Implementing Residential Solar Energy in the Montachusett Region

An Interactive Qualifying Project Report
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by

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ABSTRACT

This project aims to promote economic development in the Montachusett region by gathering information from installers on ways to improve solar adoption. Ultimately, our research targeted specific areas in the installation process where methods could be improved and costs could be cut. To identify these areas, installers were interviewed about their experience working in the region. We developed recommendations for solar installation companies as well as the Montachusett Regional Planning Commission which will assist in increasing the prevalence of solar technologies. Ultimately we identified the need for improved community outreach, marketing strategies, and financial options in order to successfully promote residential solar adoption.

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Outcome

Reduced installation cost

Increased solar adoption

Regional economic growth

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EXECUTIVE SUMMARY

Currently, Massachusetts as a whole is a leader in the development of solar energy through its use of both green initiatives and statewide incentive programs. As a result, solar adoption has steadily been increasing both commercially and residentially. In order to pair this increase in adoption with an increase in economic development, the Montachusett Regional Planning Commission (MRPC) was awarded an EDA grant to site and promote renewable energy in the region. The MRPC created ten tasks that methodically accomplish these goals. Of these ten tasks, one focused specifically on the development of solar technology in the region which established the basis for this research.

Despite the various types of solar, this project concentrated on residential-scale photovoltaics due to its accessibility to a large number of customers. Additionally, the MRPC can more effectively promote residential solar through its influence on towns in the region. Despite Massachusetts' progress with renewable energy, barriers to solar technology still exist. Research suggests that the high price tag associated with solar technologies was the most prominent barrier to adoption. While the cost of the actual solar units has steadily declined, the non-modular cost of the installation process has remained relatively unchanged. Reductions in these soft costs are necessary if solar installation prices are to continue their downward trend. Advances in the affordability and attractiveness of residential-scale solar will spark increased adoption in the region and ultimately promote economic growth.

This project looked to identify areas in the installation process with potential for improvement. The first step to pinpoint these inefficiencies was to investigate current installation methods and practices. Due to the impracticability of interviewing consumers directly, solar installation companies were targeted to be used as a representative sample. Out of approximately sixty-five index installers, six companies were selected for interviews based on a set of research strata. These criteria were comprised of various attributes, such as location, size, and participation within the Solarize Mass program, to ensure our sample was varied enough to attain a broad range of information. These interviews were supplemented by consultation with the MRPC and Boreal to gain a better understanding of the practicality of the MRPC’s resources and their intended outcome for the project.

After all research was conducted and compiled, our qualitative data was analyzed for common themes. Six topics seemed to be consistent between our interviews: Solarize Mass, permitting, marketing, ownership benefits, the installation process, and the effect of using different suppliers. These themes formed the basis for a series of recommendations to both solar installation companies as well as the MRPC to improve the process in the region. By focusing on specific shortcomings in the process, methods for improvement were formulated.

Next the scope and reach of installers and the MRPC was analyzed so that relevant and realistic recommendations could be provided to each group. Installers were given a set of best practices in the areas of marketing, financial options and community based programs whereas the MRPC was given council on the topics of permitting and a custom community based program. Together these two sets of recommendations can serve as guidelines to making the solar installation process more efficient. If these recommendations are followed, the region should see an increase in solar adoption. By promoting local renewable energy, the regional economy will be stimulated and economic growth will occur.

CHAPTER 1: INTRODUCTION

The state of Massachusetts currently harbors a strong initiative for renewable energy. Over the past decade, solar adoption in particular has increased dramatically. The state government has consistently set and achieved ambitious goals for total solar capacity. In line with this strong statewide movement, this project focused on the promoting economic development in the Montachusett region through increased residential solar adoption.

By focusing on solar adoption, this project also complements the Montachusett Regional Planning Commission's (MRPC) goals. In 2010, the MRPC was awarded an EDA grant to promote the usage of renewable options in the region. These grant funds are designed to achieve renewable energy goals including the siting and development of green energy sources such as solar.

In order to achieve the goal of increasing solar adoption in the region, our project aimed to explore and evaluate the installation process of solar technologies, as well as identify any significant barriers to market entry. Affordability and corresponding marketing practices are the key elements of increasing photovoltaic usage in the region. Particularly, because initial costs are the largest detractor for most consumers, areas where costs can be reduced have been examined. The bulk of our research was conducted through interviews and communication with solar installers as well as the MRPC and Boreal, an energy consulting firm.

To identify areas where the installation process needs improvement, six companies were picked from a list of sixty-five installers that operate locally. These six companies were interviewed to form a picture of the common frustrations and problems encountered during solar installation. Additionally, processes and marketing strategies that installer found effective were also noted. Together the successes and difficulties of installers could be analyzed to understand what steps were necessary to improve the installation process, promote solar adoption and ultimately spark economic growth in the Montachusett region.

As a result, this project aimed to compile the necessary resources to give solar installers useful "best practices" recommendations. These recommendations specifically focus on marketing techniques, financial options and participation in community-based programs in order to promote solar implementation. Additionally, guidelines have been provided to the MRPC to improve local permitting and design community programs to allow for more numerous and lower

cost installations. Lastly, the MRPC has been provided a write-up of our research and other relevant findings. As a result of this project, the MRPC will be able to more effectively promote residential solar usage in their 22 towns. Furthermore, solar installers will be able to better provide cost effective solutions to solar installation. Together these two factors will aid the goal of increasing small-scale solar alternatives in order to cultivate economic growth within the Montachusett region.

CHAPTER 2: BACKGROUND

The Montachusett region, shown below, is an area in mid-Northern Worcester County, located west of Boston and North of Worcester. The region consists of 22 neighboring towns and runs 685 square miles with a population of about 228,000. The main urban cities in this region are Leominster, Fitchburg, and Gardener. There are multiple energy suppliers for the region. A table listing the suppliers and what towns they operate in can be found in Appendix A.

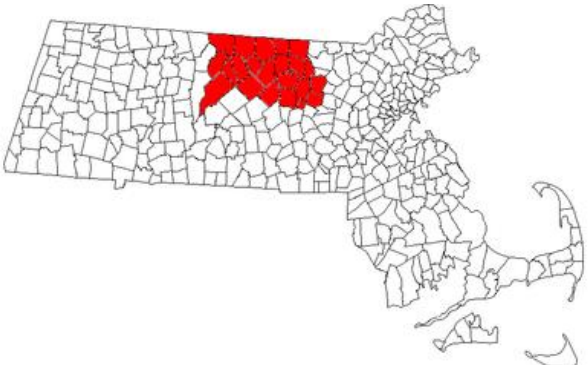


Figure 1: Montachusett Region
http://en.wikipedia.org/wiki/North_County_(Massachusetts)

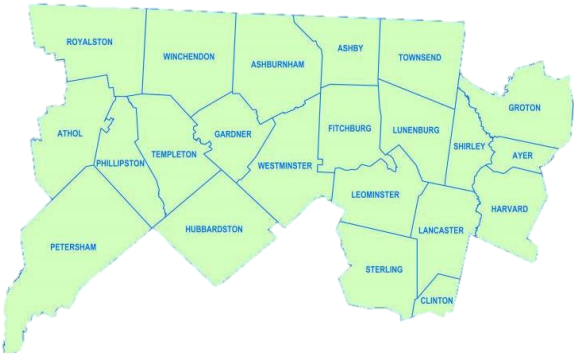


Figure 2: The 22 Towns that Comprise Montachusett
http://MRPC.org

In 2008, the region faced a terrible ice storm that resulted in numerous businesses closing down, as well as many citizens going without heat or power for an extended period of time. This storm showed that the region did not have a well-developed plan of action for emergencies and sparked the creation of the Energy Advisory Committee (EAC), of which the Montachusett Regional Planning Commission (MRPC) is a member .[1]

The MRPC is a regional planning agency dedicated to aiding community development and comprehensive planning within the Montachusett region. They assist regional communities with everything from transit to energy planning. The EAC was formed specifically to develop the Montachusett Region Energy Plan in order to better organize the energy goals of the region's 22 towns. The Economic Development Administration (EDA) awarded the MRPC with a $125,000 grant to facilitate and develop this energy plan. The purpose of the energy plan was to figure out which natural disasters would affect which communities in the region, where the vulnerable areas were, and to create strategies to reduce the risks caused by natural disasters.[2]

This energy plan included an analysis of the electrical grid structure to make sure the grid had the ability to meet the power capacity and need of the region. The EAC reviewed the existing infrastructure to find any failures or weaknesses based on past trends. They were then in contact with the company responsible for managing the capacity and reliability of that section of the grid. Furthermore, to avoid any sudden failures in the future, the EAC analyzed the data that was previously collected and developed a plan to not only maintain, but also upgrade the current infrastructure on a per-need basis.[2]

The plan recommended that the communities use a renewable energy source where environmental conditions would allow it. The energy advisory committee is also working on a siting renewable energy project. Beyond the initial goals, the EAC also hopes to use alternative energy options as a way to encourage economic development and generate jobs in the region.

The MRPC then received more federal funding which provided them the resources to move towards reducing the amount of electricity used in the region, replacing the use of fossil fuels with renewable sources, and decreasing climate change emissions. Lastly, another EDA grant was awarded to the MRPC to find sites in the region that could be used to generate renewable energy. The focus of this grant was not only to develop renewable resources in the region, but also to use these renewable energy projects as a means of stimulating economic growth. The MRPC developed ten tasks as focal points that they hoped to complete with the aid of grant funding. One of these tasks is the assessment and analysis of photovoltaic and solar hot water in the region. Specifically, it is important to the MRPC to analyze existing facilities, planning and zoning, siting photovoltaics, permits and regulations, incentive programs, and regional potential.

The cost of electricity in Massachusetts is higher compared to the rest of the United States. Using renewable energy could be one way to lower these costs. Residentially, electricity is about 30% more expensive than the U.S average due to a reliance on natural gas to generate electricity. While natural gas has less negative impacts on the environment than coal or nuclear plants, it is more expensive and directly results in higher electricity costs.[3]

2.1 Solar Technology

Solar energy is an almost unlimited energy source that sustains all life on Earth. There are many ways through which solar energy can be harvested, from organic processes, such as photosynthesis, to complex man-made processes, like the photovoltaic cell. In the case of man-made solar energy technology, radiation in the form of electromagnetic waves is either converted into useful heat energy or directly into electricity. Humans often look towards nature for innovative and efficient design, but in the case of solar energy, finely tuned artificial systems can boast efficiencies as high as 44%, whereas photosynthesis usually sits around 4% efficiency.[4] How is it possible that man-made systems can achieve efficiencies as much as 11 times greater than that of organic systems? This disparity stems from the nature of solar radiation.

Sunlight contains many different electromagnetic wavelengths. Although human eyes can only detect the portion of sunlight that is within the visible spectrum (approximately λ = 390nm to 700nm), almost half of the energy is stored outside of that range in the form of ultraviolet or infrared rays. Solar collectors can harness the energy from the entire spectrum of sunlight, providing a much larger energy output than biological processes, such as photosynthesis, which rely on enzymes limited to specific wavelength ranges. In fact, these fundamental properties of solar energy capture have been the focus of research to boost the energy efficiency of solar arrays. By increasing the efficiency of the initial energy conversion, the technology has been able to achieve other desirable traits, such as smaller sized panels and, in some cases, more affordable, economical arrays.

I. Types of Solar Energy Capture

There are many different types of solar energy capture. As previously noted, solar harvesters can be broken down into two distinct categories: heat-based and electricity-based. Heat-based systems use solar energy to heat a fluid, often water or an antifreeze solution. This fluid can then heat homes through thermal convection or directly be used for hot water. Other systems vaporize the fluid and use the resulting steam to drive turbines. Alternatively, electricity-based systems use integrated circuits to generate electricity directly from sunlight via the photoelectric effect. Different types of electricity-based systems are covered in sections II through IV.

II. Concentrated Photovoltaic Arrays

Concentrated photovoltaic arrays (CPV) sit at the high efficiency, high cost end of electricity-based solar collectors. By concentrating the sun's rays over a wide area onto a small photovoltaic cell, several optimizations can be made. First of all, the solar collector is relatively small, which is inherently cheaper than large non-concentrated solar arrays. Secondly, because the collector is so small, very high quality, tandem solar cells can be used while still being cost effective. These benefits, when combined with high concentration photovoltaics (HCPV) and multijunction solar cells, have led to the most efficient solar technologies today, reaching records of 43.5% efficiency.[5] Multijunction cells utilize multiple interfaces, called junctions, between different semiconductor types. Each junction is optimized for a different portion of the electromagnetic spectrum, reducing loss in the initial energy conversion. Single junction cells have a theoretical efficiency cap at around 34%, but this increases as more junctions are added. If possible, an infinite junction cell could approach 87% efficiency under concentrated sunlight.

However, this technology is not without its drawbacks. Concentrators must be very finely constructed in order to be efficient and mass producible while still maintaining low manufacturing tolerances and being able to keep uniform illumination of the solar cells. The concentrators also require complex solar tracking systems to optimize their output. Additionally, location is very important because concentrators rely on direct sunlight; diffused light cannot be properly focused. Lastly, focused sunlight generates a huge amount of heat and therefore powerful heat sinks must be used to keep the solar collector cool and avoid destruction of the apparatus. Due to these factors, the cost of a CPV array is often prohibitively expensive, despite its other advantages.

Researchers have adapted to these disadvantages through the development of low concentration photovoltaic (LCPV) and concentrated photovoltaic and thermal technology (CPVT) systems. The LCPV system prevents overheating issues by reducing the concentration of the array. Below a certain threshold, active cooling systems become unnecessary. Removing the need for heat sinks reduces not only construction costs, but also operating costs. Furthermore, at lower concentrations, a higher acceptance angle is possible, possibly invalidating solar tracking systems as well. The other approach is to use the heat energy generated rather than reduce it with CPVT, also known as combined

heat and power solar (CHAPS). It is a cogeneration system that simultaneously provides electricity as well as heat energy that can be used for water heating, air conditioning or other applications. While mainly being developed in Europe by a company called Zenith Solar, CPVT has the potential to increase efficiency through its dual-use approach and help the technology become more globally widespread.

III. Concentrated Solar Power

Another technology that is very similar to CPVT is concentrated solar power (CSP). CSP is identical to CPVT in the sense that it involves concentrating a large area of sunlight onto a smaller area via mirrors and lenses. The chief difference between the two technologies is that CPVT uses photovoltaic cells to directly generate electricity whereas CSP uses the sunlight to run heat engines, usually in the form of steam-powered turbines. Often the collector will be nothing more than a tube of liquid. As mentioned before, concentrated sunlight generates massive amounts of heat energy. This heat energy usually vaporizes the liquid and the resulting steam is driven through turbines to generate electricity. One advantage of CSP over CPVT is reduced cost, as expensive multi-junction solar cells are not needed. However, by introducing an intermediate process to the electricity generation, efficiency is often lost. Another shared concern between CPVT and CSP is the amount of land needed to build an array. Because a large amount of space used by the concentrators (mirrors), these technologies are impossible to implement on a residential scale or in dense urban areas.

IV. Residential Scale Photovoltaic Panels

While CPVT and CSP are fascinating and boast the highest efficiencies of any solar technology, they are not feasible for small-scale consumers hoping to offset their electric bill. This role is filled by residential scale photovoltaic panels. Residential solar panels are perhaps the fastest growing type of solar generation today. State and federal incentives, improvements in technology, as well as increased competition between installers have driven prices lower, making solar panels more accessible to the individual. However, there are many options for residential solar panels and many consumers have difficulty understanding the potential of different setups.

The first question that needs to be answered is whether or not the panels will be tied to the existing grid, or if batteries will be used. Each configuration has unique benefits and shortcomings. Battery based systems are often more expensive, as there are more initial components to purchase and install, and batteries have additional replacement and maintenance costs. In comparison, systems that are tied into the grid can forgo battery systems, but as a result, lose their independence from the grid; if the grid goes out no power is available, even if it's a sunny day. Additionally, each type handles excess electricity in different ways. Batteries obviously store power, enabling the owner to stockpile electricity during low usage hours and then use the power later during peak hours. For grid-tied systems, the electricity must either be immediately used or sold back to the grid. Electric companies are required by federal law to purchase excess electricity from residential solar panels connected to the grid, but the price is not specified. As a result, in many places the consumer might only receive a third of the wholesale rate for their excess electricity.

However, in Massachusetts there are additional laws in place to aid individuals owning residential solar panels. Not only are owners guaranteed the wholesale rate for their electricity, but also through the net metering program, excess electricity can be applied back to their own electricity bill. Furthermore, the excess energy credits can roll over month-to-month if not used up completely. Lastly, these credits can even be applied to other electric bills, enabling the owner to sell energy credits directly to other individuals for a profit.

Next, the consumer must decide what technology to use. Currently, there are three technologies for solar panels: monocrystalline, polycrystalline, and amorphous silicon, also known as thin film arrays. As always, each option has unique properties that make it more or less suitable for different applications.

A. Monocrystalline Photovoltaic

Monocrystalline photovoltaic panels were the first type of solar panels invented. They are built out of one large crystal of silicon. These grown silicon crystals are cylindrical in shape but are cut on four sides to form wafers. Although it increased silicon waste, this squared off shape allows the cells to be better placed into arrays

and increases performance. Because they are made of one solid piece, monocrystalline panels have incredible uniformity. This uniformity of structure at the molecular level allows for higher efficiencies of 15-20%, increases the lifetime of the panel, and gives it a pure bluish hue. Currently, the monocrystalline design is the most efficient (SunPower holds the residential record at 21.5%) but also the most expensive panel commercially used at the residential level.[6] As a result it is often chosen where there are space concerns. Its high efficiency allows for smaller panels to generate the same amount of electricity as larger panels of a different design.

B. Polycrystalline Photovoltaic

Polycrystalline photovoltaic panels are the most commonly used panels for residential applications. Rather than growing one continuous silicon crystal, polycrystalline panels are made by melting down silicon and pouring it into a mold. This process greatly reduces the manufacturing costs of the panels, providing savings that, in turn, can be passed off to the consumer. The downsides of this process are reduced panel efficiency (13-16%) and different aesthetics.[7] Uniformity is lost, sacrificing a small amount of efficiency and providing the panels a dappled look consisting of many different shades of blue. Some consumers feel this effect is beautiful, some see it as distracting. Besides being lower cost, one advantage of polycrystalline panels is that the molds form them into perfectly square wafers. This allows wafers to be placed more densely than their rounded monocrystalline cousins. By increasing the packing density of the panels, the loss of efficiency is offset. Another offshoot technology of polycrystalline panels are known as string ribbon panels. These panels are constructed with wires that have been coated in molten silicon. This process reduces the amount of silicon used but further sacrifices efficiency and increases production costs. Overall, the increased costs and low space efficiency have prevented this technology from gaining any foothold in the market.

C. Amorphous Silicon Panels

The last main type of solar technology used is amorphous silicon panels, commonly known as thin film solar cells. This name stems from the way in which they are manufactured. Silane and hydrogen gases are mixed and react, depositing a very thin

layer of silicon on a substrate, often glass, plastic or metal. The deposition process uses the least silicon of any of the other technologies, resulting in very low production costs. However, the molecular structure of thin film silicon cells is even less organized than polycrystalline panels. This makes thin film the cheapest but least efficient (around 12%) of the three technologies discussed. Thin film cells do have a distinct advantage though: flexibility. Depending on the substrate used, thin film cells can be much more flexible and rugged than the other two technologies. As a result, thin film is regularly used in integrated devices, toys and other applications where cost and durability are more important than high-energy output or efficiency. Interestingly, calculators were the first widespread applications of thin film technology; what child hasn't placed a thumb over the solar strip and watched as their calculator screen slowed faded to emptiness? Though these applications might be the most common, thin film is becoming increasingly common for residential roof panels. In fact, they can even be integrated into the roof covering material. This not only allows the panels to be less vulnerable to wind lifting and other weather effects but also allows the panels to be walked on carefully. These convenience factors (as well as the smaller price tag) are more important to some consumers than the raw efficiency of the other designs.

V. Solar Hot Water

The other main subsection of solar collectors is heat-based systems. This concept was already touched upon with CSP, but a more residential option is also available. Solar hot water systems use the sun's heat to provide hot potable water to a household. Often the solar ratio (or percent of total needed energy a solar system can provide) of solar hot water systems is not 100% and therefore must be used in conjunction with more conventional gas or electric water heaters. Like solar panels, there are several main options and concerns that come with solar hot water installation. A solar water heater can use either close coupled or pump circulation systems, closed or open loop heating systems, and passive or active energy collection. These combinations often confuse residential buyers.

Circulation is very important in solar water heaters. Due to the high temperatures present, precipitates form very quickly if the hot water pipes are not well circulated. The

two main options for circulation are a close coupled or a pump-driven system. Close-coupled systems rely on gravity and the physical process of thermosiphon flow to circulate the water. The water tank must be mounted either at an elevated position or on the roof of the structure. Pump circulated systems do not need to be raised; they instead use a pump to pressurize the hot water and move it to where it is needed within the household. Both systems must be carefully monitored. If either system fails, the pipes can either overheat or freeze and cause thousands of dollars of damage to the property.

Heat transfer and energy capture systems go hand in hand. The main two options for heat transfer is closed loop or open loop. Open loop systems directly heat the potable water that is used by the household. This is the simplest setup but usually has little protection from overheating or freezing. Closed loop systems on the other hand heat an antifreeze or intermediate liquid. This liquid is used to then heat the actual potable water in a water-heating tank. By using alternative fluids to transfer the heat, closed loop systems can integrate more safety features. Depending on the solution used, pipe-damaging expansion from heat or cold can be prevented. Energy capture can be done either actively or passively. Passive capture uses natural phenomenon such as heat convection to heat the water. This maintains simplicity of design and keeps cost low.

However, without active systems to optimize the process, efficiency is lost. Active systems use pumps and sensors to circulate and heat the fluid intelligently. Active measures allow a higher degree of control over the system and allow the water-heating tank to be located in different locations. Some homeowners would prefer the tank hidden rather than on the roof. Additionally, the tank can be placed in a conditioned room to protect it from weather conditions. Ultimately, active systems are safer and more efficient than the simplistic passive approach. Solar hot water is a useful option to offset the costs of traditional water heaters. The most basic systems can be cheaper than solar panels and are excellent for passive heating needs such as swimming pools. The main reason solar hot water remains less popular than photovoltaic panels is the maintenance and risk associated. Hot water systems simply have more maintenance needs than current panels. Furthermore, when solar panels malfunction, at worst power generation will be halted until repaired. When solar hot water systems fail, pipes burst and structural damage is common. This potential to cause damages if not properly maintained is an added concern

that many consumers don't want to have to deal with. Often the simplest and safest solution is the most attractive to homeowners.

2.2 Feasibility of Different Solar Technology

Despite these many types of solar technologies, only a few are feasible for residential applications. When focusing on small-scale solar projects, cost, space efficiency and durability are qualities that become more highly valued. As a result, technologies that are high efficiency but very high cost, such as CSP and CPVT, become far less feasible. The efficiency gains are simply not significant enough to offset the large increase in fixed costs. As a result, those technologies remain exclusive to large-scale commercial projects or research applications. Instead, small scale photovoltaic arrays and solar hot water are primarily used at the residential level. Specifically monocrystalline and polycrystalline photovoltaic cells are the most commonly used technology due to their durability and low cost. Thin film technology can also be used but it remains generally inefficient and thus is more commonly found embedded in products such as handheld calculators. Lastly, solar hot water can be an effective and low-cost alternative to photovoltaic technology. Despite solar hot water's feasibility, there is a higher demand for photovoltaic cells as evidenced by the amount of incentives offered and the rate at which photovoltaic adoption is increasing in Massachusetts as a whole. As a result, solar hot water was omitted from the scope of this project.

2.3 Ownership Options

When a consumer wants to install solar panels on his or her roof, there are three different ownership arrangements that can be pursued. The simplest is purchasing the panels and paying an installation company to install them. By owning the panels, the consumer is entitled to all of the incentive money and tax rebates offered through federal and state programs. However, all maintenance costs usually fall directly on the owner. Additionally, purchasing the panels requires a substantial upfront payment, which can be prohibitively expensive for some consumers.

One low cost solution is to arrange a solar leasing agreement. By leasing the panels, the consumer simply pays the solar installation company a monthly fee to use their panels. There are often very little, to no upfront costs and the company that owns the panels handles all maintenance. However, the company owning the photovoltaic panels also gets to keep all the incentives and rebates associated with solar technology. Often leasing leads to less financial benefits in the long run in exchange for a smaller initial investment.

Lastly, power purchaser agreements (PPAs) are popular at the commercial scale level. A PPA is extremely similar to a leasing agreement. The solar installation company owns the panels as before, but instead of the consumer paying a monthly fee to use the panels, the company simply uses your roof space in order to offer you a cheaper electric bill. Often PPAs are locked in for ten to twenty years and offer a set electric price. This provides a small amount of benefit for very little risk. The company, which owns the panels, absorbs any volatility in the electric market, where the consumer only needs to pay the electricity rate offered in the PPA agreement. PPAs can often offer a low cost solution with very little downsides. However, once again the long-term savings of a PPA agreement cannot compete with the incentive and tax rebates associated with owning the panels directly.

2.4 Advantages of Renewable Energy

One of the greatest benefits of renewable energy is the fact that it is more sustainable than non-renewable energy, such as fossil fuels. Energy sustainability involves the use of power in such a way that fulfills the requirements of the present without compromising the requirements of the future. Or, in short, using power sources in such a way can be sustained infinitely. This means the energy source must be renewable, which reduces the harsh emissions of non-renewable that leave lasting negative environmental, social, and health impacts. Renewable energy facilities generally require less maintenance than traditional generators due to the fact their fuel is derived from naturally available resources, specifically where these facilities run somewhat autonomous.[8] The availability of resources for renewable use substantially reduces the costs of operation. Even more importantly, renewable energy produces little or no waste products. Compared to a similarly sized conventional energy plant, renewable energy solutions produce

much less carbon dioxide or other chemical pollutants, resulting in a reduced impact on the environment.

Renewable energy technologies can also bring a number of economic benefits. These are due to the technologies' energy efficiency, which accounts for creating new job markets as site managers, panel developers, and a new maintenance market.[9] These economic benefits may be from the increased use of local services and a marketing tool to also target higher tourism in renewable communities. Overall, these technologies are advantageous in deterring foreign oil dependence and lowering numerous trading costs and taxes. In turn, various established incentives, such as tax credits and certificates given to commercial or residential use, that have been set up nationally and locally help maintain a rise in implementation of renewable technologies across the United States.

2.5 Disadvantages of Renewable Energy

Renewable energy sources struggle to generate the quantities of energy as those produced by traditional fossil fuel generators, specifically based on the inconsistency of supply of resources available to the technologies at a time. Solar technologies assist in the overall usage of energy across the country, regardless of which energy technology type is used. The utilization of these solutions, for residents and for the commercial sector, also indicates that the best results to the energy problems may be to have a balance of many different power sources, renewable and not. This balanced energy portfolio is the direction that energy consumption is heading toward, where the energy consumption is reduced as new renewable energy facilities are introduced and built.[9]

Another main disadvantage of renewable energy sources is the reliability of supply. Renewable energy often relies on the weather for its source of power such as hydro generators need for rain to fill dams, wind turbines need for specific rates of wind, and solar collectors need for clear skies and sunshine to collect heat. When these resources are unavailable, or not reliably constant, so is the capacity to make energy from them. This can be unpredictable and inconsistent. Another problematic aspect to these renewable technologies is the large price tag for first time installation, which have high up-front costs with a limited payback return. This is

because as a new technology, with a limited number of built infrastructure than traditional fossil fuel generation, and as such has extremely large capital cost.

Another drawback of installing solar energy is the very high initial costs associated with photovoltaic arrays or solar hot water. Before any government rebates, an average residential system can cost up to $25,000. For many individuals, this price tag is simply too high; even those who can afford the system, often view it as nothing more than an unnecessary financial risk. At best, the payback period for the system is 4-5 years and for many consumers it is not worth the wait. For these reasons, many Massachusetts residents may not feel comfortable taking such a large financial investment, especially when there is no guaranteed payback timeline due to the volatile nature of energy prices. One method currently being used to encourage the switch to solar energy is using government incentives to lower the initial costs and therefore decrease the time it takes to see a return on investment. [10]

Lastly, even if the consumer can overcome the high initial costs, resistance in their community may also discourage them. Solar panels can be viewed as unsightly or unnatural, possibly impacting the value of houses with rustic views. These factors often spark activists who champion the "not in my backyard" attitude. To some, the benefits of solar panels do not outweigh their unsightly nature. To combat this problem, solar companies are working on developing alternative solar panels that are blended into the roof with solar shingles as well as the solution of ground mounted panels near the home, thus reducing the incidence of aesthetic complaints.

The push for green energy with renewable technologies, in Massachusetts, like elsewhere, has opened a debate about the economics of these renewable energy technologies. Green energy encompasses both renewable energy sources such as wind, solar and biomass, and technologies such as energy efficiency and information technology- driven products designed to save energy. Many environmentalists believe the transition from carbon- based to greener energy sources is not only earth friendly but also economical. They promote a smooth transition to a "green economy" supporting "green jobs."

2.6 Government Incentives and Green Energy Programs

According to the Database of State Incentives for Renewables & Efficiency (DSIRE), funded by the U.S. Department of Energy, Massachusetts offers over 25 unique mandates, programs and incentives to promote renewable energy and energy efficiency. Massachusetts's ratepayers fund a number of mandates, programs and incentives to support green energy. The following sections provide a more detailed breakdown of those services.[11]

I. Renewable Energy

A surcharge of $0.0005 per kWh is levied on all electricity sold by private utilities. This money is used to finance the Massachusetts Clean Energy Center, a state authority that subsidizes various programs and incentives related to green energy.

II. Energy Conservation

A surcharge of $0.0025 per kWh is levied on all electricity sold by private utilities. This money is used by utilities to pay for energy efficiency measures, such as installing extra insulation in customers′ homes. [12]

III. Solarize Mass

Solarize Mass is a community based solar installation program designed to encourage entire communities to adopt residential solar. The program allows solar installers to bid for the rights to a community. Then a volunteer based force will work in the community to educate and encourage consumers to join the program. There are several price tiers that are dependent on the total amount of installations; therefore the cost is decreased if more members of the community opt into the program. This program has proven to be effective, as seen in the figure below:

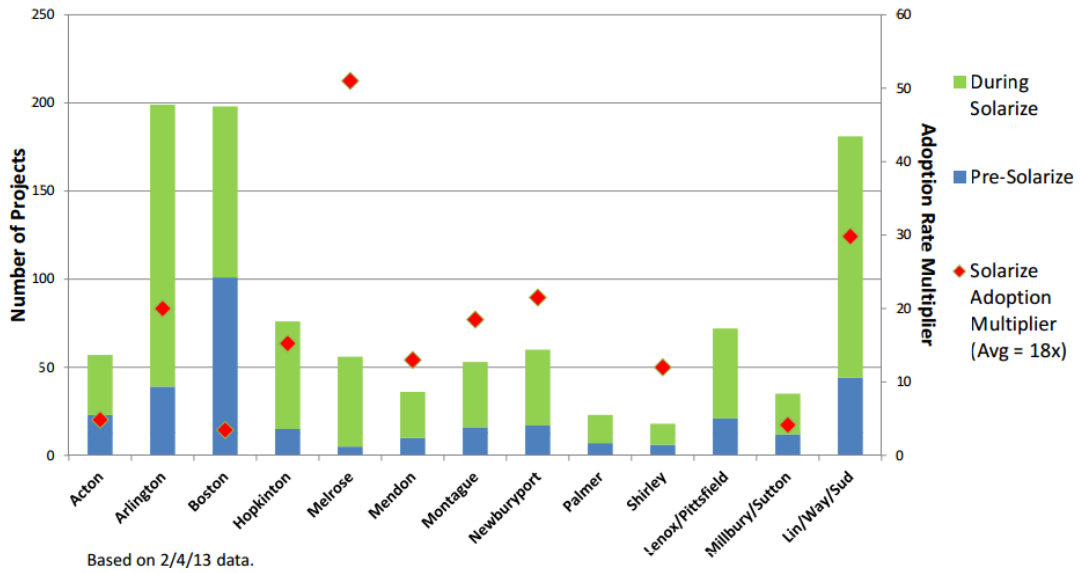


Figure 1: Solarize Mass Adoption http://www.masscec.com/content/2012-solarize-massachusetts-program-update

IV. The Regional Greenhouse Gas Initiative (RGGI)

This initiative, signed by 10 states including Massachusetts, calls for a permitting system that charges a variable cost based on carbon emissions. Electricity generators must purchase permits, while in Massachusetts 80 percent of the money raised from permit auctions is used to finance energy efficiency.[13]

V. Class I RECs

Currently, the 2012 RPS Class I requirement is five percent, and is set to increase by one percent each year. It is met through electricity production from qualified New Renewable Generation Units. New Renewable Generation Units are facilities that began commercial operation after 1997 and generate electricity using any of the following technologies: solar photovoltaic, solar thermal electric, wind energy, small hydropower, landfill methane and anaerobic digester gas, marine and hydrokinetic energy, geothermal energy and biomass fuel.

VI. Class II RECs

RPS Class II mandates that a minimum percentage of electricity sales come from each of two sources, renewable energy and waste energy. The current RPS Class II Renewable Generation obligation is 3.6 percent, and the Waste Energy Generation obligation is 3.5 percent. The obligation does not increase annually. A supplier must comply with both the minimum percentage of Renewable and Waste Energy obligations.

VII. Renewable Energy Certificates (REC's)

Renewable energy certificates (RECs), also known as renewable energy credits, green certificates, green tags, or tradable renewable certificates, represent the environmental attributes of the power produced from renewable energy projects and are sold separate from commodity electricity. Customers can buy green certificates whether or not they have access to green power through their local utility or a competitive electricity marketer. And they can purchase green certificates without having to switch electricity suppliers. Massachusetts requires utilities to purchase a percentage of electricity from providers of alternative energies, such as gasification and combined heat and power cogeneration facilities.

VIII. Solar Carve-Out Program

New regulations were filed so that a specified and growing portion of the RPS Class I renewable energy requirement comes from solar photovoltaic (PV) energy. This carve-out supports distributed solar PV energy facilities including residential, commercial, public and nonprofit projects, and is designed to help the Commonwealth achieve the installation of 400 MW of solar PV across the state.[14]

IX. Smart Grid

Each utility is required to initiate a Smart Grid pilot program. A Smart Grid is an enhanced electricity delivery grid that allows electricity use to be monitored between meter readings. These pilot programs are financed through higher electricity rates to customers.

X. Net Metering

Net metering allows customers of an electric distribution company to generate their own electricity in order to offset their electricity usage. Net metering can lower a customer's electricity bill by reducing the amount of electricity the customer must buy from the distribution company. Net metering also allows customers to be compensated for any electricity they generate but do not use.[15]

A. Class I, Class II, Class III net metering facilities

In Massachusetts, there are several categories of net-metering facilities. "Class I" facilities are generally defined as systems up to 60 kW in capacity. "Class II" facilities are generally defined as systems greater than 60 kW and up to one

megawatt (MW) in capacity that generate electricity from agricultural products, solar energy or wind energy. "Class III" facilities are generally defined as systems greater than 1 MW and up to 2 MW in capacity that generates electricity from agricultural products, solar energy or wind energy. Massachusetts also allows "neighborhood net metering" for neighborhood-based Class I, II or III facilities that are owned by (or serve the energy needs of) a group of 10 or more residential customers in a single neighborhood and served by a single utility. The neighborhood facility may also serve additional customers (including commercial) as long as the base requirements are met. All net-metered facilities must be behind a customer's meter, but only a minimal amount of load located on-site is required. In aggregate, these "non-governmental facilities" may not exceed 3% of the distribution company's peak load.

2.7 Residential Solar Implementation in Montachusett

There are many available options for solar generation. Due to the accessibility of solar options, residential solar technologies have a large room for growth. While more sophisticated concentrated arrays are not possible for residential projects, simple photovoltaic arrays have great potential to reduce dependence on traditional fossil fuel based electricity generation. Ideally, utilizing this technology, residential solar will continue to become more affordable and efficient.

Residentially, there is room to increase the solar energy usage in the Montachusett Region. This shortage in renewable resources could be due to a lack of public awareness of solar energy. Often it is difficult for budding solar energy contractors to afford advertising campaigns, especially when their direct competitors are wealthy oil companies[16]. Since solar technology is relatively new, solar companies are still young and growing. These companies have difficulty properly advertising and as a result their consumer-base is often unaware of commercial options.[16]

One way the MRPC has attempted to address a perceived general lack of knowledge in the Montachusett region was by offering workshops on siting renewable energy in the region.

These workshops were designed to be an easily accessible way for the communities to learn more about renewable energy. Unfortunately, the workshops struggled with community participation and did not have as great of an influence as initially desired.[17] The MRPC attributes the lack of attendance in part to the physical location of the workshops. There are different aspects of renewable energy and each of the twenty-two towns has their own interests and demographics relating to it. This makes it both necessary and very difficult to customize the workshops for specific towns. The MRPC attempted to achieve this customization by matching local implementations of solar energy with the topic of the workshops. For example, one of the towns was building windmills so the MRPC hosted two workshops specifically on wind energy there. Despite these efforts, attendance was still an issue, suggesting that this approach still needs improvement.[17]

2.8 Affordability Trends of Solar Technology

The number of PV systems installed in the United States in the recent years has grown at a rapid pace, driven in large measure by government incentives and programs.[18] figure below shows the drastic increase in renewable energy, especially solar energy, from 2006 to 2013.

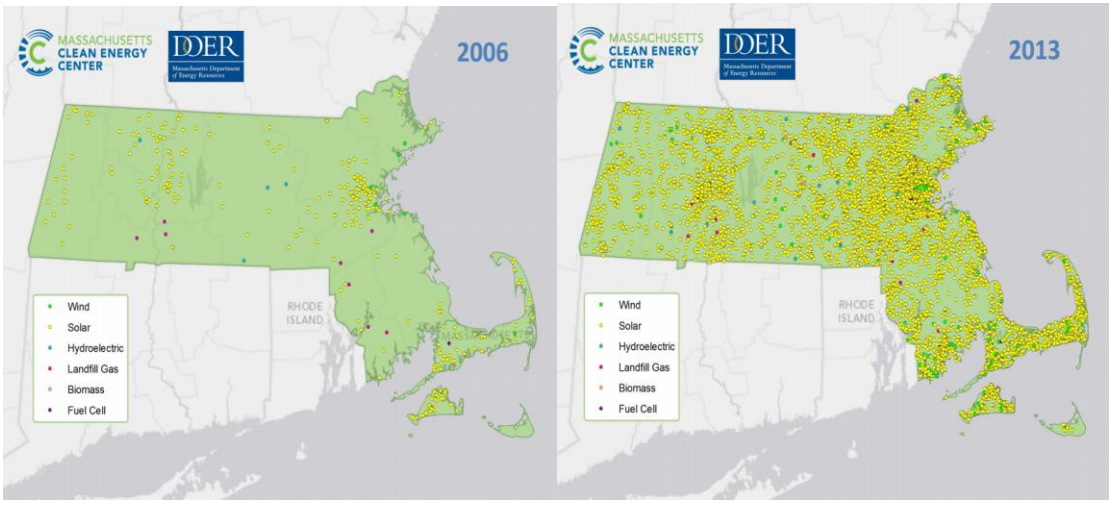


Figure 2: Renewable Energy Sites in 2006 and 2013 http://www.masscec.com/content/clean-energy-progress-animation

Given the relatively high historical cost of PV, a key goal of these policies has been to encourage cost reductions over time. Efforts to drive cost reductions have also been led by the U.S. Department of Energy's SunShot Initiative, which aims to reduce the cost of photovoltaic-

generated electricity by about 75% between 2010 and 2020.[19] As these various incentive policies and other initiatives have become more prevalent, and as PV utilization has accelerated, an increasing need has emerged for inclusive and reliable data on the cost of PV systems.

Available evidence confirms that the installed price of PV systems, which includes the upfront cost specifically by the system owner, has declined substantially since 1998.[20] However, the pace and source of those cost reductions have varied over time. Prior to 2005, installed price reductions were associated primarily with a decline in non-module costs.[21] Starting in 2005, however, installed price reductions began to stall, as the supply-chain and delivery infrastructure struggled to keep pace with rapidly expanding global demand. Starting in 2008, global module prices began a steep downward trajectory, driving installed price reductions of 40% among residential and commercial installations from 2008 through 2012. [21]

Non-module costs, in contrast, have remained relatively stagnant since 2005.[22] Trends in non- module costs may be particularly relevant in gauging the impact of state and utility PV deployment programs. Unlike module prices, which are primarily established through global markets, non- module costs consist of a variety of cost components that may be more readily affected by local policies – including deployment programs aimed at increasing demand (and thereby increasing competition and efficiency among installers) as well as more-targeted efforts, such as training and education programs.[23] Historical non-module costs reductions from 1998-2005 suggest that PV deployment policies have, in the past, succeeded in spurring cost reductions; however, the fact that non-module costs have remained largely unchanged since 2005 highlights the potential need to identify new and innovative mechanisms to foster greater efficiency and competition within the delivery infrastructure. Over the longer term, however, installed prices have fallen also as a result of reductions in non- module costs, which mainly include such items as inverters, mounting hardware, labor, permitting and fees, overhead, taxes, and general installer profit.

Within the last few years, however, module prices have declined at a much faster pace than non-module costs, and non-module costs have consequently grown in terms of their relative share of total system costs.[24] This shift in the cost structure of PV systems has heightened the emphasis within the industry and among policymakers on reducing non-module costs – particularly the variety of business process, or "soft", costs, which include such things as

marketing and customer acquisition, system design, installation labor, and the costs associated with permitting and inspection processes.

2.9 Alternative Usage of Shared Inspection

A shared implementation for groups of counties and towns is a useful spread for knowledge between multiple locations. Specifically in Massachusetts, a currently utilized shared staff is within the Law Enforcement department. The Staff Inspection Section is a component part of the Division of Standards, as part of the Law Enforcement and Criminal Justice Department, in Massachusetts. This training is designed to ensure the integrity and effectiveness of Department operations and personnel through a continuing process of intensive inspections. As outlined on the Commonwealth of Massachusetts website, this process is utilized to ensure "that all legal mandates and Department regulations are adhered to" but also seeks to make recommendations regarding methods that will improve working conditions for the men and women of the Massachusetts State Police. Secondly, the Official Website of the Executive Office of Public Safety and Security also stated that by conducting these inspections on a continuing basis, the Section is able to recognize and identify "patterns of organizational behavior that are not readily apparent to those involved in those operations" on a daily basis. The Section provides this service by inspecting every Unit, Section, and Station on a random basis as often as possible within a range of times per year.[25]

The Section currently consists of five senior officers, all in the rank of Captain. This rank structure provides the Section with the ability to effectively communicate and quickly address problems with all necessary personnel throughout the Department's table of organization. The Section inspects and confirms the integrity, storage and disposal of all contraband, narcotics and monies seized by the Department. Specifically through this process, the safety and effectiveness of the Department's holding facilities, equipment, personnel practices and makes findings of fact and recommendations based upon the results of these inspections. The Section seeks to appropriately disseminate the results of our findings throughout the Department to allow for the continuous improvement of all Department operations and practices.

Overall, the officers of the Staff Inspection Section seek to identify and propose solutions to manage risk factors, minimize the chances of Department failure or deficiency, maximize the

likelihood of success for both Department personnel and the citizenry, and enhance the professionalism of the Department's officers and operations for the benefit of all the citizens of the Commonwealth.

2.10 Justification of Project Need

The Montachusett Regional Planning Commission provides various services such as handling grant writing and administration, housing and commercial rehabilitation programs, affordable housing development, and administration of public facility and infrastructure projects. More recently, siting and implementation of various renewable resources has been added to that list of goals for the region.

Specifically, the need to increase and administer more solar technologies in the region has been identified as part of a diversified renewable energy portfolio. Residential-scale solar applications are becoming increasingly common as a means to offset power bills and stay environmentally conscious. Additionally, the price of solar installation declined "6 to 14 percent, or $0.30 per watt to $0.90 per watt, from 2011 to 2012," [26] representative of the continuing trend towards affordability. The cost of photovoltaic panels is reaching a tipping point where lower prices and incentive programs make the technology widely available and affordable. [26]

As the fixed cost of solar technology becomes more affordable, the soft cost of the installation process has become a more significant portion of the total price. If economic growth through solar adoption is desired, the price of photovoltaic technology needs to continue its decline towards affordability. This project focused on methods to decrease non-modular costs because "given the limits to further reduction in modular prices, additional deep reductions in installed prices will require significant reduction in soft costs." [27] If non-modular prices are targeted aggressively, installation rates will increase and cause economic development in the renewable energy sector.

CHAPTER 3: METHODOLOGY

This project promoted economic development through assessing economic concerns related to residential solar installations in the region. These concerns were then turned into recommendations for the MRPC and solar installers. The purpose of our research was to evaluate the solar installation process and identify potential improvements. In order to find challenges and inefficiencies, installers were interviewed about their experience working in the region. The varied results from our research were indexed into a list of "Best Practices" that contributed to the framework for region-wide understanding for the financial considerations with solar installations and its marketing to its residents. Our final report will assist the Montachusett Regional Planning Commission (in their regional energy planning efforts) in particular; we will suggest improvements or insights that could streamline the installation process for at residential sites.

3.1 Research

In order to understand the common problems encountered by consumers installing residential solar technology, we conducted focused research. Many programs such as Massachusetts Clean Energy Center have already drawn attention to common questions posed by consumers. This information was vital in determining that financial aspects were the most prevalent roadblocks to residential solar installation. Furthermore, researching this topic provided the necessary background to effectively understand and better utilize other sources. It provided a framework that was used to intelligently question both the MRPC and other expert contacts that were available.

Due to the project's close connection with the MRPC, communication was extremely important. We first contacted John Hume, the Director of Planning and Development for the MRPC. John Hume oversees the various teams working on energy and transportation and was able to direct us to the most relevant contacts within the MRPC. We initially emailed him, where we requested a copy of the EDA grant and coordinated with him for an-in person meeting and to be introduced to other vital MRPC contacts. The reason behind emailing and asking for the EDA grant and energy consumption by email was that the requested data was quantitative and did not

deal with opinion-based qualitative questions. Together the various contacts gave us access to the initial grant our project is associated with, as well as connected us to all the important people within the MRPC that are relevant to our project goal and scope.

Our meetings and interviews were conducted on-site at the MRPC offices as it allowed us to easily access other knowledgeable contacts. The main points we discussed were general feelings towards residential solar implementation, problems or barrier to completing our goals, and their professional opinions on the relevance and focus of our project. Through meeting with the various contacts, we gained insight into the motivations and goals of the MRPC and were able to better evaluate our project goals and deliverables.

3.2 Installer Sampling

To aid with our financial resources on solar installation we interviewed solar power installation companies. Installers were our chosen information source as it is be too difficult and time consuming to interview a large enough sample of consumers. Because each installer deals with many consumers, the collection of interviewed installers provided an accurate portrayal of consumer needs. Due to the fact that they deal with consumer concerns frequently, they have valuable information about what consumers need to think about when deciding to install solar panels and available financing on their these panels for their home.

While installers are easier and more useful to interview than consumers themselves, interviewing all installers is not practical. Therefore, we decided to create a representative sample of installers. We first compiled a list of installers in the Montachusett region and used that as our testing population. Next, we grouped them according to their service size. Lastly, we chose an equal amount of installers randomly from each group. This method was designed to create a balanced stratified sample. By creating strata based on size, we gave both smaller and larger companies an equal voice within our strata. Furthermore, by randomly selecting installers from within these groups, we ensured internal validity and removed sampling bias.

After creating the sampling list of installers, we picked the installers to interview for the data-collection process of the analysis. The essential elements required to systematically choose these installers was based on the requirement of a sample and that is be as representative as possible of the population from which it is drawn. A sample is considered to be representative if

the analyses made using the researcher's sampling unit produce results similar to those that would be obtained had the researcher analyzed the entire population[28]. With our samples, which appeared to be representative of the entire population of renewable solar installers, we were able to gather comprehensive data for installers. However, we maintain stratified sampling, to ensure that different groups of the installer population are represented in the sample. This is primarily to increase the level of accuracy for our data collection when estimating these parameters[28]. The necessary conditions for dividing our sample of installers was based on the strata of variables to consider when we picked our installers.

One of these criteria was for location-based installers, with installers based solely in Massachusetts as well as an installer with a state-by-state business model. Another criteria that we filled was the installer's participation in the Solarize Mass program, as it is a very important State program that directly correlates with residential solar installation financing. Lastly, our final criteria were different installment financing options offered on the websites from the exhaustive list we created. This would ensure different marketed options for financing, such as solar-leasing utilized with the Power Purchase Agreements (PPA) and residential solar ownerships, and would be included in the cluster sampling of installers.

Overall, the combination of these elements in the strata, allowed our final installers to offer different representations for the population of installers. Our cluster sampling involved our first selection of larger groupings, known as clusters, and then selecting the sampling units from the clusters. Based on our research problem statement, we made the selection from within the clusters using the stratified sampling procedures[28].

Figure 3: Installer Strata

We used the judgment sampling method to choose our pool of installers that we interviewed. This is when the researchers use their own judgment to choose who will be the most productive for them to interview. It is used to choose the best candidates to interview when there are not enough resources to conduct an extensive amount of interviews.[29] This method was used in case study about tourism management in Turkey. They used judgment sampling to choose whom they would interview about views on tourism control. This is similar to what we did because it involved them using a stratum to narrow down the list of interviewees and they then used semi-structured interviews to gain research as to whether or not tourism control was a problem and how it should be fixed.[30]

3.3 Interview Protocol

Before conducting interviews, we consulted the WPI Institutional Review Board (IRB) to ensure that our interview process complied with the ethical guidelines and regulatory requirements for research involving contact with human subjects, in this case the installers. The identities of the personal contacts interviewed would be kept anonymous and only the names of the companies would be linked to their responses. The IRB reviewed and ultimately approved our application for exemption and thus, we did not have to continue with the IRB approval process.

The interviews were held over the phone to reduce scheduling concerns and remain time efficient. In this case, it was possible to schedule multiple interviews within a day and achieve more interviews than if they were conducted on-site.

When in the interviewing process we used interview techniques of probing and informant lead discussions. These techniques allowed for the interviewees to answer without having our opinions interrupt or influence their responses.[31] Some of specific probing techniques we used included remaining quiet while we wait for them to continue speaking followed by us repeating what the installers last said and asking them for any additional comments. This method was very encouraging to the interviewee to continue speaking. It was also paired by periodic comments on their discussion points as well as continually exhibiting interest in their topic to encourage further discussion, such as following up their information with interest phrases like, "uh-huh"[31]. Recording devices were not used, in order to avoid the interviewee filtering their responses based on the knowledge that they are being recorded. These devices were also unnecessary, as we had three group members taking notes during the interviews.

We used a mixed-methods approach for our interview questions. Collecting qualitative and quantitative information is a way to better understand why customers are not switching to solar energy. The quantitative data was used as background to gather basic information about different installers. The data we collected from those questions then shaped the rest of the interviews. We also used qualitative research as a way to observe how installers answer certain questions and see if/how they deter customers from switching to solar energy. We were also interested in learning how permits and local governments influenced installation costs. A mixed methods approach has been used in a lot of studies such as Reiss' study of citizen and police transactions[32]. The mixed methods approach works well for combining ground research and fieldwork such as interviews and surveys[32].

For our interview we used the semi-standardized method. This is a method where there is a set of questions but they may change as the interview goes on. Semi-standardized interviews assume that the interviewers do not know what all the necessary questions are and that more questions may develop as the interviews continue[28]. Semi-standardized interviews are commonly used when interviewing experts on a certain topic. Semi-standardized interviewing is also used when researchers have some understanding of their topic of interest and will have some idea as to what the interviewee will say, but still remain open to changing their initial understanding.

This method of interviewing worked well for what we wanted to accomplish because we collected data as to why customers are not utilizing solar energy and how installers can change this, and then using that data to reshape our interview questions. During our interviews we saw how installers market their different solar financial options to consumers and, in turn, saw how that affected a customer's willingness to purchase a solar system. Based on how installers responded changed our questions or asked alternate follow-up questions. The data from our interviews further guided our research and molded our questions for future installers.

When crafting our interview questions we made sure to make them open-ended as opposed to questions that could be answered with one word. This is a common way to get more information out of an interviewee because it does not allow them to sum up their answer in just one or two words. Instead it requires them to think more about the questions and speak about the topics in greater depth.[33] In order to do this, we used question words such as who, what, when, where and why.

We wanted to make sure our questions were framed and backed up by previous research. This created informed questions and resulted in more developed answers than strictly giving the interviewee a general topic to discuss. This gave the questions and overall interviews a specific frame of reference that allowed our group to receive answers to the topics we needed more information on.

We created our installer interview questions with a few goals in mind. Not only did we want to gather general information about the process and approach used by the company, but also we wanted to specifically research their various financing policies in accordance to our project's cost-based focus.

Because we wanted information from several main topics, we broke out questions into preliminary categories and put them in a logical order. This systematic approach to asking questions allowed us probe the installer for the answers we desired without the risk of accidentally skipping over topics or forgetting questions.

The first major question we asked concerned the process of a solar installation. We prompted the installer to give a rundown of what their process is and how they executed it. This was an effective way of getting the installer representative talking and comfortable in the interview. Additionally, because all of our questions relate back to the overall process in some way, starting with this broad question helped set the stage for us to follow up with more specific

questions. At this point we also asked about possible additional costs that might come up and how the installer handles informing and working with the customer to rectify any issues. This is important because potential conflicts during installation must be identified and addressed in order for the client to go forward with the project.

Next, we asked several questions about finances including the different payment plans offered, incentive programs available and bank partnerships. However, more importantly, we asked the installers how they introduce these topics to their customer and the general implications of different choices. We asked about payment plan offers because we believe that initial cost is the highest market barrier to residential solar. We used this question to analyze if these payment options do in fact help attract customers. Incentive programs were asked about for the same reason because they directly affect the affordability of a project. However, we also wanted to determine if installers handle the paperwork on for their customers and any positive implications that might bring. Additionally, we asked if any financial incentives are used for marketing in order to explore the effectiveness of these mechanisms for attracting customers.

In addition to the financing, permitting and regulations are very important. We specifically asked about how the experience varies from town to town. This question was designed to identify problem areas that can be improved to streamline the inspection and permitting process.

Next we asked about the actual hardware suppliers used. The price and model of the supplied solar panels directly affect the consumer price of panels. As a result we wanted to gather information about big name players in the supplier business as well as gauge how installers pick their suppliers. This was useful to further analyze how the costs to the consumer can be mitigated.

Lastly, we asked for additional informational and marketing materials from the installers. Not only did this give us a physical product to relate back the information, but it also gave us insight into how companies market themselves. Marketing materials showed the topics that an installer values most and as a result may help identify any gaps in an installer's educational materials.

Overall, our questions were designed to gain a general understanding of the installer-customer relationship as well as thoroughly investigate financial concerns. This approach allowed us to identify common trends that were beneficial to the adoption of residential solar.

Additionally, the more broad questions allowed for the installer to drive the conversation and touch upon points they feel are important. This was particularly useful in unearthing problems and inefficiencies in the current system. Identifying both the best practices used as well as the areas where improvement is still needed ultimately allowed us to aid the adoption of residential solar through focused and specific recommendations to both installers and the MRPC.

3.4 Interview Process

The first step in our interview process was a pilot interview, which was conducted with $(PV)^2$. This provided us with useful feedback as how we should change our questions to elicit a better response. After asking the question, "Could you outline the general process you go through when contacted by a consumer looking to install solar options?" we found that it was sort of awkward to just start the conversation with this so we decided that background questions should be added. We decided to ask about how long the company has been operating, how many installations they perform in a year, and where they operate. We found that the second question, "At what point in the process do you inform your customers about additional incurring costs that may develop when installing?" was answered during the first question so we decided to remove it.

The conversation then moved towards incurring costs so we rearranged the order of the questions and asked about how they inform their customers about the additional costs. During the interview, the interviewee did not fully understand what we were asking when we said "How do you go about informing your customers about the additional incurring costs?" so we reworded the question to say "How do you go about informing your customers about the costs?" We feel as though this question will encompass additional costs as well as tell us whether the way in which the installer tells consumers about costs change whether or not they switch to solar energy. This topic then led to us asking about which suppliers they go through because it came up as a potential cost. Finally, we decided to make a note to ask if people walk away from contracts in the next interview because it is useful to know how many people actually go through with the installation after inquiring.

After the second interview our questions changed again but not dramatically so. As far as learning background information, we decided to ask, "where are you based out of?" as well as

"where do you operate?" because a lot of companies will travel further, so asking where they operate does not answer where they are located. One new question that emerged was if a non-refundable down payment is required. We feel as though this is an important topic to cover because a large non-refundable payment could deter consumers from going through with a solar installation. We also decided to ask why people walk away from contracts instead of if they do. This was useful because we are trying to increase solar use so it is good to know what causes people to not go through with switching. We also decided that for the third interview we will reword the question "Are there any local permits that affect how you operate?" to "Do you find that local permitting significantly affect the way you operate?" We did this because we feel the second wording will tell us whether permitting affects those, instead of asking which permits specifically affect them. Finally, due to the unexpected response about Solarize Mass from the first interview we decided to ask them specifically about their participation in it.

3.5 Interview Analysis

There are four steps to qualitative data analysis. They are data preparation, data exploration, data reduction, and interpretation[34].

Step 1: Data Preparation

During the interviews, the three of us took notes on the basic thoughts on what was said. For the duration of the interview, we summarized the main points discussed after each question we administered. When specific details were highlighted by the installer or contained new and useful information, we took direct quotes of those discussion. We were not concerned with verbal data such as emotions, pauses, laughter, etc.

Step 2: Data Exploration

After each interview we did a brief summary/analysis to pick out any main points that stood out. These acted as memos for us and we referred back to them to quickly pick out important themes and ideas. After every two interviews we did an analysis to see any overarching themes as well as any significant differences. We used this analysis to re-shape our questions if necessary and to help us determine other themes to look out for in

the future interviews. This is known as an iterative process and is often used when collecting and analyzing data[34].

Step 3: Data Reduction

After reviewing all of our data we looked at the major themes and determined what was important for our deliverable. We found the major themes to be Solarize Mass, permitting, marketing, leasing vs. owning, installation process, and suppliers. We then focused only on the relevant data and conducted a qualitative analysis.

Step 4: Interpretation

Based on the qualitative methods of our research, both interpretation and analysis were fluid phases within our research process. We constantly engaged simultaneously within our collection, analysis, and interpretation of our data. This included gathering data from individuals from the MRPC and groups of individuals such as the solar installers. As we transitioned from problems with data collection to issues of interpretation and writing up the research results, other questions begin to emerge concerning the interpretation of our qualitative data[35].

3.6 Deliverables

Once all the data was processed and received from the number of companies and agencies, it was compiled into our deliverables. The deliverables consisted of "best practices" for installers on how to increase their effectiveness. Additionally, a set of recommendations was provided to the MRPC with methods for utilizing the EDA grant funds to promote regional economic growth through improving the solar installation protocols and permitting processes. These deliverables can be located in chapter 5.

3.7 Presentation

We presented our results to the MRPC energy committee on February 21st 2014 to solicit feedback. A copy of our presentation can be viewed in Appendix O.

CHAPTER 4: RESULTS AND DISCUSSION

Following each conducted interview, an analytical summary was written which outlined the key topics discussed. These summaries are found in Appendix C-L. Additionally, comparative analyses were synthesized after every two interviews as a way to identify similar themes in the installers' responses, which can be found in Appendix M. Finally, all interviews were considered for a comprehensive analysis of all major themes

After initial data collection and summarization was completed, the major themes covered by the installers were extracted and expanded upon. The most common and relevant topics discussed in the interview process were grouped thematically and then further analyzed. Qualitative analysis of Solarize Mass, permitting, marketing, ownership benefits, the installation process, and effect of supplier was conducted and summarized in the following sections.

4.1 Solarize Mass

Before conducting the interviews, background research was done to see what programs were used to already attempt and aid in an increased adoption of solar energy. Through this research it was found that the Solarize Mass program was a way to encourage whole communities to use solar energy. Information on the Solarize Mass program and what it does specifically can be found in the background on page 24. Going into the interviews, our group thought that the Solarize Mass program was a great way to generate business for local installation companies, as well as influence a large amount of people to adopt solar energy use at the same time. Based on our interviews we found that the Solarize Mass program is not as beneficial to local installers as we initially believed. We found that smaller companies tended to dislike the program because it has a long process to go through in order to become accredited and approved. For smaller companies this process can be difficult and takes up a lot of their resources. Another negative we found was that larger companies tend to beat out the smaller, local companies because they have the financial backing to out-bid them. This actually causes most of the revenue from the solar technologies to leave Massachusetts because a lot of the larger solar installation companies are based out-of-state.

However, we did find from the interviews that when larger, Massachusetts based companies become involved in the program it significantly helps their business. We found that installers overall believed that the program does help increase solar use and is a good way to have a large group of consumers switch over at once. The program is largely volunteer driven and because of that it makes more people tend to switch because they see their neighbors putting in the time and effort to talk to them, which is viewed as a more reliable source than a solar company. We would suggest that a similar, community based solar adoption program that was easier for smaller companies to become a part of would help the local economy. It would serve a double purpose of decreasing electricity bills through the uses of solar technologies as well as increase the business for local solar installers.

4.2 Permitting

One major focus of the interviews was the topic of permitting. The process for obtaining building and electrical permits can vary significantly between towns. These inconsistencies make permitting a fertile area to improve the effectiveness of renewable energy projects. Analyzing the inefficiencies of permitting is an important step towards making the entire installation process quicker and cheaper, resulting in savings that will be passed on to the consumer.

Based on the interviews with installers, there were several areas with permitting that were inefficient and frustrating. First, the actual cost of the permitting process can vary from area to area. This did not bother some installers, especially the larger companies because the cost is frequently just included in the project proposal. However, smaller companies especially expressed that variable fees can be inconvenient and hard to keep up with.

Another problem is the relationship with the actual permit inspectors. Based on familiarity, inspectors can either be more lax or more stringent with their policies. Installers stated that often permits could be obtained faster if they had worked in the area previously and shown a history of high quality work. Additionally, some inspectors are more demanding than others. This can due to extra security measures being taken, differences in local rules on permitting or even the temperament of the inspector himself. Inspectors have been described as the “king of their own castle” and installers feel that they can arbitrarily influence the permitting process.

Additionally, some installers mentioned that the process of getting an inspection appointment can put the project on hold. At times, the inspector can be busy and not be able to inspect the project and provide a permit quickly. This can be time consuming and frustrating. Installers also mentioned that the steps to make an appointment can vary greatly. Some towns have online forms, while others require a phone call or for the forms to be mailed in. Figuring out the necessary ways to interact with each town or region is just another factor that can slow down installers.

Many installers want to see the process simplified, arguing that reducing the inconsistencies of the process will make it cheaper and more efficient without sacrificing the safety permitting provides. Some companies mentioned keeping policies uniform across town boundaries, which would not only make it easier on the installers but also the inspectors, as there will be less confusion. Furthermore, several installers argued that the actual scheduling of inspections can be easily improved. For example, some towns have developed online applications where all necessary information is inputted and it automatically creates an appointment request. The inspector can then directly contact the installer with times for the inspection. Installers favored this process, as it is more convenient and explicit about what is required.

4.3 Marketing

Another distinction brought up between the companies was their marketing strategies to the consumer. A large number of installers mentioned the lack of marketing their company actually needed, as the Solarize Mass program provided most of their consumer-base. It was determined that no special advertising or promotions was required to really draw the installations in. This was noticed however, in larger companies who were able to be a part of the Solarize Mass program. This types of companies tended to be larger, cover more ground in their consumer-base, and held more installations per year over other non-Solar Mass companies.

In line with those terms, the companies unaffiliated with Solarize Mass, tended to be smaller, work in a more localized region, and had fewer installations per year. Those smaller, local companies tended to need to market their company differently to make up for those differences. This was determined by the disadvantage of not being within the Solarize Mass

program. A need for a local program, like Solarize Mass, to be implemented together, other installation companies, was mentioned to be a great program for the local companies. This need was highlighted, as many of the local companies discussed the installations that were being picked up by the larger companies, who were able to differentiate their pricing and provided competitive quotes to attract the residential installations. This is something that is not as easily attainable with the smaller companies.

Based on our interviews we did find that one company actually held information sessions at prior consumers' homes. They used this as a way to show the effect that switching to solar had on actual customers as a way to market to potential new customers. We believe that this would be a good recommendation for solar installation companies as a way to generate more interest in solar energy and to easily market their company.

Similarly, another installer mentioned their company's utilization of blogging and email newsletters. They use these tools as a way to increase their online presence and keep their customers informed. Prior to conducting the interviews, this type of social media was not considered. These companies are successfully using online vectors for marketing and thus are able to maintain relationships with both past and prospective customers. Consequently, competing solar installers should follow suit in order to stay relevant within the digital age.

4.4 Owning vs. Leasing

From all the installers interviewed, there were a number of concepts that were observed about the solar installation process. It was learned that when financing for solar technology of a residential installation, it was actually more attractive to have full ownership of the photovoltaic panels rather than leasing. It was determined that this idea of ownership allowed the resident to have better arrangements for their own solar usage. The homeowner was completely in charge of maintenance, handling roofing issues, aesthetic factors, refinancing the home, and selling the property. There were a number of issues that would arise if the system was leased because the previous obstacles would conflict with various characteristics of the home.

Another aspect that made owning solar panels more attractive was based on the allocation of the money for the installation. If the system is leased, the money does not necessarily go to the region, but rather where the installation company or suppliers were regionally based. This could

determine where the true economics for the panels go when they are not owned. However, when a system is owned, regardless if the payment is in conjunction with a bank, the panels are regionally based and benefit the economy for that installed region.

To also aid with ownership of panels, there are a number of banks that are partnering with a variety of installers by lending specially tuned loans with preferential rates, regardless of their participation in the Solarize Mass program. This partnership allows homeowners to receive better financing that would aid their solar panels installation and over cost in the long-run. It would actually allow the homeowners to save more for the longevity of their system, rather than leasing would.

However, a number of installers brought up the Harvard Solar Gardens (HSG) projects when financing and the attributes of owning versus leasing was mentioned. It was described as a hybrid of owning and leasing. The installers exhibited this project as an upcoming project that would be attractive to the consumers who are interested in either owning or leasing, as it had the combination of both. HSG is made up of residents and businesses who cannot or do not wish to install solar on their own property. The Harvard Gardens solar panel project would allow homeowners to share a payment by investing in a square footage of panels, as it also has shares available to National Grid account holders in more than 100 towns across the state of Massachusetts.. This shared payment would contribute to the home of the consumers directly, without having to have a panel on their own home. This allowed the convenience of leasing and owning to be combined and increase the utilization and investment into this type of technology.

4.5 Installation Process

Prior to conducting our interviews we wanted to see if there was a uniform installation process. We were not sure if the way that solar installation companies went about the installation process affected the amount of customers they had. We found that the companies tended to all follow the same general process outlined below:

When photovoltaic contractors are contacted about a solar installation, a general process is followed to identify the potential and needs of the project. According to installers' websites and other general sources, the installation process seems to vary slightly between projects and companies in terms of exact timeline, but the main steps are universal.

1. **Gather Customer Information**

   The first step is to gather information from the client. Ideally, this step will broadly identify the type of project the client desires while also identifying any issues that may develop later in the process. For some installers this begins with an online form; others require a phone call to start the process. The information gathered at this point usually includes name and contact information as well as some questions about the solar system desired. Normally, the basic type of solar energy system is identified and some preemptive screening for the suitability of the roof is conducted. Often the roof screening includes questions about the orientation, age, shading and angle of the roof. Additionally, installers may look at satellite images of the client's house to give additional details. In the case that the installer can install ground-mounted systems, they might also ask questions about using extra yard space as an alternative to an unsuitable roof. Besides the physical concerns of the property, the installer will also often ask for copies of the client's electric bill. By viewing the electric bill, an installer can better approximate the potential savings a solar unit could bring to the client. Overall, the information gathered helps the installer identify if solar is a possibility on the client's property.

2. **Site Visit**

   The second step is an on-site evaluation of the property. This includes gathering some basic information about the insolation (or amount of sunlight hitting an area) of the roof and property. This visit will also identify any possible issues missed in the information-gathering step. Potential problem areas may include tree shadowing on the roof or more technical issues like the distance from the electrical inverter to the grid connection. This step double-checks if the property is suitable for a solar installation and provides more detailed information such as roof dimensions.

3. **Project Proposal**

   Next, the installer will review all the information gathered and put together a project proposal. This sometimes is done during the on-site visit. A project proposal outlines the terms of the installation and provides a breakdown of the cost. Often it will also include projections about the solar system's estimated output and the derived payback period.

Additionally, the proposal often includes schematics concerning the type of solar panels and other electrical components being used as well as their planned location on the property. The proposal is a crucial step in the installation process because it determines whether or not the client will go through with the installation. Sometimes the proposal includes a contract with a nonrefundable down payment.

4. **Installation**

   Once the proposal is accepted, usually the installer will provide a timeline of the work and set milestones for the project. Local building codes and permits are identified and any necessary building inspections are completed. Then the installation can begin and the work is completed by the installation company. Some more complicated projects may require an installer to go through a third-party contractor or builder to make the necessary modifications to the property. This step can take very different amounts of time depending on the size and type of the solar installation.

5. **Rebates and Incentives**

   Concurrently with the installation, applying for rebates and incentive programs can be completed. Different installers offer different levels of help with this process, but at the minimum an installer should help the client identify qualifying incentives. Some installers will fill out most of the paperwork for the client or even credit the amount of the rebates up front. These rebates and incentives often are the deciding factor on whether or not a solar system is cost effective to the client. Sometimes these rebates also depend on the regional power company; municipal companies may be ineligible for state rebate programs.

6. **Briefing**

   After the installation is completed, the installer provides the client with information on how to monitor and care for their solar system. This may include a user's guide and other materials to help optimize the function of the solar system. However, for the most part, photovoltaic systems require very little maintenance.

7. **Checkups**

   Some installers will keep in contact with their customers after the project is completed. A one-year checkup and maintenance is sometimes offered free of charge. Additionally, for specific problems or damages to the system, the installer can be contacted for special maintenance.

We also thought that there may be a point in the installation process that would cause consumers to want to walk away from the installation due to finances. Through our research we found that it was rare for consumers to drop out of the contract once it was signed and if they did it was usually due to home-life situations and emergencies, rather than having to do with finances. One recommendation that we have based on the installation process is that companies could try to lower the down-payment. We found that the initial cost tends to deter consumers from switching to solar energy so if they could reduce the initial down payment they may attract more customers.

4.6 Suppliers

Another issue that seemed important was the suppliers and manufacturers through which the installers purchased their equipment. These companies see an incredible amount of turnover; often companies go in and out of business year by year. This volatile nature of the business was expected to strongly affect the cost and reliability of solar installations. However, upon being interviewed, installers revealed that they were not very concerned with suppliers going out of business. Most installers compare prices from several local manufacturers and select the best based on cost and how the hardware specifications matched the details of the project. This method is designed to customize the panel for the project while minimizing cost. Ultimately it seemed to not matter which supplying companies fell out of business because there are always other competitive options for installers.

Additionally, installers were specifically asked about SunPower because it was identified as an industry standard for premium panels. SunPower requires installers to apply for a SunPower certification in order to offer their solar panels. Most installers mentioned that it was

mainly for the title and to keep the option open; SunPower often was not their first choice of supplier. SunPower tends to be more expensive because of its brand name and this actually dissuaded several smaller installers from applying for certification. The business model of selling to only certified dealers was even negatively described as a "Secret Handshake Club" by one installer. Despite the polarizing nature of SunPower's premium business model, they are important as one of the few suppliers with a large financial backing and a history of stability in the market.

As a result of the interviews, several key concepts can be expanded on. First, SunPower panels are generally less cost effective that other competitive models. Despite this price differential, getting certification from SunPower can grant a measure of legitimacy and offer particular customers a premium option. However, the more important focus is to form relationships with several suppliers and check prices across them. This will encourage them to have lower competitive prices and help the installation process be cheaper and more efficient. Getting better deals on specific components can result in cheaper custom installations rather than focusing on a one-size-fits-all boxed solution.

CHAPTER 5: DELIVERABLES

5.1 Installer Recommendations

BEST PRACTICES

We interviewed six different solar installation companies and found some techniques that worked well for them to increase the amount of solar installations they complete each year. These various installers varied from local and non-local, small and large, and participants as well as non-participants of the Solarize Mass program.

1. Marketing

Improve marketing options to the consumer by utilizing community outreach with site visits, providing examples of current customers' electricity bills, and community workshops. Emphasize the focus less on financial promotions and more on community outreach and word-of-mouth. Place stress on the regional economic benefits and long-term savings with purchasing versus leasing solar units and its positive effects as a way to gain community support.

2. Use of Solarize Mass / Other Community-Based Program

Take advantage of various state-run green programs such as Solarize Mass to increase installations. Look into partnering with local communities to develop a similar smaller-scale program.

3. Financial Options

Partner with banks, when possible, to create specialized green loans as a way to reduce costs for homeowners. In line with this aspect, try to minimize initial down payments, as high up-front costs tend to deter prospective consumers. Highlight the benefits of long-term savings through purchasing photovoltaic systems, despite higher upfront costs.

5.2 MRPC Recommendations

1. **Community Based Program**

Create a community-based, "Solarize Montachusett," program that works with energy and installation companies to better encourage solar adoption in the Montachusett region. In order to achieve these specific goals, the MRPC's involvement should:

- Ease permitting requirements and process
- Site viable locations
- Organize region-wide bulk purchasing and financing
- Subsidize installation costs for consumers with EDA grant funding
- Partner with various local organizations, state departments, and energy companies to maximize additional incentives and financing options
- Encourage volunteers to advocate for solar technologies by highlighting its positive effects on the environment and local economy

Similar programs, such as Solarize Boston, have proven successful at stimulating local solar expansion. A program following this framework is necessary because solar adoption is best achieved through community involvement, as shown by the successes of Solarize Mass. By specifically collaborating with local companies, not only will the program increase solar installations, but also the money and jobs generated will remain within the region and promote further economic development.

2. **Permitting Process**

Standardize and streamline the inspection and permitting process for the 22 towns in the region. This should:

- Reduce inspection fees
- Create an online form to apply for permits and schedule on-site inspections
- Ease permitting requirements for residential solar installations

A proposed method of accomplishing these goals would be funding a full-time inspector for residential solar permitting in the region in a "shared" fashion. By providing an inspector for the region there will be a willingness among the towns to follow these guidelines. Furthermore, by standardizing the process the quality of the permitting and inspections will be improved and unsafe conditions will be avoided. By having one person in charge of all solar inspections all costs can be monitored and the application process can be expedited and simplified. Overall, this will create a more efficient process for permitting and ultimately reduce costs for the installation companies and labor costs for the towns.

CONCLUSION AND RECOMMENDATIONS

Overall, the goal of this project was to promote economic development in the Montachusett region through increased residential solar adoption. Residential-scale photovoltaic systems were identified as the most relevant and promising technology for small-scale consumers in the region. The largest market barrier to implementing residential solar technology is financing the sizable installation cost. This barrier can be overcome if the steps are taken to make the technology more affordable and attractive to consumers in the region. This project focused on a two-pronged approach of providing recommendations to not only the MRPC but also regional installers.

In the case of the MRPC, the recommendations focused on developing a regional incentive program and improving the permitting process. Establishing a community-based program will aid economic development in the region by providing business to local companies as well as decreasing installation costs through bulk purchasing. The MRPC can further promote installations through standardizing and reducing the cost of the permitting process. In the case of the installers, a list of best practices will provide information to improve their process, take advantage of government incentives and ultimately better market their product. Together, these steps will result in more installations, which, in turn, will lead to larger energy savings for the region and stimulate economic growth.

Based on the cumulative findings of the research, there are a number of steps to implement that could expand on the goals of this project. Some of these future considerations would look more closely in executing a regional shared inspection program. If a region-wide renewable energy inspector is funded by the MRPC, the process will become cheaper and expedited for solar installers. This could work hand-in-hand with the development of a "Solarize Montachusett" program that would foster community support for solar technologies. Along those lines, verifying the effectiveness of the recommendations given to installers and the MRPC, would elicit more explicit and refined guidelines for promoting solar technology. Lastly, a similar evaluation of the commercial scale installation process could be conducted to provide a parallel set of recommendations, specifically focused on larger solar projects. If these additional projects are explored, the Montachusett region will see a further increase in solar adoption, and thus would continue its economic expansion.

Appendix A: Power Suppliers

Town	Electricity Supplier
Ashburnham	Ashburnham Municipal Electric
Ashby	Unitil
Athol	National Grid
Bolton	National Grid
Clinton	National Grid
Gardner	National Grid
Fitchburg	Unitil
Harvard	National Grid
Hubbardston	National Grid
Lancaster	National Grid
Leominster	National Grid
Lunenburg	National Grid/Unitil
Phillipston	National Grid
Petersham	National Grid
Princeton	Princeton Municipal Electric
Royalston	National Grid
Shirley	National Grid
Sterling	Sterling Municipal Electric
Templeton	Templeton Municipal Electric
Townsend	Unitil
Westminister	National Grid
Winchendon	National Grid

Appendix B: Index of Solar Installers

Name	Operating Region	Website	PV	Solar Hot Water	Solar Lease	PPA
Adam Quenneville Roofing and Siding	MA	http://1800newroof.net/	Y			
Advance Electrical Contracting		http://advancedelectricalcontracting.com/	Y	Y		
Advanced Energy Systems Development	MA	http://www.advancedenergysystemsusa.com/	Y	Y		
Advanced Mechanical Systems, Inc.	MA	http://www.advancedmechanical.net/	Y	Y		
Alpine Solar Heat and Hot Water	MA	http://www.alpinesolarheat.com/	Y	Y		
Alternate Energy Center	MA	http://www.dcsolar.net/index.html	Y	Y		
Astrum Solar	DE, CT, MD, MA, MI, NJ, NY, OH, PA, VA, DC, WV	http://www.astrumsolar.com/	Y	N		
Avid Solar	MA, NH	http://www.avidsolar.com/	Y	Y	N	N
Berkshire Photovoltaic Services	MA	http://www.bpvs.com/index.php	Y	N		
Blue Selenium Solar*	MA	http://www.bluesel.com/	Y	Y	Y	Y
Boston Solar*	MA	http://bostonsolar.us/	Y	N	Y	Y
Brightstar Solar	MA	http://www.brightstarsolar.net/	Y			
Clean Energy Design	MA, RI	http://cleanenergydesign.com/	Y	Y		
Cotuit Solar		http://www.cotuitsolar.com/	Y	Y	Y	Y
Country Comfort Heating & Cooling		http://cleancountryair.com/index.html	N	Y		
D&D Electrical Contractors, Inc.	MA	http://www.danddnet.com/	Y			

E2 SOLAR.	MA	http://www.e2solarcapecod.com/	Y	Y		
Endless Mountain Solar Systems	PA, NJ, NY, CT, RI, MA	http://www.endlessmtnsolar.com/	Y	Y		
Falcon Solar		http://www.falconsolar.co.za/index.htm	Y	Y		
GeoSun Design		http://www.geosundesign.com/	N	Y		
Go Green Industries	MA, NH, ME	http://www.gogreenindustries.us/	Y	Y	N	N
Gotsun-gosolar		http://www.gotsun-gosolar.com/	Y	Y		
I.n.o. Electrical Service Inc.	MA	http://www.site.inoelectricalservice.com/	Y			
JV Mechanical Contractors.		http://www.jvmech.com/	Y	Y		
Light Energy Solar	CA, MA, NJ, NY	http://www.1stlightenergy.com/	Y			Y
Macdougall Plumbing And Mechanical LLC	MA	http://macdougallmechanical.com/		Y		
Marchetti Engineering	MA	http://www.marchettieng.com/index.htm	Y			
Mass Renewables Inc.	MA	http://massrenewables.net/Home_Page.php	Y			
McCrohan Electrical	MA	http://mccrohan-electrical.com/	Y			
Mercury Solar Systems	CT, MA, NY, NJ, PA	http://www.mercurysolarsystems.com/	Y		Y	
Moss Hollow Solar	MA	http://mosshollow.com/	Y	Y		
Munro Distributing Co. Inc.		http://www.munroelectric.com/silvereclipse/index.jsp?path=home	Y	Y		
New Day Energy	MA	http://www.new-day-energy.com/page_home.html	Y	Y		
New England Clean Energy	MA	http://newenglandcleanenergy.com/	Y	Y	N	N
New England Solar Hot Water		http://neshw.com/	N	Y		
Next Step Living	MA, CT	http://www.nextstepliving.com/	Y		Y	Y
NorthEast Solar Design	MA	http://northeast-solar.com/	Y	N	N	N
Paradise Energy Solutions	DE, CT, MA, MD, NJ, NY, OH, PA	http://www.paradisesolarenergy.com/	Y	Y		
PV Squared	MA	http://pvsquared.coop/	Y	N	Y	Y

Second Generation Energy	MA	http://sgegroup.com/home	Y	N	Y	
Ralco Electric, Inc.		http://ralcoelectric.com/	Y	Y		
Real Goods Solar*	CA, CO, CT, MA, MI, NY, VT	http://realgoodssolar.com/	Y	N	Y	Y
Ross Solar Group	CT, NJ, NY, MA, PA	http://www.rosssolargroup.com/	Y		Y	
SolarCity (state-by-state basis)		http://www.solarcity.com/	Y	N		Y
S & H Construction	MA	http://www.shconstruction.com/	Y			
Second Generation Energy		http://sgegroup.com/	Y		Y	
Sirois Electric.	MA, NH, ME, VT	http://www.siroiselectric.com/solar/index.asp	Y			
Skyline Solar	NJ, MA, CT, RI	http://skylinesolarnj.com/services/	Y			
Solar Connection	MA, RI, CT	http://www.solarconnectionma.com/		Y		
Solar Design Associates.	MA	http://www.solardesign.com/	Y	Y		
Solar Edison		http://www.sunedisonhomesolar.com/	Y	Y	Y	
Solar Installation, Llc		http://www.solarinstallco.com/				
Solaradiant		http://www.solarradiant.com/thermal/	Y	Y		
SolarFlair Energy	MA	http://www.solarflair.com/	Y	Y		Y
Southcoast Greenlight	MA, RI, VT	http://southcoastgreenlight.com/	Y	Y		
Southpoint	MA	http://www.southpoint-llc.com/	Y			
St Electric Llc		http://stelectricllc.com/	Y			
SunBug Solar		http://sunbugsolar.com/	Y	Y		
Sunlight Solar Energy, Inc. - Waltham	CT, MA, OR, WA	http://sunlightsolar.com/home/massachusetts/?state=ma	Y	Y		
Sunwind, Llc		http://sunwindllc.com/	Y	N	Y	
Transformations Inc.	MA	http://transformations-inc.com/installations/	Y			
United Solar Associates	MA, NH	http://www.unitedsolarassociates.net/	Y	Y		
US Solar Works	MA, RI	http://ussolarworks.com/	Y			
Vanguard Energy Partners	MA	http://www.vanguardenergypartners.com/				

Appendix C: MRPC Questions

1. What do you see as the biggest roadblocks to residential solar?
2. Are there any negative side effects from increased residential solar usage?
3. In your opinion how educated are consumers about solar options?
4. What resources are currently available for consumers?
5. In what ways could a checklist increase solar usage?
6. In what ways could an installer index increase solar usage?
7. If you were installing solar panels on your home what sort of details would you want to know?

Appendix D: First Installer Questions – $(PV)^2$

1. Could you outline the general process you go through when contacted by a consumer looking to install solar options?
2. At what point in the process do you inform your customers about additional incurring costs that may develop when installing?
3. How do you go about informing your customers about the additional incurring costs?
4. What suppliers do you go through with your solar products for installation?
5. What sort of payment plans do you offer?
6. What sort of financial contracts if any do you offer to attract customers
7. Are there any local permits that affect how you operate?
8. Do you provide customers with information about their net metering options?
9. In what ways do you help customers find financial incentives?
10. Are you partnered with any banks to offer specialized solar installation loans?
11. Can you provide us with the marketing materials used?

Appendix E: Second Installer Questions – New England Clean Energy

1. How long has your company been in operation?
2. How many installations on average do you perform in a year?
3. Where do you operate?
4. Could you outline the general process you go through when contacted by a consumer looking to install solar options?
5. How do you go about informing your customers about the costs?
6. What sort of payment plans do you offer?
7. What sort of financial contracts if any do you offer to attract customers?
8. In what ways do you help customers find financial incentives?
9. Do you offer any promotional deals?
10. Do you provide customers with information about their net metering options?
11. Are you partnered with any banks to offer specialized solar installation loans?
12. Are there any local permits that affect how you operate?
13. What suppliers do you go through with your solar products for installation?
14. Have you participated in the Solarize Mass program?
15. Can you provide us with the marketing materials used?

Appendix F: Third Installer Questions – Northeast Solar

1. How long has your company been in operation?
2. How many installations on average do you perform in a year?
3. Where are you based out of?
4. Where do you operate?
5. Could you outline the general process you go through when contacted by a consumer looking to install solar options?
6. How do you go about informing your customers about the costs?
7. Do you require a non-refundable down payment?
8. What sort of payment plans do you offer?
9. What sort of promotional deals do you offer to attract customers?
10. In what ways do you help customers find financial incentives?
11. Have you participated in Solarized Mass?
12. What are the main reasons that customers choose not to continue with the solar installation after the proposal has been made?
13. How do you provide customers with information about their net metering options?
14. Are you partnered with any banks to offer specialized solar installation loans?
15. Do you find that local permitting significantly affects the way you operate?
16. What suppliers do you go through with your solar products for installation?
17. Can you provide us with the marketing materials used?

Appendix G: Summary of $(PV)^2$ Interview

The pilot interview was very successful. One main point that was learned was that the actual cost of solar installation is discussed in a proposal that the company writes up following a home inspection. Another thing to note about the inspection was that the company will first use a satellite to look up the house and inspect the roof/yard to find any additional costs upfront, before the in home inspection. $(PV)^2$ made sure to note that they always try to predict additional costs upfront as to avoid having an increase in the cost after the initial proposal. They mentioned that they would educate the consumer on all of the incentive programs and how net metering works, as a way to market the upfront cost of solar. They will discuss all of these points during the on-site inspection and during the proposal process.

Also, $(PV)^2$ made a note to say that they try to reduce the cost of installation through in-house installation instead of outsourcing to other companies. They also said that they try to reduce maintenance costs by choosing reliable suppliers that have been in business for a while. They stressed that this was important because companies are always going out of business which means that a warranty on their solar panels would be pointless and could cost the consumer more in the long run.

Various ways that $(PV)^2$ help the consumer save money on the installation and help to reduce upfront costs was mentioned during the interview. They said that they fill out all paperwork to receive the incentives as well as provide the consumer with the tax forms that they need to fill out. It was also discussed that small promotional discounts do not seem to be very effective for promoting solar installations because in the big scheme of the price they do not really help much.

An important point that was learned was that solar leasing is not used as often nowadays as it used to be. The company said that it was actually costing the consumer more money in the long run to lease their panels and that the money from the leasing went out of state to large companies and was hurting the local economy. Instead, the norm now is to take out a loan through a bank that has close ties with the installation company.

They also discussed some ways that would make the installation process cheaper and easier. The first point was that dealing with permitting could be difficult. They said that each town has different permit regulations and some inspectors are more difficult than others. They

said that streamlining the process could be very helpful and this may be something worth noting to the MRPC. The second point was that it is more difficult working with municipal energy companies because they have their own rules and incentive programs so it would be nice if the process could be standardized somehow.

A main point that was unexpected was that this company did not like the Solarize Mass program. This was an unexpected response because the program is viewed as a way to increase solar use and has a positive connotation. This company said that they believe Solarize Mass ends up costing the consumer more in the long run because the systems are not customized to the individual which means they are not as efficient as they could be. This could just be a bias from the company as a way for them to make more money off of individual installations.

Appendix H: Summary of New England Clean Energy Interview

The second interview with New England Clean Energy was very effective with the information provided by the installer. The general process for installation that was discussed involved the initial phone inquiry to include satellite screening of the site using digital imaging. This was explained to be effective in further evaluation of the site for on-home and ground mounts and provide the consumer with more responsive evaluation. The next point that we learned from this installation company was their generation of the proposal during the site visit. This allowed the customer to get an immediate quote for their home and not wait for a follow-up for the proposal. It was also an interesting point to discover a non-refundable down payment deposit is administered once a contract is signed to deter their consumers to back from their installation.

Overall their installation and cost breakdown in the proposal is itemized and very clear for the consumer. This also includes incentives and net pay that are calculated with upfront costs. This is to eliminate any further costs to incur and have to be paid after the final contract is signed. In terms of additional costs, they have "Adders" which could be supplemented to the original proposal price based on roofing concerns and reinforcements after engineer site-evaluation occurs during the site visit.

A main point that was discussed for the financial programs that New England Clean Energy provided was the Green Energy Loan. This was a consumer incentive that the installer determined has benefited the company in maintaining and receiving customers. This combo energy loan was a no money down, program that provided savings from solar panel offset / covers loan payment.

Another aspect to the interview covered the marketing strategy that New England Clean Energy offered to their customers to attract photovoltaic installation. The installer spoke about the ads that have been run for a discounted amount off the installation, however it was said that it was not as utilized and no significant results were observed for an increase in their installation rate during that time period. The main market for retaining customers from their company was their education practices to maintain customer awareness throughout the entire installation process.

Appendix I: Summary of Northeast Solar

Interviewing Northeast Solar gave insight on several new topics but also reinforced some answers we previously had gathered. Northeast Solar is a well-established regional company. While they have gone through three name changes in their company's lifetime, they have remained a presence in Massachusetts for over 25 years and focus on dependability. In the past years, they have been steadily growing, reaching a current velocity of 120-150 installations a year. They attribute their successes to an attention to education.

Northeast Solar has an extremely stripped down financial approach. They do not offer any specialized payment plans, but will refer a customer to bank if a loan is desired. Additionally, they reinforced the fact that solar leasing is currently unpopular and unhealthy for the region. As other installers mentioned, leasing causes a lot of the incentive money to leave the state and is ultimately detrimental to the local economy.

When prompted about lack of more personalized or alternative financing options, Northeast Solar posited that most of their customer base begins the process fully capable of affording the project. This confidence in the customer to be able to cover the cost seemed to disagree with our previous identification of initial cost as the primary market barrier to residential solar.

In addition to the use of financial programs, Northeast Solar focused on thorough home evaluations and a policy of giving the customer an educated understanding of the situation. They stressed that no additive costs are ever brought up after a proposal has been drafted; all issues and concerns will have been identified and itemized prior to the proposal being presented. Additionally, Northeast Solar will walk the customer through all the paperwork for incentives and rebates. Northeast Solar gave a simpler look into the Solarize program, however. They strongly supported the program and participated in the Montague project. Additionally, they were interested in local programs that emulated the Solarize program, specifically mentioning their current work with Greenfield to develop a community based incentive program for solar.

However, the most important topic Northeast Solar covered was permitting. They first emphasized the additional concerns surrounding ground-mounted systems, which include a special permit and inspection. Similar to the answers of other installers, Northeast Solar stressed the need to streamline the process. They suggested several ways of doing this including working

through green communities and improving scheduling. Green communities are often easier to get permitting cleared due to special simplified inspection processes for renewable energy. Additionally, they are often more familiar and welcoming of solar installation projects with speeds up the process. However, Northeast Solar also stressed the difficulty of scheduling the meetings with the inspectors. Some kind of standardized scheduling process for inspectors may go a long way in organizing and streamlining the entire process. Additionally, bringing industry people together with local planning commissions and energy advisory boards may aid in effectively improving this process.

Overall, Northeast Solar were interesting due to their minimalistic approach to financial programs, focus on education and recommendations for improving the permitting and inspection process. They additionally supported the institution of community based incentive programs such as Solarize Mass and reinforced the negative aspects of solar leasing.

Appendix J: Summary of Next Step Living

The fourth interview was with the small, newly started solar installation company, Next Step Living. This company has only been established for five years and only started doing solar installations in the past two and half years. The same questions that were used for the third interview were used for this one.

Next Step living is located in Boston, MA and has a new office in Hartford, CT. They will complete installations mostly in Eastern Massachusetts. They had the same general process as the other companies we have researched. It starts with using a satellite to look up the home and make sure that it has potential for a solar installation. Then they will schedule home visits and do an assessment. Finally, they create a proposal and educate the consumer on the overall cost. The third visit is when the contract happens and requires a $500 down payment. They had the same response that we have seen when asked about additional costs. They said that the costs are all upfront and they take everything into account during the assessment and in the proposal.

When asked about why customers walk away they had similar responses as seen in other interviews. The main reasons were that the savings were not high enough, that consumers could be skeptical of the technology, and that it can be a long process. They also agreed that solar leasing and PPAs were not as readily used and that owning the system is better for saving money. They do offer a PPA with a locked-in rate for 20 years. They also mentioned that they do work closely with local banks as a way to get lower interest loans.

One point that really stood out was the fact that the company has only been performing installations for two and a half years but they have already done over 800 installations. This is a very large amount compared to the other solar companies we have interviewed with. One reason behind this is that they have program outreach managers, which go out and find customers. Other reasons are their promotional deals, education techniques and community outreach.

Next Step Living offers two promotional deals. The first is an initial visit deal where they will give a discount if the consumer signs the contract at the initial visit or early on in the process. Second, they team up with local stores and will provide gift cards to potential customers if they participate in an installation assessment. These deals are good ways to push people to participate in a site assessment which could change their opinion on solar power and ultimately lead to them installation.

Next Step Living also used educational techniques that we had not heard of during other interviews. One way that they provide education on net metering and SREC is with open houses at past customers homes. They will host an open house and ask neighbors to come. At these open houses the homeowners will show their energy bill and explain how they are actually saving money. They also will do a presentation on net metering and answer any questions that potential consumers may have. A final way they use educational techniques to promote solar is that they hold an educational visit as the final step in the proposal process. At this meeting they will explain the breakdown of the cost, how the incentives will save them money and finally their return on investment. They will also explain how they will file all the paperwork necessary to get all of the incentives and rebates.

An interesting point that came up was community outreach. Next Step Living said that they would donate money to the community after an installation has been completed. They stated that they found that this would push people towards installing solar systems because it helps the community and brings the installation into the public eye.

Another interesting point that was made was about solar challenges. We asked them about working with Solarize Mass and they agreed that it was a great process and worked well to increase solar use but they said that solar other community developed campaigns worked even better. They said that when communities come together to reach their own goals then they tend to set higher goals and have more help/support from the community itself.

When asked about challenges they said that some Municipal plants have different net metering rules, which can cause problems, and that they do not always accept the incentive programs which could increase the final cost to the consumer. Surprisingly, they said that permitting is not really much of a problem and that most permitting boards will allow installations pretty easily. This may have to do with the fact that they have someone on staff, which directly deals with all the permitting issues.

They ended the interview by saying that they would love to present to the MRPC if that would be helpful and that they have a lot of experience working with the MAPC so they might be a good resource.

Appendix K: Summary of Go Green Industries Interview

The interview with Go Green Industries gave an insight into the workings of a smaller heating-system based company. Handling roughly a dozen combined solar hot water and photovoltaic jobs a year, Go Green Industries operates on a small local scale. They don't offer solar leasing or PPA options but they mentioned that general awareness for solar technology and different financing options are on the rise and that they are working with Admirals Bank to provide an NFHA loan of up to $40,000. This loan is effective because after the first 18 months it gets reevaluated based on the amount payed off. Event with these programs, they feel that they are potentially losing customers to companies offering solar leases with no upfront cost. Despite this, Go Green Industries wants to avoid offering a lease because they feel it gives the customer less benefits.

This installer's general process was fairly standard, however, they stressed that systems can be designed to cater either to a specific solar ratio or to the customer's budget. Additionally, they stressed that roof concerns were not difficult to remedy. Reinforcing a roof is roughly a "2 out of 10" in difficulty.

In the project proposal, Go Green Industries provides an itemized list of costs. They also specially mentioned the MLG142 installation laws, however upon research it seems that those laws are only applicable to plumbing systems (such as solar hot water). Additionally, they collect 8-10% of the project cost as a down payment. These funds pay for the permitting process and any preliminary steps needed to start the installation process. They mentioned that they are legally entitled to collect up to 33% of the project cost up front and are not required to refund it in the case the customer cancels the project. Despite these laws, they will usually show the customer the receipts of what has been spent and then refund what is left of the down payment if the customer backs out late in the process.

On the topic of permitting, Go Green Industries thought the system lacked any sort of consistency between towns. Process, information needed and fees all can vary greatly. As a result, they preferred to work in towns like Arlington and Westford that have an online form to start the inspection process. The installer simply needs to fill out a form with the information

needed by the inspector and then the inspector will contact them via email. This seems like an excellent way to streamline the process.

Go Green Industries also gave a different angle on the Solarize Mass program. They stressed how much effort the application process is for smaller companies. They made it to the second round table interview for the Shirley but weren't given the bid. They feel the program is more geared towards bigger companies that are less personalized but have the financial backing to win the bids. Despite this, they would still be interested in a community-based program.

Go Green Industries is also the first company we have interviewed to not offer Sunpower panels. The reasoning behind this is based both on the business model and the technical specifications of Sunpower's panels. First, Go Green doesn't like the "secret handshake club" aspect of Sunpower authorization. They feel that it is exclusive for no reason and actually results in higher priced solar panels.. Additionally, Sunpower's panels are a positive ground, a convention that Go Green feels is less stable and durable. Instead, Go Green tries to focus on finding good deals by comparing local suppliers such as AltE, Conergy, and Alba Solar.

Appendix L: Summary of SolarFlair Interview

The interview with SolarFlair was another solar installation company that was working on a larger-scaled market as they have only been in existence since 2007 with already over 250 installation averaging in the last year. Based out of Framingham, SolarFlair works in the consumer-based largely within the state of Massachusetts. SolarFlair is also a very Solarize Mass-oriented company with 95% of business generated by the program. The Solarize Mass program had led to 95% of SolarFlair's business in Hopkinton, Mendon, Arlington, Carlisle, Chelmsford, Brookline and Newton.

Their general installation process was outlined much like the other companies we had previously interviewed. They outline the general costs to a consumer along with quotes for the pricing, including any special accommodations and additions based on the standards of the home and roof, and proceed to draw up a contractual agreement for the install. Initially, they screen the home through Bing Maps and Google Earth to get a better, more accurate, estimation of the installation site to attain better installation policies for the home. This is then followed-up with an on-site visit of a trained installer, and the proposal can then be drawn-up. When asked regarding permitting troubles for installation in various towns throughout Massachusetts, it was deemed to not be an issue at all. This is based on the community already being involved, whereas the permitting process does not seem to become an issue through Solarize Mass

The information sessions that SolarFlair offers, are followed by a site visit, and eventually and finally a formal proposal for the payment plan. This also includes a conditional non-refundable deposit in order to ensure the seriousness the consumer portrays into the installation of the project. For residential projects, a $2,000 down payment is required. If a customer backs out a refund will be offered based on whatever was not yet spent of the $2,000 down-payment.

The various payment plans that SolarFlair also offer, much like other interviewed companies, included full-ownership, Purchase Power Agreements (PPA's), and 98% ownership. Along with these payment options, SolarFlair also provides financing optiona with Admirals Bank loan and TD Bank Home Equity loan.

Some main reasons regarding a customer's choice not to continue with the solar installation after the proposal has been made, is usually based on the installation seen as expensive expenditure. Secondly, it comes down to where owning is expensive and people prefer not to sign for a PPA, especially in the case they want to possible later own. Lastly, some customers' reaction to the technology's aesthetic appeal was not great. These were responses that have already been recorded from previous interviews as well.

Appendix M: Comparative Analysis

First Two Interviews

Interviewing Pioneer Valley Photovoltaics $(PV)^2$ and New England Clean Energy gave insight not only into the process of solar installation but also into the effectiveness of the interview questions used. Both companies answered the interview questions very similarly. Besides having very analogous general installation processes, the most notable commonalities involved the Solarize Mass. program, the effectiveness of solar leasing, costs, and the process of local permitting.

According to the background research conducted for this project, the Solarize Mass. program seemed to be extremely effective and well received by the participating communities. New England Clean Energy has extensively participated in the Solarize Mass program, however $(PV)^2$ has not. When prompted about their lack of participation in the program, $(PV)^2$ stated they did not want to participate. They felt that the Solarize Mass. program encourages a one-size-fits-all mentality. Additionally they felt that the tiered pricing system often backfired and resulted in higher system costs than more personalized custom systems. This opinion on the Solarize Mass program was interesting as previously we had only viewed the positives of the program in our background research. However, like $(PV)^2$, New England Clean Energy also criticized the program. According to New England Clean Energy, large out of state companies with deeper pockets have encroached on the Solarize Mass program and forced out many of the local companies. Against the larger budgets of these companies, local businesses cannot win the bids for communities. New England Clean Energy feels this shift goes against the community-based aim of the Solarize program and often results in inferior, less personalized service. Additionally, this influx of large companies means that much of the revenue from the associated solar projects is leaving the state and not contributing to the local economy. All in all, the Solarize program may not be as positive as research seemed to suggest. Despite all these criticisms, New England Clean Energy was also quick to admit they have participated in four different communities with the program and supported the general aims of Solarize. New England Clean Energy also stressed that Solarize is only as successful as the dedication of the volunteers in the community who run the program, citing the Harvard trial as a successful example of this.

As the focus of this project is the financial aspects of residential photovoltaic systems, the trends in payment plans are important. Both companies answered very similarly on this topic. Solar leasing used to be popular but has since fallen out of favor for several reasons. First, having the panels owned by a third party company hurts the local economy. Second, without owning the panels, the customer cannot claim any of the federal or state incentives for solar panels. As a result, most solar installations at the residential level are being bought. Third, home-equity loans are becoming increasingly popular. New England Clean Energy stated that often the monthly payments on these loans are offset completely by the energy savings for the solar panel. Power Purchase agreements (PPAs) were also discussed with both companies but this option is more commonly used at the commercial level, not the residential level.

When handling costs, both installers create detailed project proposals after an on-site evaluation. Both $(PV)^2$ and New England Clean Energy collect recent electric bills and do some financial analysis to help show the client potential savings. However, promotional deals were seen as generally ineffective. Northeast Solar sometimes uses advertisements worth a discount on an installation, but $(PV)^2$ did not offer any marketing promotions. In both of their cases, they felt that most business comes from word of mouth and that promotional deals have limited success at best. Additionally, both companies stressed putting the customers' needs first and mentioned that they help their customers find incentives and fill out paperwork. Furthermore they supported education and confirmed they talk to their customers about net metering and the concept of SRECs during and after installation.

Another important topic is local permitting and inspection. Both companies emphasized that permitting is something that varies greatly from town to town. Some building and electrical inspectors tend to slow down the process and be very deliberate in the inspection process. This can make a project take longer or even increase the cost of the project. Other inspectors develop a relationship with the installing companies and tend to be more trusting once they are shown high quality work. Both companies seemed to be interested in ways to streamline this process by making it more standardized or straightforward.

Along the same lines as building inspections, energy companies can vary from community to community. Each energy company handles grid connections and other regulations slightly differently. Both installers mentioned that projects that connect to the grid of municipal

energy companies are ineligible for state rebates. However New England Clean Energy also mentioned that sometimes the municipal companies can offer their own rebates.

Overall, both companies approached installations very similarly, stressing the concepts of customer service and regional connectedness. They both found the local economy important and were worried by factors that may be taking business revenue out of state. The importance they place on local issues reflects the fact that they are small regional companies and find most of their business through word of mouth.

Second Two Interviews

The interviews we conducted with North East Solar and Next Step Living allowed our team to better add to our pool of data from the previous interviews and ground our interview questions and their effectiveness for future interviews. The two companies had comparable and differing standards on their operations and the effectiveness of certain financial programs and its effect on their consumers.

The main difference between the two companies was how established each one was in their community. With the fluctuating variation in the quantity of installations and their consumer-base was also contrasting. According to the background research conducted for this project, the Solarize Mass program seemed to be extremely effective and well received by the participating communities. Again, as with the previous two interviews we conducted, they felt that the tiered pricing system often backfired and resulted in higher system costs than more personalized custom systems.

Overall, both companies approached installations very similarly, stressing the concepts of customer service and regional connectedness. They both found the local economy important within the realm of their communities of service and were worried by factors that may be taking business revenue out-of-state.

Final Two Interviews

The interviews with Go Green and SolarFlair gave a lot of insight into the similarities and differences of large and small scale solar installation companies. Go Green is a small company with about twelve installations per year where SolarFlair had about 250 installations in a year.

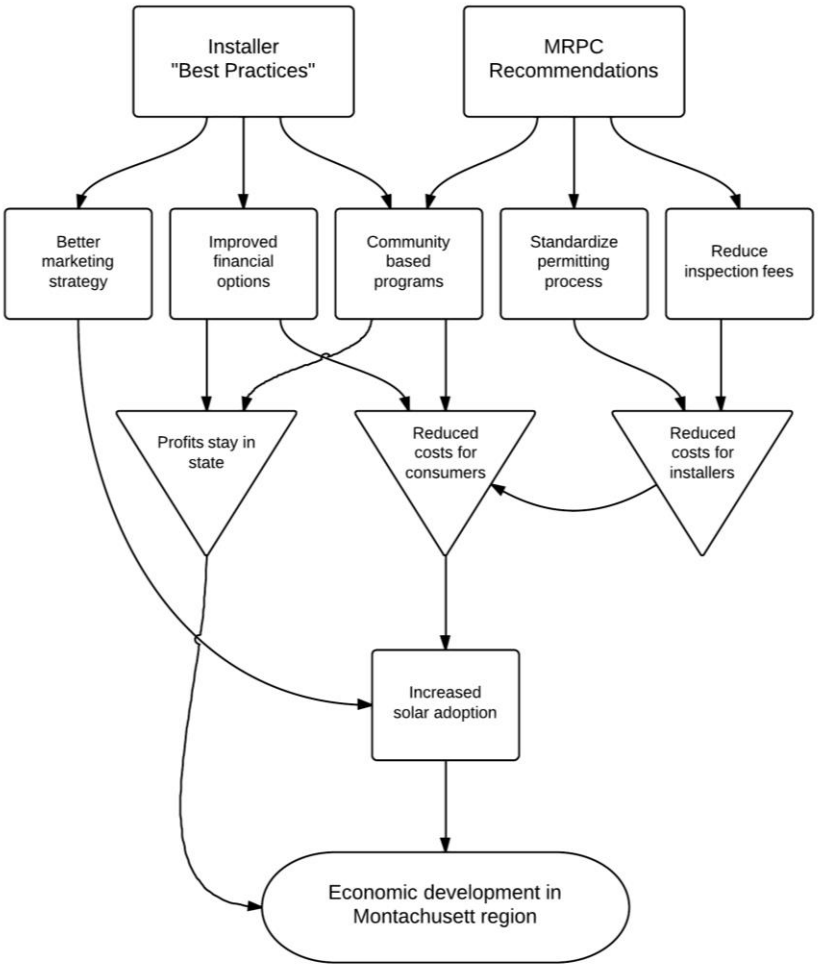
Overall the companies had a similar installation process. They both provide consumers with an itemized list of costs and provide them with any additional fees up-front. One difference between the companies was their down payment. Go Green based the down payment on the final estimated cost of the project whereas SolarFlair requires a $2,000 down payment for all its consumers. This is interesting because the $2,000 down payment could deter some consumers if it is too expensive and they are having a small system installed. They both offered to refund any money that was not spent from the down payment if the consumer chose to back out of the installation. Another difference is that SolarFlair offers information sessions to their consumers before the initial on site visit as a way to clear up any questions before the process begins.

Both companies believed that solar-based loans from banks work well for financing. Go Green does not yet have a loan or set up with a local bank yet but they are working towards it. SolarFlair also offers PPAs and solar leasing which was something Go Green could not have because they could not afford it. They noted that it does sound appealing to a consumer that they can install solar panels with no money down and they thought that brought a lot of consumers in. Both companies noted that PPAs and leasing are not preferred financing methods because they are not always beneficial to the consumer and end up costing them more money in the end.

Another major difference between these two companies is their use of Solarize Mass. Go Green applied for Solarize Mass but did not end up participating, where Solar Flair has had 95% of their business through it. SolarFlair really enjoys working with Solarize Mass and believes it is a great way to increase solar usage in the community and a great way to get customers. Go Green has a completely different opinion of Solarize Mass. They found that the process was very difficult for small companies to go through because they do not have the finances to compete with the bigger companies. They also found that the process was very long and involved a lot of paperwork that is difficult for smaller company to do. They said that they like the concept of a community based solar installation because it helps solar companies and helps the community increase solar usage but they would like an easier process with less competition.

The final difference between the two was with their opinion on the permitting process. Go Green thought that the process lacked consistency between towns with the process, necessary information, and fees. They believe that having a streamlined process and online form would allow the process to go a lot smoother and would result in cheaper installations. SolarFlair said that they did not have an issue with the permitting process at all and that it was fine the way it is. This may have to do with the fact that they hire someone specifically to handle the permitting process because they are a larger company.

Appendix N: Project Goals Flowchart



Appendix O: MRPC Presentation

WPI

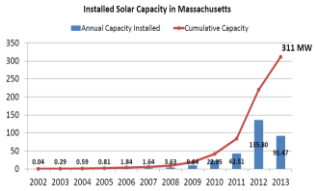
Implementing Residential Solar in the Montachusett Region

Aims to promote economic development by gathering information from installers on ways to improve solar adoption.

Rachel Feyler
Brian Gallenstein
Yael Rosenblum

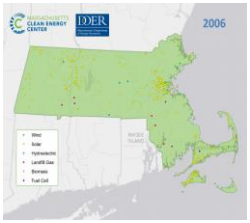
Statewide Solar Goals

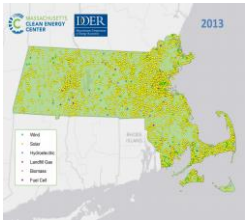
- Governor Patrick's goals
  - 400MW by 2011
  - 2,000MW by 2020
- Government incentives



http://www.mass.gov/eea/grants-and-tech-assistance/guidance-technical-assistance/agencies-and-divisions/doer/renewable-energy-snapshot.html

MA Growth in Solar





http://www.masscec.com/content/clean-energy-progress-animation

Why Residential Photovoltaics?

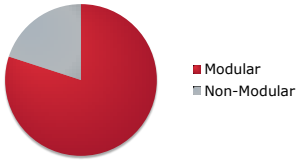
"Photovoltaics are the sexy new technology" -Go Green Industries

Incentives	• 30% federal tax credit
Market	• High potential for growth
Impact	• MRPC can influence towns in region

Modular vs. Non-Modular Costs

"The highest hurdle for residential solar is financing" -Northeast Solar

- Modular costs are steadily declining
  - Fell $2.6/W between 2008 and 2012
  - Comprises 80% of the total drop in installation price
- Reaching a "tipping point" in price



Process/Methodology

Northeast Solar
(PV)2 PioneerValleyPhotoVoltaics
GoGreen Industries
Ownership Focus
New England Clean Energy
solarflair CLEAN ENERGY SOLUTIONS
next step living
Operate out of State
Solarize Mass Participant

Key Themes

- Installation Process
- Supplier of Components
- Marketing Strategies
- Financial Options
- Community Based Programs
- Permitting

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Key Themes

- Installation Process
- Supplier of Components
- Marketing Strategies
- Financial Options
- Community Based Programs
- Permitting

Marketing Strategies

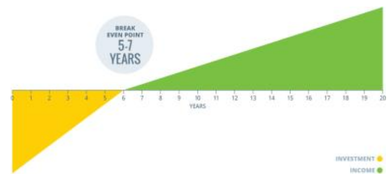
"[Word of mouth] is a big piece of our community outreach programs"
-Next Step Living

- Focus on community outreach
- Stress regional benefits of owning
- Establish online presence

Financial Options

"Leasing is not the best value proposition"- Northeast Solar

- Encourage ownership
- Partner with banks
- Minimize up-front costs

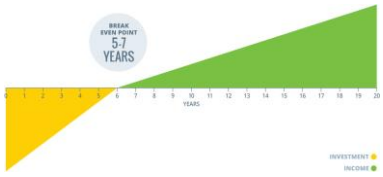


http://northeast-solar.com/residential

Financial Options

"Leasing is not the best value proposition"- Northeast Solar

Encourage ownership | Partner with banks | Minimize up-front costs



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Financial Options

"Leasing is not the best value proposition"- Northeast Solar

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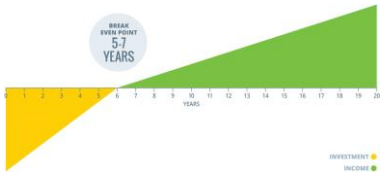


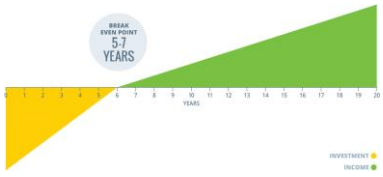
http://northeast-solar.com/residential

Worcester Polytechnic Institute

Financial Options

"Leasing is not the best value proposition"- Northeast Solar

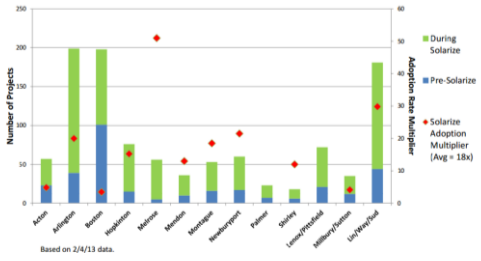
Encourage ownership | Partner with banks | Minimize up-front costs



http://northeast-solar.com/residential

Worcester Polytechnic Institute

Solarize Mass Adoption in 2012



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Solarize Montachusett

Use Solarize Mass as model → Promote community-wide adoption

Provide opportunities for local installers → Keep revenue in region

Permitting

Shared solar inspector

Standardization	Efficiency
Consistent Forms and Fees	Specialized process
Inspector relations	Online scheduling

Outcome

Reduced installation cost

Increased solar adoption

Regional economic growth

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