of solar PV installation.

The Zero Carbon Evolution strategy has a lot of potential for positive influence in the community, and we believe our research and data provided in this report can help further enhance the effectiveness of this program. Solar is a clean and viable energy source for Australia, and we hope for it to be implemented in the future by businesses in the Moreland municipality.

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APPENDIX A

Glossary of Terms

AU ..... Australian <currency>
BESD ..... Brunswick Electricity Supply Department
CER ..... Clean Energy Regulator
ERF ..... Emissions Reduction Fund
GWh/yr ..... gigawatt-hour per year
kW ..... kilowatt
kWh ..... kilowatt-hour
LEED ..... Leadership in Energy and Environmental Design
m^2 ..... square meters
MCC ..... Moreland City Council
MEFL ..... Moreland Energy Foundation Ltd.
MW ..... mega Watt
PV ..... photovoltaic, photovoltaic
RET ..... Renewable Energy Target
SME ..... small and medium enterprise
UVR ..... ultraviolet radiation
ZCE ..... Zero Carbon Evolution
ZCM ..... Zero Carbon Moreland

APPENDIX B

Northern vs. Southern Hemisphere UVR Exposure

Latitude °N	Location	Yearly UVR (SEDs)*		Latitude °N	Location	Yearly UVR (SEDs)*
				12.4	Darwin, Australia	16750
19.5	Mauna Loa, USA	17700**		23.7	Alice Springs, Australia	15200
26.0	Naha, Japan	10172		27.5	Brisbane, Australia	11698
30.4	Tallahassee, USA	9652				
31.6	Kagoshima, Japan	9146				
31.8	El Paso, USA	12000**		31.9	Perth, Australia	12234
32.8	Fort Worth, USA	8960		33.9	Sydney, Australia	9502
35.0	Albuquerque, USA	11270**		34.9	Adelaide, Australia	10500
36.0	Tsukuba, Japan	7828		36.5	Leigh, NZ	9234
37.7	Oakland, USA	8560		37.8	Melbourne, Australia	8728
39.9	Philadelphia, USA	6100				
41.6	Barcelona, Spain	8200				
43.0	Sapporo, Japan	5812		42.9	Hobart, Australia	7365
44.9	Minneapolis, USA	6006		45.0	Lauder, NZ	7482
47.3	Garmisch, Germany	5494**				
48.0	Bilthoven, Neth	4400				
52.0	Chilton, UK	3600				
52.0	Potsdam, Germany	4690				
53.8	Leeds, UK	3240				
55.7	Lund, Sweden	4222				
55.9	Glasgow, UK	2800				
*Standard Erythema Dose(SED): 2 SEDs will produce sunburn in people with fair skin						
**Some effect due to altitude						

Table 2 - Northern vs. Southern Hemisphere UVR Exposure (Gies, 2003)

APPENDIX C

Summary of Victorian Feed-in Tariffs

Type	Status to Entrants	Max System Size	Rate	Duration
Current	Open 1/1/13	5kW	8 ₵/kWh	Rate reviewed annually through 2016
Standard	Closed 12/31/12	10kW	1 to 1 at retail tariff rate	Until 12/31/16
Transitional	Closed 12/31/12	5kW	25 ₵/kWh	Until 12/31/16
Premium	Nov 2009-Dec 2011	5kW	60 ₵/kWh	Until 2024 with no additional panels

Table 3 - Summary of Victorian Feed-in Tariffs ("Victorian Feed-in Tariff Schemes," 2014)

APPENDIX D

Preamble for Surveys and Interviews

For each survey and interview, the preamble listed below was written or spoken, respectively.

"The Moreland Energy Foundation is conducting a survey of Moreland business owners and landlords to better understand the local business community's situation with regard to energy. The survey data will be used to better assist businesses to manage and reduce their energy consumption and install solar panels.

The survey will take around five minutes to complete and your response is greatly appreciated. It is also completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous unless you provide your consent to release your name or business' name.

The survey is being coordinated by a group of students from Worcester Polytechnic Institute in the United States. They are working in Moreland with MEFL on a project researching the feasibility of solar panels and energy savings for Moreland businesses."

APPENDIX E

Complete Business Survey for Objective 1

Local Business Opinions on Energy

The Moreland Energy Foundation is conducting a survey of Moreland business owners and landlords to better understand the local business community's situation with regard to energy. The survey data will be used to better assist businesses to manage and reduce their energy consumption and install solar panels.

The survey will take around five minutes to complete and your response is greatly appreciated. It is also completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous unless you provide your consent to release your name or business' name.

The survey is being coordinated by a group of students from Worcester Polytechnic Institute in the United States. They are working in Moreland with MEFL, on a project researching the feasibility of solar panels and energy savings for Moreland businesses.

* Required

1. **What is the name of your business** *
   For internal documentation, not to be made public without permission.

2. **What category would you say your business falls under?** *

Mark only one oval.

- ◯ Construction
- ◯ Professional, Scientific and Technical Services
- ◯ Transport, Postal and Warehousing
- ◯ Rental, Hiring, and Real Estate Services
- ◯ Retail Trade
- ◯ Finance and Insurance
- ◯ Manufacturing
- ◯ Heath Care and Social Assistance
- ◯ Accommodations, Food Services
- ◯ Wholesale Trade
- ◯ Administrative and Support Services
- ◯ Arts and Recreation Services
- ◯ Education and Training
- ◯ Information Media and Telecommunications
- ◯ Agricultural, Forestry, Fishing, and Hunting
- ◯ Public Administration and Safety
- ◯ Electricity, Gas, and Water Supply
- ◯ Mining
- ◯ Other Services

3. **How many full time equivalent employees do you employ?** *

Mark only one oval.

- ◯ 0
- ◯ 1 - 9
- ◯ 10 - 19
- ◯ 20 - 29
- ◯ 30 - 39
- ◯ 40 - 49
- ◯ 50+

4. **Do you have solar panels installed on your business?** *
   If yes, did you or a previous occupant/owner have them installed?
   Mark only one oval.

   ◯ Yes, I had the system installed. *Skip to question 16.*
   ◯ Yes, the system was installed under a previous occupant/owner. *Skip to question 5.*
   ◯ No *Skip to question 39.*

5. **How long has the system been installed?** *
   Mark only one oval.

   ◯ 0 - 1 years
   ◯ 2 - 3 years
   ◯ 4 - 6 years
   ◯ 7+ years

6. **What is the size of your installed system?** *
   If unknown, please answer "Other" and estimate the number of panels your system consists of.
   Mark only one oval.

   ◯ Less than 5 kW
   ◯ 5 - 10 kW
   ◯ 10 - 30 kW
   ◯ More than 30 kW
   ◯ Other: _____

7. **What time of day do you consume most of your electricity?** *
   Check all that apply.
   Check all that apply.

   ☐ Day time (7am - 7pm)
   ☐ Night time (7pm - 7am)
   ☐ Continuous use

8. **Was the installed solar PV system a factor in chosing to move your business to its current location?** *
   Mark only one oval.

   ◯ Yes, a major factor
   ◯ Yes, a minor factor
   ◯ No

9. **Are you satisfied with your system?** *
   Why or why not?

10. **Where is your business located?** *
    Mark only one oval.

    - In a residence *Skip to question 57.*
    - In a commercial building *Skip to question 11.*

11. **What is your average monthly summer electricity cost?** *
    Mark only one oval.

    - Less than $200
    - $200 - $500
    - $500 - $2000
    - $2000 - $5000
    - More than $5000
    - Unknown

12. **How significant a portion are your electricity costs of your total business expenses?** *
    Mark only one oval.

    - No significance
    - Low significance
    - Moderate significance
    - High significance
    - Unknown

13. **What is your electricity tariff in c/kWh?** *
    If unknown please answer N/A.

14. **What are your average monthly summer gas expenses?** *
    If unknown please enter N/A.

15. **Do you own or lease the location of your business?** *
Mark only one oval.

- ◯ I lease the location of my business
- ◯ I own the location of my business

Skip to question 53.

16. **How long has the system been installed?** *
Mark only one oval.

- ◯ 0 - 1 years
- ◯ 2 - 3 years
- ◯ 4 - 6 years
- ◯ 7+ years

17. **What were your primary reasons for installing your system?** *
Check all that apply.
Check all that apply.

- ☐ Reduce energy costs
- ☐ Environmental benefit of generating renewable energy
- ☐ Improve public perception of business
- ☐ Client/customer demand
- ☐ Other: _____

18. **What is the size of your installed system?** *
If unknown, please answer "Other' and estimate the number of panels your system consists of.
Mark only one oval.

- ◯ Less than 5 kW
- ◯ 5 - 15 kW
- ◯ 15 - 30 kW
- ◯ More than 30 kW
- ◯ Other: _____

19. **What time of day do you consume most of your electricity?** *
Check all that apply.
Check all that apply.

- ☐ Day time (7am - 7pm)
- ☐ Night time (7pm - 7am)
- ☐ Continuous use

20. **Are you satisfied with your system?** *
Why or why not?

_____

_____

_____

_____

_____

21. **What was the largest challenge you had to overcome when installing the system?** *
Check all that apply.
Check all that apply.

- [ ] High upfront costs
- [ ] Insufficient roof space
- [ ] Difference in opinion with landlord
- [ ] Other: _____

22. **In how many years did you or do you expect the system to pay itself off?** *
Mark only one oval.

- ◯ Less than 5 years
- ◯ 5 - 7 years
- ◯ 8 - 10 years
- ◯ More than 10 years

23. **Are you satisfied with this payback time?** *
Mark only one oval.

- ◯ Not satisfied
- ◯ Somewhat satisfied
- ◯ Moderately satisfied
- ◯ Highly satisfied

24. **Where is your business located?** *
Mark only one oval.

- ◯ In a residence *Skip to question 37.*
- ◯ In a commercial building *Skip to question 25.*

25. **What is your average monthly summer electricity cost?** *
Mark only one oval.

- ◯ Less than $200
- ◯ $200 - $500
- ◯ $500 - $2000
- ◯ $2000 - $5000
- ◯ More than $5000
- ◯ Unknown

26. **How significant a portion are your electricity costs of your total business expenses?** *
Mark only one oval.

- ◯ No significance
- ◯ Low significance
- ◯ Moderate significance
- ◯ High significance

27. **What is your electricity tariff in c/kWh?** *
If unknown please answer N/A.

_____

28. **What are your average monthly summer gas expenses?** *
If unknown please answer N/A.

_____

29. **How much money are your solar panels saving you per summer month?** *
Mark only one oval.

- ◯ Less than $100
- ◯ $100 - $300
- ◯ $300 - $500
- ◯ $500 - $2000
- ◯ More than $2000
- ◯ Unknown

30. **How significant are these savings on your expenses?** *
Mark only one oval.

- ◯ No significance
- ◯ Low significance
- ◯ Moderate significance
- ◯ High significance

31. **Do you own or lease the location of your business?** *
Mark only one oval.

- ◯ I lease the location of my business *Skip to question 32.*
- ◯ I own the location of my business *Skip to question 53.*

Skip to question 53.

32. **How many years were remaining on your lease when you installed your solar panels?** *
Mark only one oval.

- ◯ Less than 3 years
- ◯ 4 - 6 years
- ◯ 7 - 10 years
- ◯ More than 10 years

33. **Did you, or do you, plan to renew your lease?** *
Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Unknown

34. **What was the level of involvement of your landlord when installing the system?** *
Check all that apply
Check all that apply.

- ☐ Landlord paid for the system
- ☐ Restructured lease agreement to allow solar panels
- ☐ Approved installation but did not need to restructure lease
- ☐ No involvement
- ☐ Other: _____

35. **Who do you pay your electricity costs to?** *
Mark only one oval.

- Electricity company directly
- Landlord
- Electricity is included in the price of the lease

36. **Please provide your landlord's name and contact information here.**
Optional

_____

Skip to question 53.

37. **How much money are your solar panels saving you per summer month?** *
Mark only one oval.

- Less than $100
- $100 - $300
- $300 - $500
- $500 - $2000
- More than $2000
- Unknown

38. **How much influence do these savings have on your business expenses?** *
Mark only one oval.

- No influence
- Low influence
- Moderate influence
- High influence

Skip to question 57.

39. **Have you previously considered installing solar panels for your business?** *
Mark only one oval.

- Yes *Skip to question 40.*
- No *Skip to question 42.*

Skip to question 43.

40. **What are your primary reasons for not yet installing solar panels?** *

Check all that apply.
Check all that apply.

- [ ] High upfront cost
- [ ] Return on investment was less than desired
- [ ] Don't know where to start
- [ ] Difficulties with installer
- [ ] Regulatory restrictions
- [ ] Difference in opinion with landlord
- [ ] Insufficient roof space
- [ ] Other: _____

41. **What are some of your reasons for considering installing solar panels?** *

Check all that apply.
Check all that apply.

- [ ] Reduce energy costs
- [ ] Implement renewable energy
- [ ] Improve public perception
- [ ] Other: _____

Skip to question 43.

42. **What are the primary reasons you have not looked into installing solar panels?** *

Check all that apply.
Check all that apply.

- [ ] Lack of time
- [ ] Don't know where to start
- [ ] Do not own building
- [ ] High upfront cost
- [ ] Payback time is too long
- [ ] Solar panels would not benefit me
- [ ] Inadequate roof space
- [ ] Business may cease operation soon
- [ ] Other: _____

43. **What time of day do you consume most of your electricity?** *
Check all that apply.
Check all that apply.

- [ ] Day time (7am - 7pm)
- [ ] Night time (7pm - 7am)
- [ ] Continuous use

44. **What is your average monthly summer electricity cost?** *
Mark only one oval.

- ◯ Less than $200
- ◯ $200 - $500
- ◯ $500 - $2000
- ◯ $2000 - $5000
- ◯ More than $5000
- ◯ Unknown

45. **How significant a portion are your electricity costs of your total business expenses?** *
Mark only one oval.

- ◯ No significance
- ◯ Low significance
- ◯ Moderate significance
- ◯ High significnce
- ◯ Unknown

46. **What is your electricity tariff in c/kWh?** *
If unknown please answer N/A.

_____

47. **What are your average monthly summmer gas expenses?** *
If unknown please answer N/A.

_____

48. **What is the maximum upfront cost you would be willing to pay to install solar panels?** *

Mark only one oval.

- ◯ Less than $2500
- ◯ $2500 to $7000
- ◯ $7000 to $20000
- ◯ $20000 - $50000
- ◯ More than $50000
- ◯ Unknown

49. **In what amount of time would you like the system to have paid itself off?** *

Mark only one oval.

- ◯ 3 - 4 years
- ◯ 5 - 7 years
- ◯ 8 - 9 years
- ◯ 10 - 12 years
- ◯ Unknown

50. **Based on the previous two questions, how much of your electricity consumption do you think you could receive from a solar panel system?** *

Mark only one oval.

- ◯ Not at all
- ◯ Under 50%
- ◯ Over 50%
- ◯ Cover my electricity use
- ◯ More than my electricity use
- ◯ Unknown

51. **In what type of property does your business operate?** *

Mark only one oval.

- ◯ Commercial, leased *After the last question in this section, skip to question 53.*
- ◯ Commercial, owned *After the last question in this section, skip to question 53.*
- ◯ Residential *After the last question in this section, skip to question 57.*

52. **If you lease your commercial business space, please provide your landlord's name and contact information here.**

Optional

_____

53. **Are you willing to provide more information and opinions by participating in a short interview in the near future?** *

Mark only one oval.

- ◯ Yes (in person or over the phone) *Skip to question 54.*
- ◯ No *Skip to question 57.*

54. **How may we best contact you to schedule an interview time?** *

You will not be contacted for solicitation of any sort; your contact information is only to get in touch to schedule an interview. Thank you for your extra help and information.
Check all that apply.

- ☐ Telephone
- ☐ Email

55. **Please provide your telephone number here to be contacted for an interview.** *

If you are providing your email below, enter N/A here.

_____

56. **Please provide your email here to be contacted for an interview.** *

If you provided your telephone number above, enter N/A here.

_____

Thank You!

Thank you for your time and for the information you have provided. It will be very helpful and beneficial to the study, and to the Moreland Energy Foundation Ltd. If you have any questions regarding the survey or our study, please email us at wpi@mefl.com.au and we are more than happy to answer any questions you may have. If you would like to learn more about lowering your energy costs or renewable energy, feel free to visit http://www.mefl.com.au/

57. **If there are any other questions or comments you would like to add, feel free to discuss these thoughts below.**

_____

_____

_____

_____

_____

58. **If you would like to learn more about energy saving and/or renewable energy, or about what MEFL does, enter your email below to be added to MEFL's distribution list.**

_____

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APPENDIX F

Business Interview Questions for Objective 1

Businesses without Solar PV that Have Considered Installing a System

1. In your survey responses you mentioned you have considered installing solar, and some of the key barriers you mentioned were _____. Could you elaborate anything on this?
    a. Upfront cost
        i. What do you think the upfront cost is?
        ii. Have you considered Finance options? What type? [Leasing or PPA (Power Purchase Agreement)?]
    b. Return on investment was less than desired
        i. What is an acceptable payback time?
    c. Path forward unclear
        i. (see question 2 below)
    d. Difficulties with solar company
        i. What type of difficulties?
    e. Regulatory restrictions
    f. Difference in opinion with landlord
        i. What type of differences?
        ii. Is there any middle ground or compromising that could happen?
            1. Can council help?
    g. Insufficient roof space
        i. Have you considered panels mounted on the ground?
        ii. Are you aware of/would you be interested in learning about the opportunity to purchase renewable energy from the grid?
2. You have considered installing solar panels? How much research would you say you've done?
    a. What resources have you found helpful when researching solar panels?
    b. What would be a good/easy way for you to get information?
3. What is your apprehension when it comes to installation?

4. Have you spoken to any solar panel installers?
    a. Have you heard of MEFL or Positive Charge?
5. Do you expect that getting solar might improve your clients' perceptions of your business?
    a. Have you tried any other Green initiatives? Are you carbon neutral?
6. What were you expecting to get from today's meeting?
7. Would you be interested in getting an independent solar assessment to see whether solar would make sense for your business?

Businesses without Solar PV that Have Not Considered Installing a System

1. In your survey responses you mentioned you have not considered installing solar, and some of the key barriers you mentioned were _____. Could you elaborate anything on this?
    a. Lack of time
        i. Don't know where to start
    b. Do not own building
        i. Would you consider working with your landlord to install solar?
        ii. Have you ever had a conversation with your landlord about solar?
        iii. If you were to install solar, have you had any thoughts on how you may want to compromise the upfront costs or the payments of the system?
    c. Upfront cost is too high
    d. Payback time is too long
    e. Solar panels would not benefit me
        i. How so?
    f. Inadequate roof space
        i. Have you considered panels mounted on the ground?
        ii. Are you aware of/would you be interested in learning about the opportunity to purchase renewable energy from the grid?
    g. Business may cease operation soon
2. If you were to begin researching solar options, where would you begin?
3. What is your apprehension when it comes to installation?
4. What would you like to know or see to become more interested in installing solar panels?

5. What were you expecting to get from today's meeting?
6. Would you be interested in a solar assessment for your premises to find out whether solar is right for you?

Leased Property with Self Installed Solar PV

1. You said that you installed solar panels for X,Y,Z. Can you elaborate?
    a. What prompted you to investigate installing solar panels?
    b. What resources did you find helpful when researching solar panels?
        i. What was your first step?
            1. What was your process like and was it easy?
            2. How was finding your installer? Did you use a third party to find your installer? Were you happy with your installer?
            3. Did you have any concerns prior to installation?
    c. Did these concerns prove to be a problem or barrier?
        i. If yes, how easily were they overcome?
        ii. What barriers did you actually encounter? You mentioned X, Y, Z. Can you elaborate?
        iii. Did you have more roof space that you could have installed panels on?
            1. If yes, why did you not? (Upfront cost, etc.)
2. Did you pursue government or NGO support for your installation?
3. You lease your property, and you said that during the installation process, you interacted with your landlord in X, Y, Z. Can you elaborate?
4. Does your current system cover your entire electricity usage? What proportion of your electricity usage does it cover, approximately?
5. Do you expect your clients' perceptions of your business will improve? relationship with the community to improve from a "Green" initiative?
    a. Have you tried any other Green initiatives? Are you carbon neutral?
    b. Did any people (such as customers) have any initial reactions to the system when first installed?
6. Are you glad you installed solar panels on your property and would you encourage others to do the same?
7. Why were you willing to meet with us today?

Leased Property with Previously Installed Solar PV

1. You mention that the solar panel system had X influence on your decision to move into the location. Can you elaborate?
    a. What about it drew you? Being green, saved electricity costs, customer view?
2. Did your previous location have solar panels?
    a. If no, have you noticed what, if any, initial reactions of people (such as customers) to the system?
3. As you lease your property, what is your agreement with your landlord on the solar panel system?
    a. Were they already paid off before you began your lease here? Do you pay a higher rent but your landlord pays for the system? Do you cover the payments of the system while you lease?
    b. Do you pay your electricity bill or is it incorporated into your rental payment?
    c. Did you take the solar system into consideration when negotiating your lease?
4. Do you expect your clients' perception of your business to improve?
    a. Have you tried any other Green initiatives? Are you carbon neutral?
5. Does your current system cover your entire electricity usage? What proportion of your electricity usage does it cover, approximately?
    a. If no would you consider installing more panels if space allows?
6. Are you glad you have solar panels on your property and would you encourage others to install themselves?
    a. What would you tell them? How would you convince them to or not to install?
7. Why were you willing to meet with us today?

Owned Property with Self Installed Solar PV

1. You said that you installed solar panels for X,Y,Z. Can you elaborate?
    a. What prompted you to investigate installing solar panels?
    b. What resources did you find helpful when researching solar panels?
        i. What was your first step?
            1. What was your process like and was it easy?
            2. How was finding your installer? Did you use a third party to find your installer? Were you happy with your installer?

2. What were your perceived barriers prior to installation?
    a. Did these concerns prove to be a problem or barrier?
        i. If yes, how easily were they overcome?
3. What barriers did you actually encounter? You mentioned X, Y, Z. Can you elaborate?
4. Does your current system cover your entire electricity usage? What proportion of your electricity usage does it cover, approximately?
5. Did you have more roof space that you could have installed panels on?
    a. If yes, why did you not? (Upfront cost, etc.)
6. Did you pursue government or NGO support for your installation?
7. Do you expect your clients' perception of your business to improve?
    a. Have you tried any other Green initiatives? Are you carbon neutral?
8. Did any people (such as customers) have any initial reactions to the system when first installed?
9. Are you glad you installed solar panels on your property and would you encourage others to do the same?
    a. What would you tell them to convince them to install or not to install?
10. Why were you willing to meet with us today?

APPENDIX G

Traders Association Interview Questions

1. How many and of what type of businesses do you represent or have regular communications with?
2. What geographic area do you operate in?
3. Are electricity bills a large factor in business expenses?
4. Do business owners see their electricity bill as a fixed cost that cannot be changed or as something that has the potential to change and that they would like to change?
5. Approximately how many businesses which you represent lease their property compared to own their building?
6. Is it common for landlords to own multiple buildings? How many businesses on average?
7. For those buildings, how would you describe the relationship or level of interaction between the landlord and their respective tenants?
8. Are their interactions frequent?
9. Have you gotten an impression from businesses that they would want to switch to solar energy?
10. Do many businesses have the resources to install solar energy or would financing options be necessary?

APPENDIX H

Installer Interview Questions

1. How often do businesses come to you to talk about solar? How is this number compared to residential inquiries?
2. What size of businesses do you see most often that install? That are most interested but may not install?
3. Are there a certain type of business (manufacturing, retail, etc.) that seems to install more than others?
4. How much do businesses typically know about solar when they come to you?
5. What are some common misconceptions that businesses have prior to starting the installation process?
6. What are some reasons businesses wish to install solar?
7. What are some of the first concerns that businesses present to you?
8. What are some common things that businesses that wish to install need? Such as financing, guidance on what they actually need compared to their misconceptions, etc.
9. In the end, what are some common reasons businesses end up not installing?
    a. In your professional opinion are these reasons often true barriers that cannot be overcome, or are they still misconceptions business owners may have?
10. What are some strategies/points you try to make to businesses that are on the fence about installing to try to convince them to install?
11. If a business that wishes to install a solar panel system leases its business property/space, do you often interact with the landlord, business owner, or both?
12. Do you typically see business owners or property owners install more often?
    a. What method(s) would you suggest using in order to incentivize landlords?

APPENDIX I

Complete Landlord Survey

Investing in Solar Panels for Your Properties

* Required

1. **Do you lease residential or commercial properties?** *
   Mark only one oval.
   - ◯ Residential
   - ◯ Commercial
   - ◯ Both

2. **Where are your commercial properties loacted?** *
   Mark only one oval.
   - ◯ All within Moreland
   - ◯ Most within Moreland
   - ◯ Some within Moreland
   - ◯ None within Moreland

3. **Do you have solar panels installed on any of your properties?** *
   Mark only one oval.
   - ◯ Yes, residential and commercial *Skip to question 10.*
   - ◯ Yes, residential *Skip to question 10.*
   - ◯ Yes, commercial *Skip to question 10.*
   - ◯ No *Skip to question 4.*

4. **Have you ever considered installing solar panels on one or more of your properties?** *
   Mark only one oval.
   - ◯ Yes *Skip to question 5.*
   - ◯ No *Skip to question 8.*

5. **Who prompted considering solar?** *
   If you have multiple properties with different scenarios, check all that apply.
   Check all that apply.
   - ☐ You
   - ☐ Tenant(s)
   - ☐ Other: _____

6. **What were your primary reasons for considering installing solar panels?** *

Check all that apply
Check all that apply.

- [ ] Reduce energy costs
- [ ] Implement renewable energy
- [ ] Improve public perception
- [ ] Attractive feature to tenants
- [ ] Other: _____

7. **What stopped you from pursuing solar panels further?** *

Check all that apply
Check all that apply.

- [ ] Upfront cost
- [ ] Return on investment was less than desired
- [ ] Path forward unclear
- [ ] Difficulties with installer
- [ ] Regulatory restrictions
- [ ] Difference in opinion with tenant
- [ ] Other: _____

Skip to question 17.

8. **What are the primary reasons you have not looked into installing solar panels?** *

Check all that apply
Check all that apply.

- [ ] Lack of time
- [ ] Don't know where to start
- [ ] Tenants not interested
- [ ] Upfront cost is too high
- [ ] Payback time is too long
- [ ] Solar panels would not benefit me
- [ ] Inadequate roof space
- [ ] Other: _____

9. **What would you like to know or have available to you to make installing solar panels more attractive?** *

_____

_____

_____

_____

_____

Skip to question 17.

10. **How many commercial properties do you own?** *

_____

11. **How many of these commercial properties have solar panel systems installed?** *

_____

12. **How many residential properties do you own?** *

_____

13. **How many of these residential properties have solar panel systems installed?** *

_____

14. **Who prompted the installation on your properties?** *

If you have multiple properties, check all that apply.
Check all that apply.

- [ ] You
- [ ] Your tenant
- [ ] Other: _____

15. **Are the panels owned by you or a tenant, or leased from a utility company?** *

If you have multiple properties, check all that apply.
Check all that apply.

- [ ] Owned
- [ ] Leased
- [ ] Unknown

16. **Who purchased/leased the solar panels?** *

Check all that apply
Check all that apply.

- [ ] You
- [ ] Your tenant
- [ ] Split upfront cost

Skip to question 17.

17. **Are you willing to provide more information and opinions by participating in a short interview in the near future?** *

Mark only one oval.

- ◯ Yes, in person *Skip to question 18.*
- ◯ Yes, over the phone *Skip to question 18.*
- ◯ No *Skip to question 21.*

18. **How may we best contact you to schedule an interview time?** *

You will not be contacted for solicitation of any sort; your contact information is only to get in touch to schedule an interview. Thank you for your extra help and information.
Check all that apply.

- [ ] Telephone
- [ ] Email

19. **Please provide your telephone number here to be contacted for an interview.** *

If you are providing your email below, enter N/A here.

_____

20. **Please provide your email here to be contacted for an interview.** *

If you provided your telephone number above, enter N/A here.

_____

Skip to question 21.

Thank You!

Thank you for your time and for the information you have provided. It will be very helpful and beneficial to the study, and to the Moreland Energy Foundation Ltd. If you have any questions regarding the survey or our study, please email us at wpi@mefl.com.au and we are more than happy to answer any questions you may have. If you would like to learn more about lowering your energy costs or renewable energy, feel free to visit http://www.mefl.com.au/

21. **If there are any other questions or comments you would like to add, feel free to discuss these thoughts below.**

22. **If you would like to learn more about energy saving and/or renewable energy, or about what MEFL does, enter your email below to be added to MEFL's distribution list.**

Powered by Google Forms

Landlord Interview Questions

Landlords with Solar Photovoltaic

1. How many commercial buildings do you own that you lease?
    a. How many of them have solar?
        i. How long have you had solar on this/these buildings?
2. Do you have any other energy saving mechanisms in any of your buildings? (energy rated appliances, insulation, etc.)
3. Was it your decision to install PV or the current tenant's?
4. What convinced you?
    a. EX: Feed-in tariffs? Energy savings? Reduce carbon footprint? Publicity?
    b. If you've had multiple tenants since installation, has the presence of PV been considered an attribute by prospective tenants?
5. What agreement do you have with your respective businesses since you have the unique situation of solar PV on your buildings?
    a. Who technically owns the panels? Who has responsibility for them?
    b. Who sees the most payback, you or the tenant?
        i. How are the utilities arranged? Who pays them?
6. Was the decision making process smooth? Were there differences in opinions on solar technology and who pays?
    a. If so, how were they worked out and what compromises were reached?
7. Has the tenant changed since installation?
    a. How many tenants have you had since installation?
    b. Do new tenants find the system as a positive when looking at your building(s)?
8. Do you have any additional comments on anything we've covered today? Is there any other information you think would be helpful to our research?
9. Why were you willing to meet with us today?

Landlords without Solar Photovoltaic

1. How many commercial buildings do you own that you lease out?
2. Are all of your properties in Moreland?
    a. Where else?
3. Have you considered/researched PV?
4. Have any of your tenants presented the idea of installing solar?
5. Have you approached any of your tenants about installing solar?
    a. If so, has it been received positively or negatively?
6. Do you have any other energy saving mechanisms in any of your buildings? (energy rated appliances, insulation, etc.)
7. What is keeping you from installing PV?
    a. EX: High capital cost? Low feed-in tariffs? Unknown payback scheme?
8. What does or does not attract you to PV?
    a. EX: Energy savings? Reduce carbon footprint? Publicity?
9. Have you considered how you would like to specialize your tenant agreement if you were to have solar PV installed?
    a. EX: Who would be responsible for maintenance and upkeep, who would see the most financial benefits, how you would see payback.
10. Is there anything that you would like to see available or know about that would encourage you to investigate and possibly install solar?
11. Do you have any additional comments on anything we've asked today? Is there any other information you think would be helpful to our research?
12. Why were you willing to meet with us today?

APPENDIX J

Summary Response Sheets from Surveys

What is the name of your business	XXX
What category would you say your business falls under?	Other
How many FTE employees do you employ?	1-9
Do you have solar panels installed on your business?	No
Have you previously considered installing solar panels for your business	No
What are the primary reasons you have not looked into installing solar panels?	Do not own building
What time of day do you consume most of your electricity?	Day
What is your average monthly summer energy cost?	2000-5000
How significant a portion are your electricity costs of your total business expenses?	Moderate
What is your electricity tariff in c/kWh?	n/a
What are your average monthly summer gas expenses?	nil
What is the maximum upfront cost you would be willing to pay to install solar panels?	Unknown
In what amount of time would you like the system to have paid itself off?	Unknown
Based on the previous two questions, how much of your electricity consumption do you think you could receive from a solar panel system?	Unknown
In what type of property does your business operate?	Commercial leased
Are you willing to provide more information and opinions by participating in a short interview in the near future?	Yes
Phone	XXXX XXXX

What is the name of your business	XXX
What category would you say your business falls under?	Wholesale Trade
How many FTE employees do you employ?	50+
Do you have solar panels installed on your business?	No
Have you previously considered installing solar panels for your business	Yes
What are your primary reasons for not yet installing solar panels?	Upfront cost
What are your primary reasons for considering installing solar panels?	Reduce energy costs
What time of day do you consume most of your electricity?	Day 7AM-7PM
What is your average monthly summer energy cost?	More than $5000
How significant a portion are your electricity costs of your total business expenses?	(not in survey)
What is your electricity tariff in c/kWh?	(not in survey)
What is the maximum upfront cost you would be willing to pay to install solar panels?	Unknown
In what amount of time would you like the system to have paid itself off?	3-4 years
Based on the previous two questions, how much of your electricity consumption do you think you could receive from a solar panel system?	Under 50%
In what type of property does your business operate?	Commercial, leased

What is the name of your business	XXX
What category would you say your business falls under?	Wholesale Trade
How many FTE employees do you employ?	1-9
Do you have solar panels installed on your business?	No
Have you previously considered installing solar panels for your business	No
What are the primary reasons you have not looked into installing solar panels?	Do not own building, high upfront cost
What time of day do you consume most of your electricity?	Day
What is your average monthly summer energy cost?	200-500
How significant a portion are your electricity costs of your total business expenses?	Low significance
What is your electricity tariff in c/kWh?	26.68
What are your average monthly summer gas costs?	No gas used
What is the maximum upfront cost you would be willing to pay to install solar panels?	Unknown
In what amount of time would you like the system to have paid itself off?	Unknown
Based on the previous two questions, how much of your electricity consumption do you think you could receive from a solar panel system?	Unknown
In what type of property does your business operate?	Commercial, leased
Are you willing to provide more information and opinions by participating in a short interview in the near future?	Yes, over the phone
Email	XXX

What is the name of your business	XXX
What category would you say your business falls under?	Other Services
How many FTE employees do you employ?	0
Do you have solar panels installed on your business?	No
Have you previously considered installing solar panels for your business	No
What are the primary reasons you have not looked into installing solar panels?	Business may cease operation soon
What time of day do you consume most of your electricity?	Day
What is your average monthly summer energy cost?	200-500
How significant a portion are your electricity costs of your total business expenses?	Moderate significance
What is your electricity tariff in c/kWh?	0.2608
What are your average monthly summer gas expenses?	nil gas
What is the maximum upfront cost you would be willing to pay to install solar panels?	Unknown
In what amount of time would you like the system to have paid itself off?	3-4
Based on the previous two questions, how much of your electricity consumption do you think you could receive from a solar panel system?	Cover my electricity
In what type of property does your business operate?	Commercial Owned
Are you willing to provide more information and opinions by participating in a short interview in the near future?	No

What is the name of your business	XXX
What category would you say your business falls under?	Manufacturing
How many FTE employees do you employ?	1-9
Do you have solar panels installed on your business?	No
Have you previously considered installing solar panels for your business	No
What are the primary reasons you have not looked into installing solar panels?	Do not own building
What time of day do you consume most of your electricity?	Day
What is your average monthly summer energy cost?	200-500
How significant a portion are your electricity costs of your total business expenses?	Low
What is your electricity tariff in c/kWh?	0.1478
What is the maximum upfront cost you would be willing to pay to install solar panels?	Unknown
In what amount of time would you like the system to have paid itself off?	3-4 years
Based on the previous two questions, how much of your electricity consumption do you think you could receive from a solar panel system?	Unknown
In what type of property does your business operate?	Commercial, leased
Are you willing to provide more information and opinions by participating in a short interview in the near future?	Yes, phone
How may we best contact you to schedule an interview time?	Phone
Phone	XXXX XXXX

What is the name of your business	XXX
What category would you say your business falls under?	Arts and Recreation
How many FTE employees do you employ?	1-9
Do you have solar panels installed on your business?	Yes, self
How long has the system been installed?	4-6 years
What were the primary reasons for installing your system?	Reduce energy costs, environmental benefit
What is the size of the installed system?	Less than 5 kW
What time of day do you consume most of your electricity?	Night
Are you satisfied with your system? Why or why not?	Yes, it generates most of usage
What was the largest challenge you had to overcome when installing the system?	Upfront costs
In how many years did you or do you expect the system to pay itself off?	8-10 years
Are you satisfied with this payback time?	Moderately satisfied
Where is your business located?	Residential
How much money are your solar panels saving you per summer month?	More than $150
How much influence do these savings have on your business expenses?	Low influence

What is the name of your business	XXX
What category would you say your business falls under?	Accommodations, Food Services
How many FTE employees do you employ?	1-9
Do you have solar panels installed on your business?	No
Have you previously considered installing solar panels for your business	No
What are some of your reasons you have not looked into installing solar panels?	Do not own building
What time of day do you consume most of your electricity?	Night time (7PM-7AM)
What is your average monthly summer energy cost?	$200-500
How significant a portion are your electricity costs of your total business expenses?	Moderate
What is your electricity tariff in c/kWh?	N/A
What are your average monthly summer gas expenses?	$300
What is the maximum upfront cost you would be willing to pay to install solar panels?	Less than $2500
In what amount of time would you like the system to have paid itself off?	3-4 years
Based on the previous two questions, how much of your electricity consumption do you think you could receive from a solar panel system?	Under 50%
In what type of property does your business operate?	Commercial, leased

What is the name of your business	XXX
What category would you say your business falls under?	Retail Trade
How many FTE employees do you employ?	1-9
Do you have solar panels installed on your business?	No
Have you previously considered installing solar panels for your business	No
What are the primary reasons you have not looked into installing solar panels?	Do not own building
What time of day do you consume most of your electricity?	AM
What is your average monthly summer energy cost?	200-500
How significant a portion are your electricity costs of your total business expenses?	Unknown
What is your electricity tariff in c/kWh?	N/A
What are your average monthly summer gas expenses?	0
What is the maximum upfront cost you would be willing to pay to install solar panels?	Unknown
In what amount of time would you like the system to have paid itself off?	Unknown
Based on the previous two questions, how much of your electricity consumption do you think you could receive from a solar panel system?	Unknown
In what type of property does your business operate?	Commercial, leased
Are you willing to provide more information and opinions by participating in a short interview in the near future?	No

What is the name of your business	XXX
What category would you say your business falls under?	Professional
How many FTE employees do you employ?	50+
Do you have solar panels installed on your business?	No
Have you previously considered installing solar panels for your business	Yes
What are your primary reasons for not yet installing solar panels?	Upfront cost return on investment was less than desired
What are your primary reasons for considering installing solar panels?	Reduce energy costs, environmental benefit, improved public perception, Other: R&D
What time of day do you consume most of your electricity?	Day
What is your average monthly summer energy cost?	More than 5000
How significant a portion are your electricity costs of your total business expenses?	Moderate
What is your electricity tariff in c/kWh?	.052123 plus network costs
What are your average monthly summer gas expenses?	N/A
What is the maximum upfront cost you would be willing to pay to install solar panels?	20,000-50,000
In what amount of time would you like the system to have paid itself off?	8-9 years
Based on the previous two questions, how much of your electricity consumption do you think you could receive from a solar panel system?	Under 50%
In what type of property does your business operate?	Commercial Owned
Are you willing to provide more information and opinions by participating in a short interview in the near future?	No

APPENDIX K

Objective 2 Maps

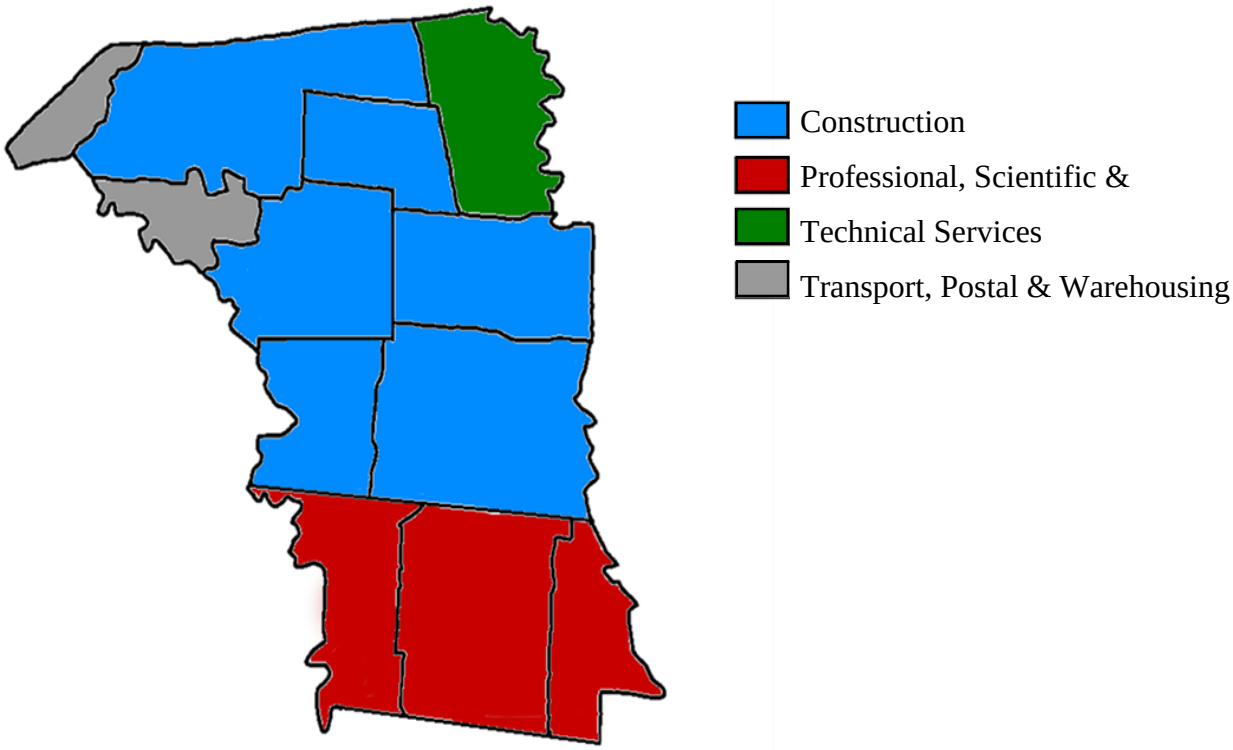


Figure 14 - Top Industry in Individual Moreland Suburbs

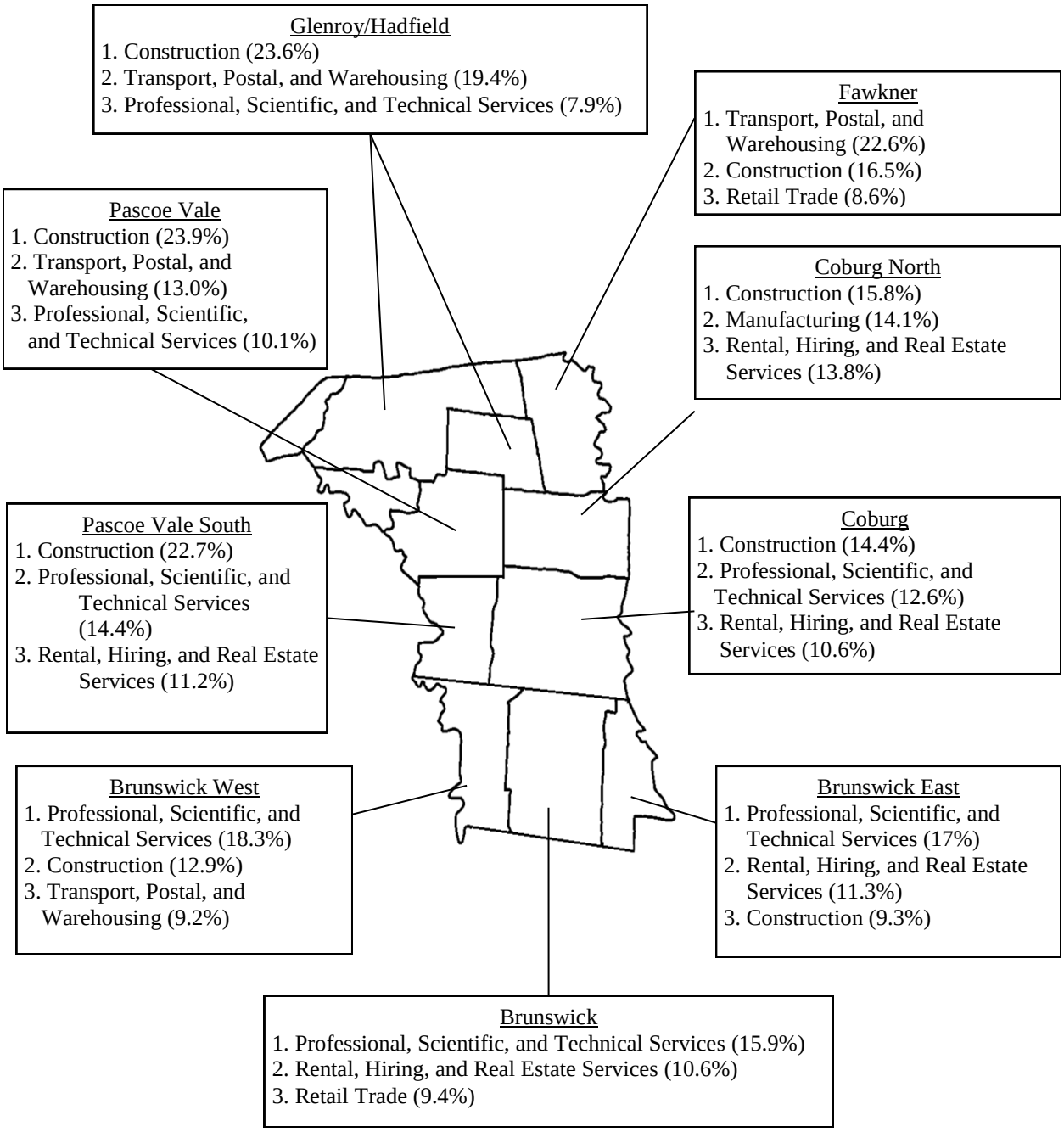


Figure 15 - Top Three Industries in Individual Moreland Suburbs

APPENDIX L

NearMap Key

Rather than using the virtual solar panel installation tool on NearMap for every building, it was quicker to simply take the dimensions of the roof and calculate the number of solar panels that could fit. Given the dimensions of the solar panels we were virtually installing (1m by 1.7m), after determining the appropriate orientation for the panels, we would calculate how many could fit on the roof space available, rounding down to be conservative. On slanted roofs the panels could be installed right next to each other but on flat roofs, because the panels would be mounted on slanted frames to increase their efficiency, we would need to leave a 0.6 m gap to prevent the panels shading each other. While it was easy to multiply by 1m to determine how many panels could fit across, finding how many rows there could be was harder. Below is the chart we used to quickly determine how many rows could fit on the roof and an example of a roof measurement with panels virtually installed as well to show the accuracy of our calculations (see Figure 16 and Table 4).

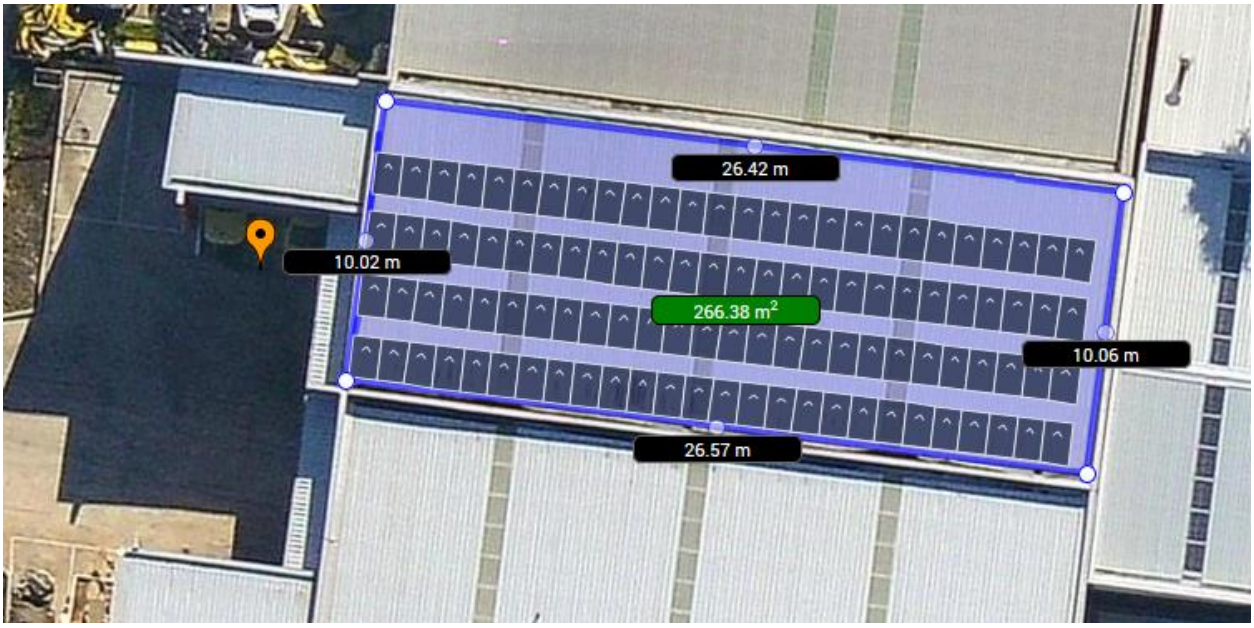


Figure 16 - NearMap Area Measurement

Flat Roof Range (meters)	Number of Rows	Slanted Roof Range (meters)
1.7 - 4.0	1	1.7 - 3.4
4.0 - 6.3	2	3.4 - 5.1
6.3 - 8.6	3	5.1 - 6.8
8.6 - 10.9	4	6.8 - 8.5
10.9 - 13.2	5	8.5 - 10.2
13.2 - 15.5	6	10.2 - 11.9
15.5 - 17.8	7	11.9 - 13.6
17.8 - 20.1	8	13.6 - 15.3
20.1 - 22.4	9	15.3 - 17.0
22.4 - 24.7	10	17.0 - 18.7
24.7 - 27.0	11	18.7 - 20.4
27.0 - 29.3	12	20.4 - 22.1
29.3 - 31.6	13	22.1 - 23.8
31.6 - 33.9	14	23.8 - 25.5

Table 4 - NearMap Panel Installation Conversions

APPENDIX M

NearMap Percent Error Calculation

In order to calculate the percent error of a data sample, the following equation is used:

$$\frac{(\text{measured value} - \text{accurate value})}{\text{accurate value}} * 100$$

We considered the virtual installation method as the accurate value and the area method as the measured value. By calculating the percent error for 10% of the businesses assessed, we determined our accuracy for the area estimates which can then be applied to our study as a whole to determine a more accurate solar potential estimate. Figure 17 below shows how the two different calculation methods can produce different results.

Figure 17 - Discrepancy Between Area and Virtual Installation Measurement Methods

APPENDIX N

Solar Capacity Calculations

Solar Capacity of Moreland Businesses

$$446{,}000\ kW\ installed\ potential * \frac{3.6\ kWh}{day} * \frac{1\ MWh}{1000\ kWh} = 1605.6\frac{MWh}{day} = 586.044\ \frac{GWh}{year}$$

The conversion for kW to kWh is dependent on daylight hours and weather conditions. The correction factor of 3.6 was provided by MEFL.

Energy Consumption of Moreland

$$\frac{2{,}054TJ^{4}}{year} = \frac{570.56\ GWh}{year}$$

Where terajoules [=] TJ

Solar Capacity/ Total Energy Consumption

$$\frac{586.044\ potential}{570.56\ consumed} * 100 = 102.7\%$$

[4] ("NAGA Municiple Energy Profiles 2012 v1_7," 2012)

APPENDIX O

Solar Capacity by Industry

Moreland

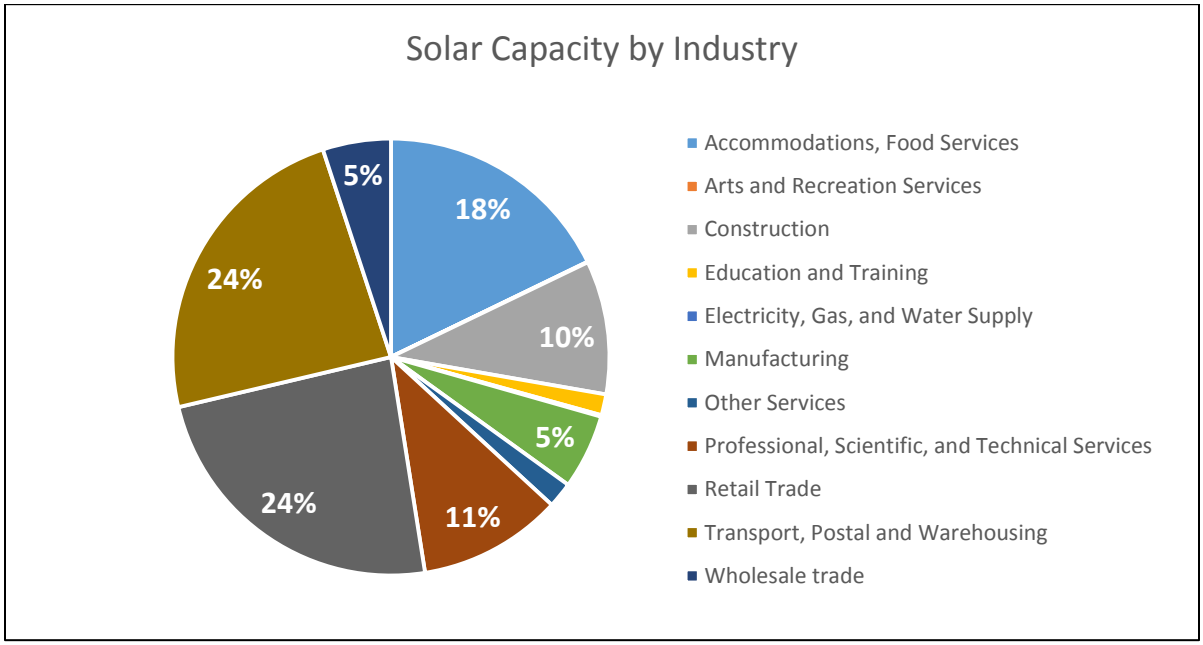


Figure 18 - Moreland Solar Capacity by Industry

Brunswick

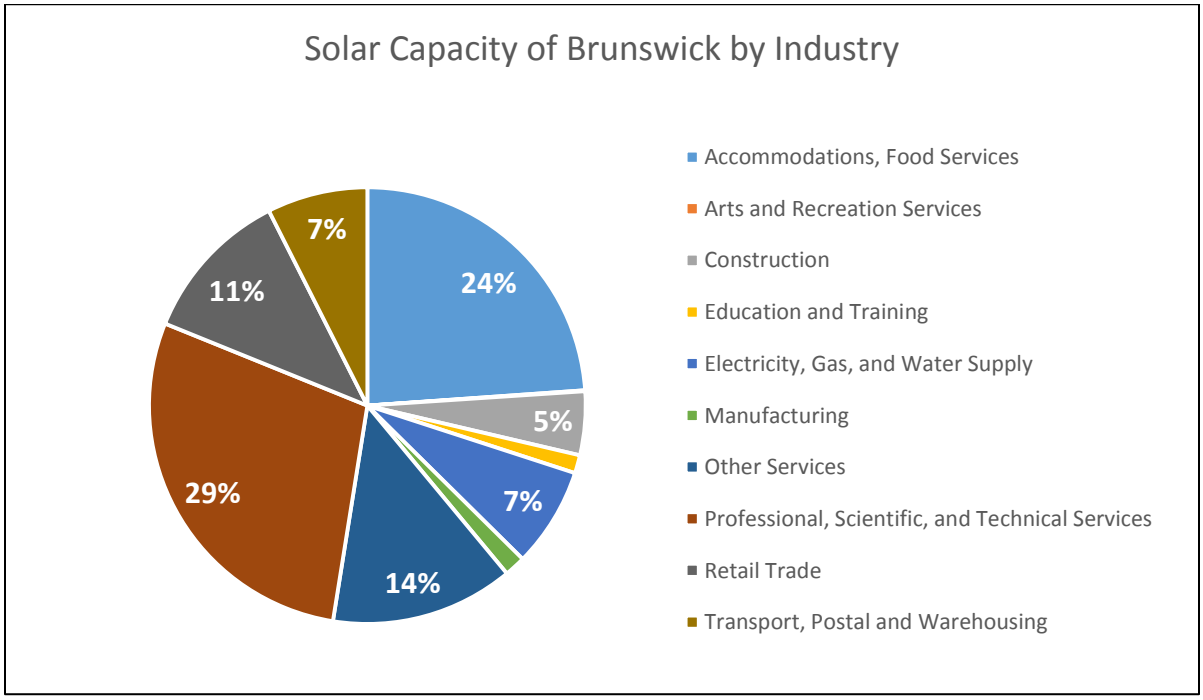


Figure 19 - Solar Capacity of Brunswick by Industry

Brunswick East

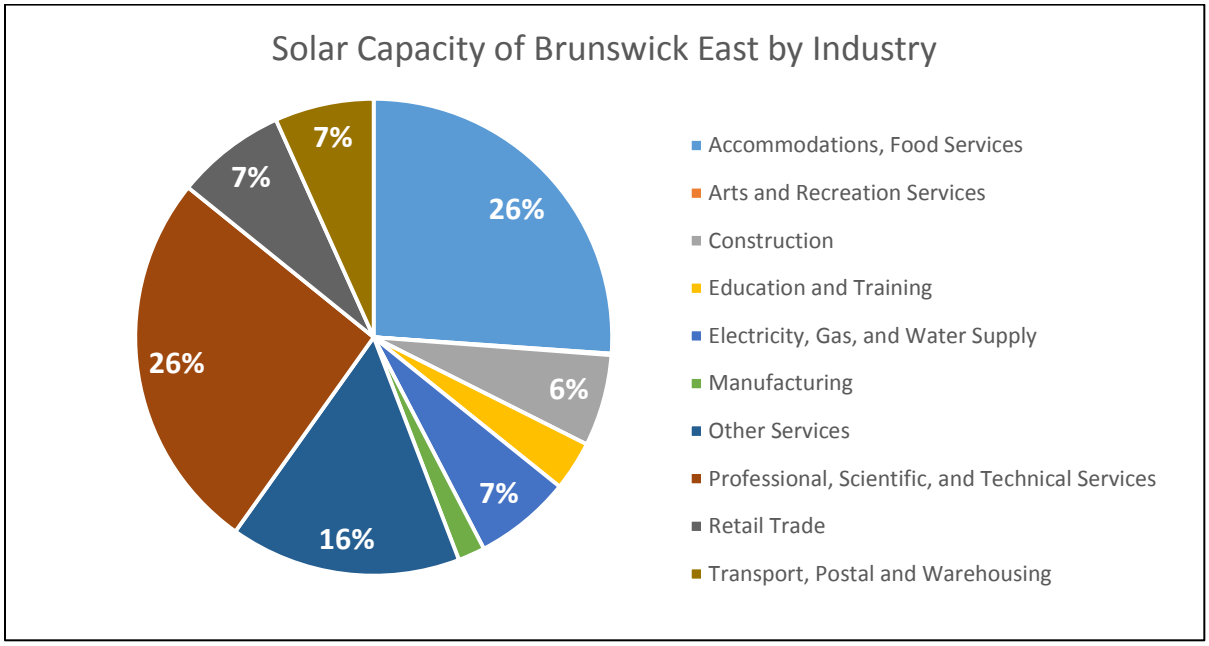


Figure 20 - Solar Capacity of Brunswick East by Industry

Brunswick West

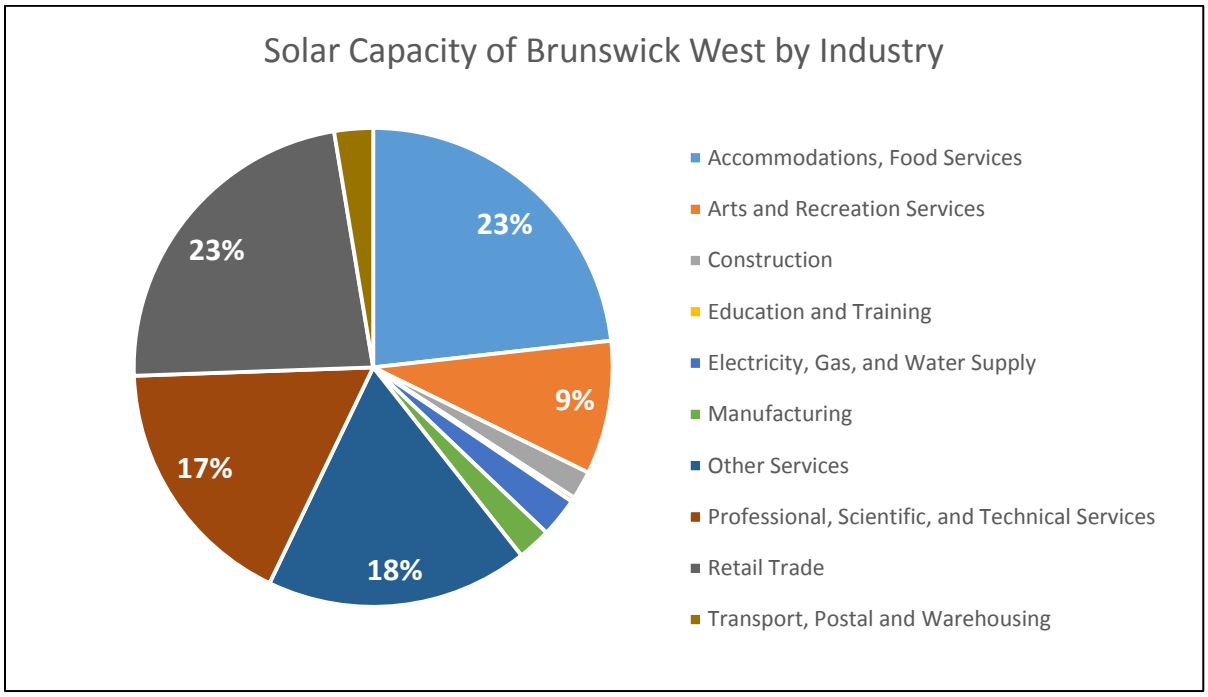


Figure 21 - Solar Capacity of Brunswick West by Industry

Coburg North

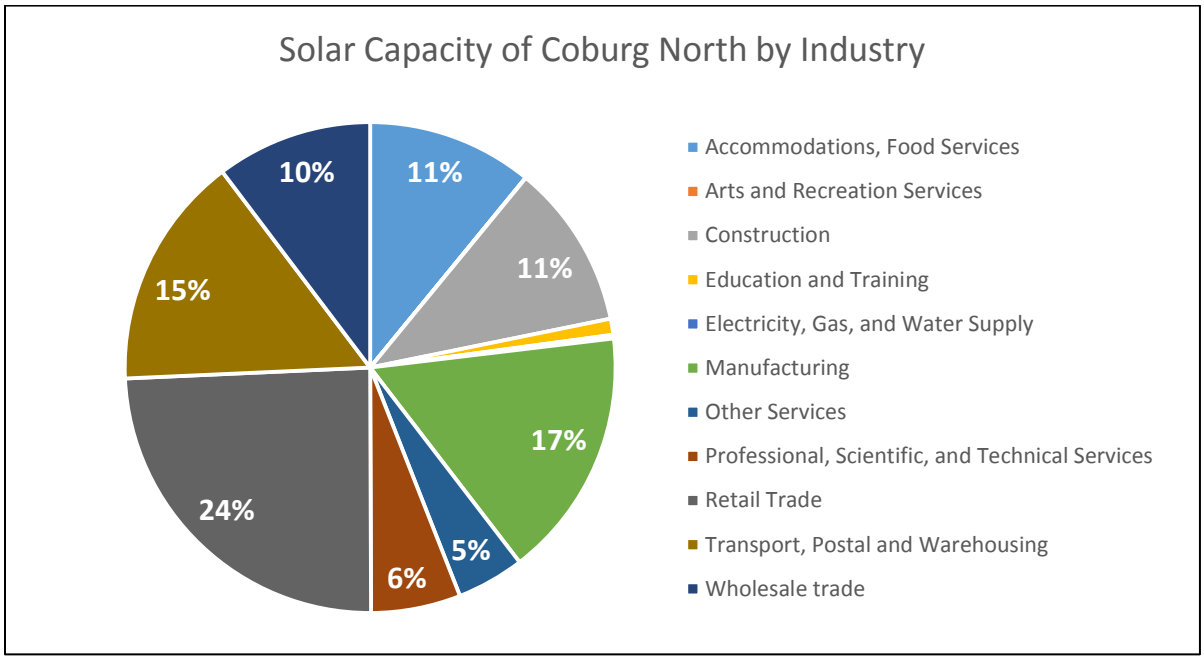


Figure 22 - Solar Capacity of Coburg North by Industry

Fawkner

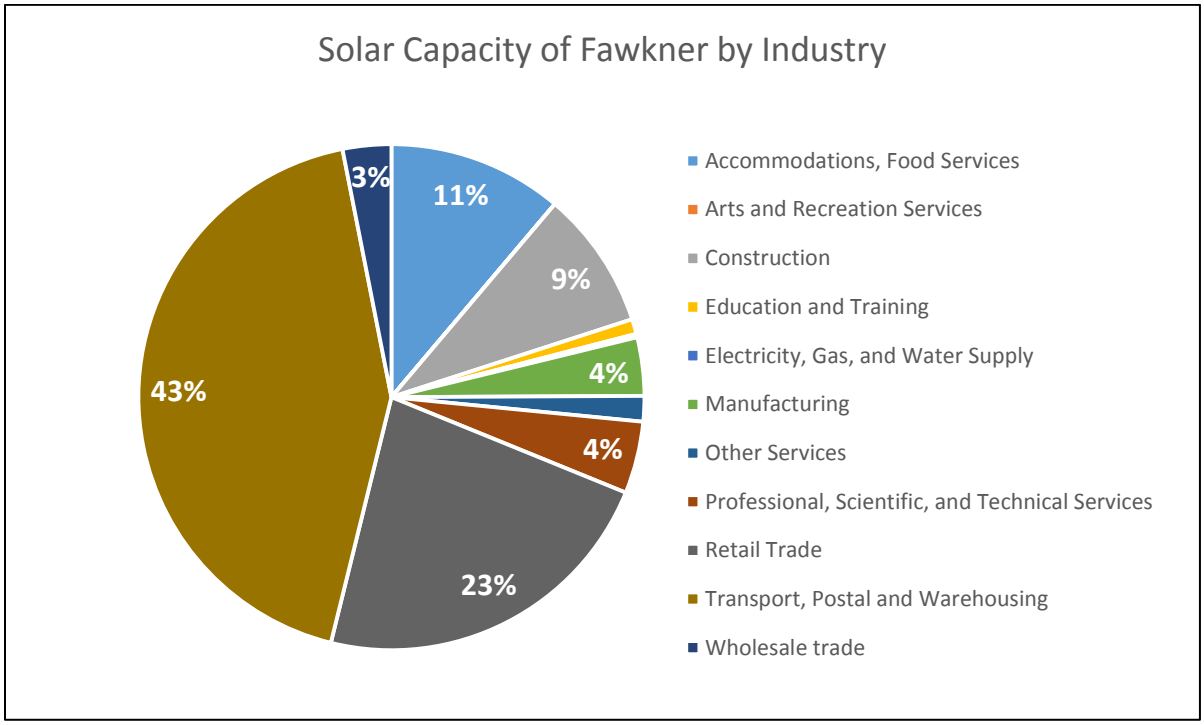


Figure 23 - Solar Capacity of Fawkner by Industry

Glenroy - Hadfield

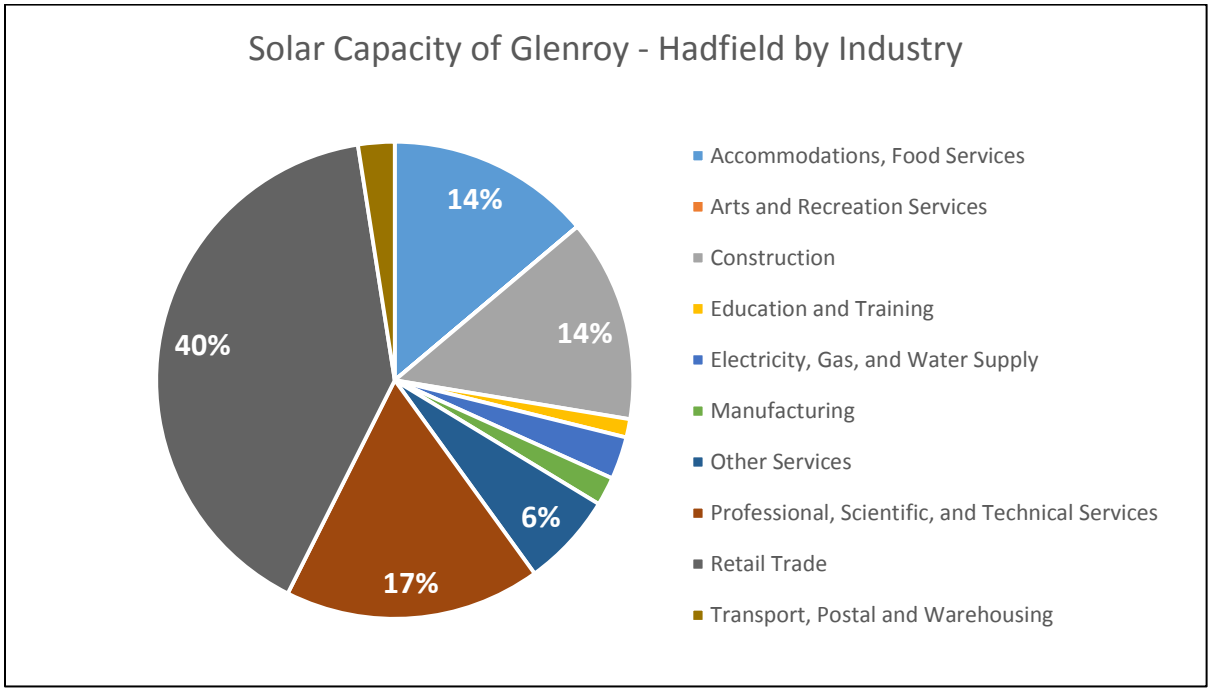


Figure 24 - Solar Capacity of Glenroy - Hadfield by Industry

Pascoe Vale

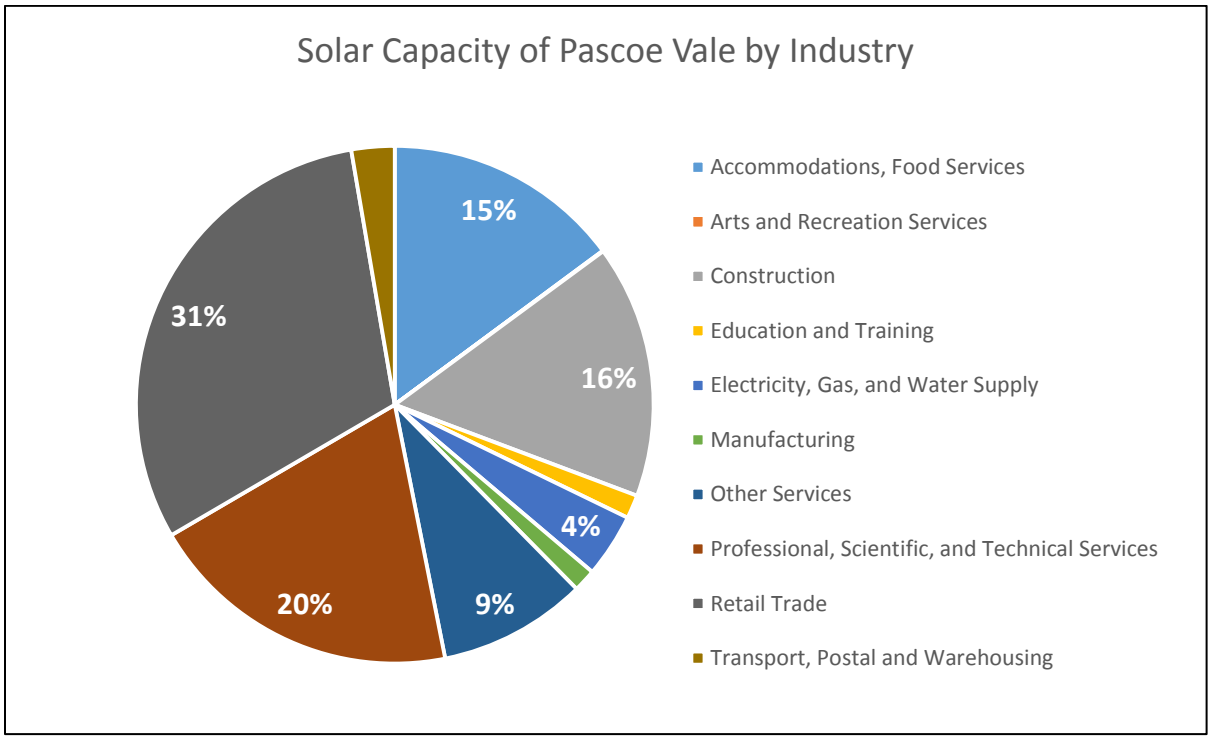


Figure 25 - Solar Capacity of Pascoe Vale by Industry

Pascoe Vale South

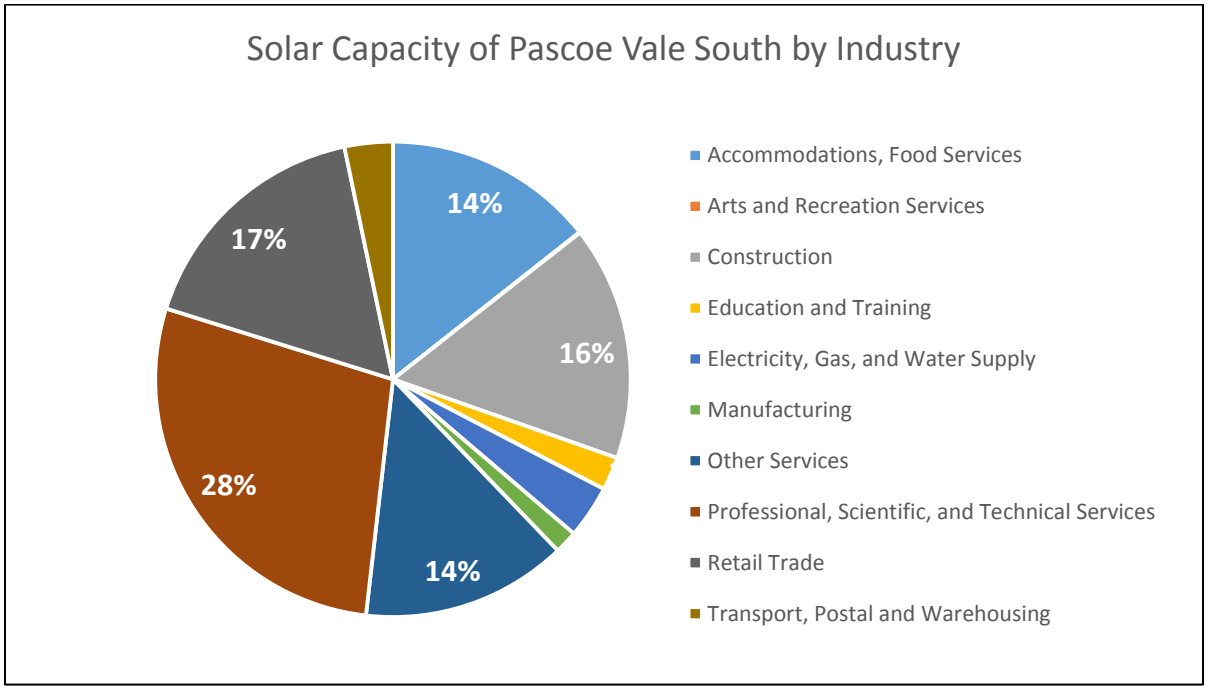


Figure 26 - Solar Capacity of Pascoe Vale South by Industry

APPENDIX P

Case Studies

Case Study 1

positive charge

Solar PV Assessment

Property Address

**** Street, Brunswick East

Building Summary

+ ***Business Name***
+ Wholesale Trade
+ North facing - slanted roof

Proposed PV Array Placement

Solar PV

System Size	10 kW system - 40 x 250W panels
Annual system output	12171 kWh
System Cost*	$16,300
Estimated cost savings pa*	$3,572
Electricity provided by solar	58%

Estimated Payback Period

We estimate based on the information provided that a 10 kW solar PV system for would pay for itself within 4.6 years. The total savings after 10 years is estimated to be $37,289 and $77,976 after 20 years.

System Performance Estimate

Placement

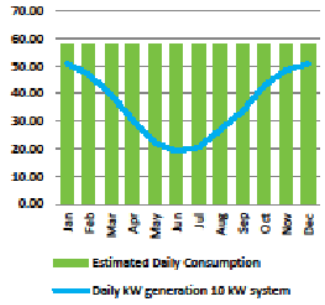
Orientation	North (345-15 Degrees)
Tilt	Pitch 20-30 degrees

Estimated yield (output in kW per day averaged over calendar month)*

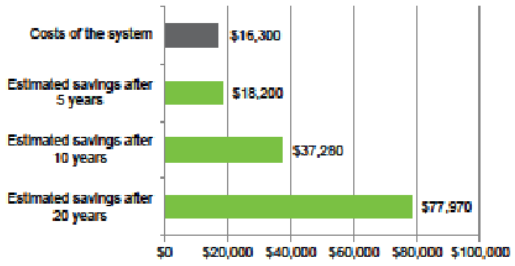
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
50.9	46.8	39.6	30.4	22.2	19.2	20.6	27.0	33.6	43.0	48.5	50.8

*estimate only, will depend on multiple factors particular to the property.

Electricity Consumption & Solar Generation



Financial savings



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Case Study 2

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Solar PV Assessment

Property Address

**** Road, Glenroy

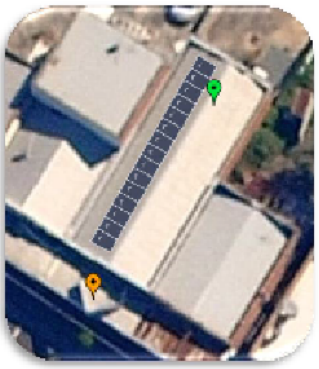
Building Summary

+ ***Business Name***
+ Real Estate Agency
+ 300 Degrees facing - slanted roof

Solar PV

System Size	3.75 kW system - 15 x 250W panels
Annual system output	4336 kWh
System Cost*	$6,100
Estimated cost savings pa*	$1,244
Electricity provided by solar	20%

Proposed PV Array Placement



Estimated Payback Period

We estimate based on the information provided that a 3.75 kW solar PV system for would pay for itself within 4.9 years. The total savings after 10 years is estimated to be $12,985 and $27,154 after 20 years.

System Performance Estimate

Placement

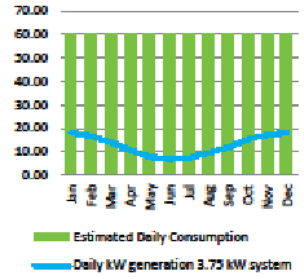
Orientation	North West (300 - 345 Degrees)
Tilt	Pitch 20-30 degrees

Estimated yield (output in kW per day averaged over calendar month)*

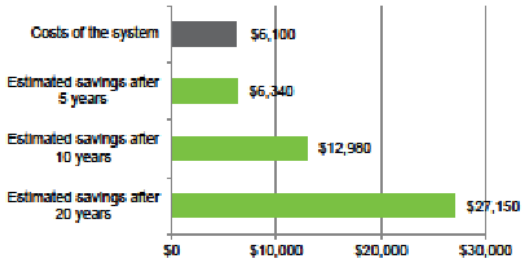
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
18.1	16.7	14.1	10.8	7.9	6.8	7.4	9.6	12.0	15.3	17.3	18.1

*estimate only, will depend on multiple factors particular to the property.

Electricity Consumption & Solar Generation



Financial savings



The graph above left shows the average daily consumption estimated from the electricity bills we received. The blue curve represent the average daily electricity generation of the proposed system. The graph above right illustrates the amount of financial savings that can be expected if solar PV is pursued

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Case Study 3

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Solar PV Assessment

Property Address

**** Street, Coburg North

Building Summary

+ ***Business Name***
+ Manufacturing
+ Slanted - North facing

Proposed PV Array Placement

Solar PV

System Size	5 kW system - 20 x 250W panels
Annual system output	6086 kWh
System Cost*	$8,900
Estimated cost savings pa*	$1,406
Electricity provided by solar	48%

Estimated Payback Period

We estimate based on the information provided that a 5 kW solar PV system for would pay for itself within 4.9 years. The total savings after 10 years is estimated to be $14,675 and $30,888 after 20 years.

System Performance Estimate

Placement

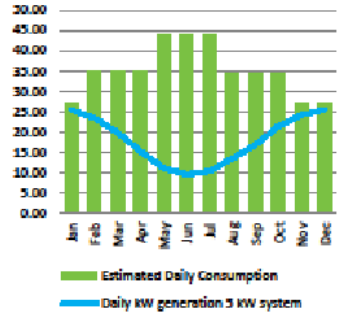
Orientation	North (345-15 Degrees)
Tilt	Pitch 20-30 degrees

Estimated yield (output in kW per day averaged over calendar month)*

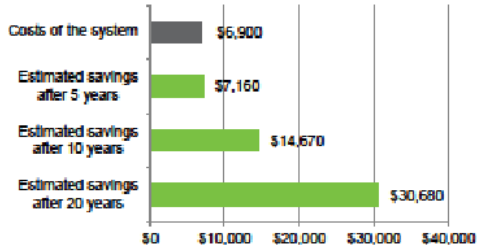
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
25.4	23.4	19.8	15.2	11.1	9.6	10.3	13.5	16.8	21.5	24.3	25.4

*estimate only, will depend on multiple factors particular to the property.

Electricity Consumption & Solar Generation



Financial savings



The graph above left shows the average daily consumption estimated from the electricity bills we received. The blue curve represent the average daily electricity generation of the proposed system. The graph above right illustrates the amount of financial savings that can be expected if solar PV is pursued.

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Case Study 4

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Solar PV Assessment

Property Address

**** Street, Brunswick

Building Summary

- ***Business Name***
- Manufacturing
- North facing – slanted and flat roof

Solar PV

System Size	24.25 kW system - 97 x 250W panels
Annual system output	29515 kWh
System Cost*	$39,200
Estimated cost savings pa*	$4,610
Electricity provided by solar	53%

Proposed PV Array Placement

Estimated Payback Period

We estimate based on the information provided that a 24.25 kW solar PV system for would pay for itself within 8.5 years. The total savings after 10 years is estimated to be $48,128 and $100,641 after 20 years.

System Performance Estimate

Placement

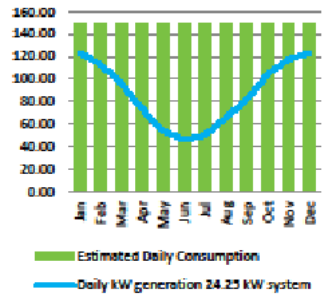
Orientation	North (345-15 Degrees)
Tilt	Pitch 20-30 degrees

Estimated yield (output in kW per day averaged over calendar month)*

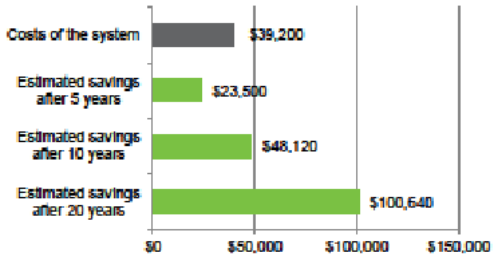
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
123.3	113.6	96.1	73.8	53.9	46.5	50.1	65.5	81.5	104.3	117.7	123.2

*estimate only, will depend on multiple factors particular to the property.

Electricity Consumption & Solar Generation



Financial savings



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