IQP-AHP-NBSP

ESTABLISHING A SOLAR POWER INITIATIVE: SOME GUIDELINES FOR MUNICIPALITIES IN MASSACHUSETTS

An Interactive Qualifying Project
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Abstract

This project presents a case study of the New Bedford Solar Initiative in order to develop guidelines for other Massachusetts municipalities. The first phase of this project was to research solar energy and the solar industry, specifically in Massachusetts. The second phase was to interview municipality energy directors, solar developers, and state offices. These interviews gave insight into the solar procurement process and the solar industry. The third phase was to develop a set of guidelines that will provide an overview for municipalities interested in generating a renewable energy program, specifically in solar power. The focus is to provide insight to city or town municipality members on common methods, while guiding them towards potential ways to expedite the process. The goal of this project is to provide a source for municipalities to reference, should they intend to procure solar power.

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Chapter 1: Introduction

As the United States of America continues to depend on the consumption of fossil fuels for our energy needs, we face a growing energy crisis, consequences of which include the depletion of energy sources as well as tax hikes and price increases on the energy we depend on (Federal and State Incentives for Businesses & Institutions, 2015). Cities across the country are faced with this energy crisis and are forced to seek alternate sources of energy. Knowledgeable of the many benefits of renewable energy, city leaders across the country find it in their best interest to search for and utilize the most efficient and cleanest forms of renewable energy. Benefits for these cities range from tax deductions to credits to other various federal incentives (Federal and State Incentives for Business & Institutions, 2015). One solution that many cities have successfully developed is the production of solar energy. Due to recent improvements in technology, cost efficiency, and convenience, solar energy is at the forefront of renewable energy alternatives (Solar Energy Industries Association, 2014).

The need for American cities to decrease their dependence on exhaustible resources has caused an evolution in the environmentally-friendly industry. The solar industry has experienced tremendous success due to technological innovation as well as government support with 200 times more solar capacity is installed today than in 2002 (Burr, Dutzik, & Jordan, 2014). This government, as well as state, support aims to offset the high input costs, which will translate to an expected annualized revenue of $710 million in 2019 (IBIS World US- Industry, Company and Business Research Reports and Information, 2014). The factors that contribute to the growth of the industry will eventually lead to grid parity, a point at which an energy source can generate electricity at a price equal to or less than that of the grid (IBIS World US- Industry, Company and

Business Research Reports and Information, 2014). At this point, with the establishment of environmental businesses, solar energy will become prominent in the production of solar energy.

Solar energy owes a great deal of its current progression to government incentives created to promote alternative energy. The major market segmentation is composed of utilities, the commercial sector, and industrial users; occupying 36%, 34%, and 30% of the major market segmentation respectively and totaling $491.9 million (IBIS World- US Industry, Company and Business Research Reports and Information, 2014). A common method of energy production is for a company to generate their own solar energy, which they eventually sell to a consumer at a set price. Energy produced by these companies is sold through power purchasing agreements (United States Environmental Protection Agency, 2014). With an increasing amount of cities taking initiative, solar power is taking strides towards becoming a major source of alternative energy.

Among many cities currently establishing alternative energy programs, New Bedford, Massachusetts has taken the initiative of proving how any city can go solar through improved solar policies when the appropriate steps are taken. Being a small city, New Bedford has demonstrated a powerful push to convert their municipal sector over to solar; producing nearly 16 megawatts in 5 years, New Bedford is leading the way in solar development. Other potential solar initiatives can benefit greatly by learning about New Bedford's success, and not better way to do that than to structure a set of guidelines from their steps that can aid in establishing these initiatives.

An important step that cities are strongly advised to take when establishing a solar initiative is to observe the process executed previously by other cities. It is an important primary step for cities to establish an energy office that is dedicated to enhancing renewable energy

resources. New Bedford established an Energy Department that is dedicated to reducing their dependence on non-renewable resources. Once a government progresses toward becoming run by alternative energy, its citizens are given a greater opportunity to change their own environmental footprint. These strides must be taken note of in a set of guidelines so that other cities can follow with their own development of solar industry.

Our efforts will outline the proper steps needed to successfully produce solar energy in a city from the planning all the way through completion. We will highlight the success New Bedford has experienced, as well as create a deliverable so that other cities can see the vast progression and success of New Bedford. We hope that our guidance will help them eventually begin their own process of harvesting renewable solar energy.

Chapter 2: Background

In order to understand the scope of this project it is important, first, to have a firm grasp on some of the concepts and vocabulary associated with the solar industry and public projects. This section is intended to help the reader comprehend all topics discussed later in the paper, as well as convey all research that we performed prior to the project's completion.

2.1 Solar Powered Energy Production Technologies

Recent technological advances in the solar industry directly relate to the current influx in solar power. The most common method that has developed over the past few decades is the use of photovoltaic cells. This method converts sunlight directly into energy using the photovoltaic effect. Concentrating solar power is another method that converts sunlight into energy indirectly. The advantage to this method is the thermal storage ability which allows the system to continuously dispatch energy when there is no sunlight (Stoddard, Abiecunas, & O'Connell, 2006). These two most common methods have different applications where they would be successful.

2.1.1 Photovoltaic Systems

Photovoltaic (PV) systems have greatly evolved since they were first produced in the 1950's. Originally they were designed to provide power for satellites but advances in manufacturing and performance enabled them to be used for low powered devices ("Solar Electricity Basics," 2014). These advantages opened the door for photovoltaics in consumer products, such as watches, calculators, and telecommunication equipment. PV module energy production is broken into two categories, stand-alone and grid-connected systems ("Solar Electricity Basics," 2014). Stand-alone systems do not provide energy to the grid and are generally used to provide specific energy loads. These systems are used on devices such as

ventilation fans, water pumps, and for off-grid homes. Grid-connected systems are interconnected with the energy grid, converting the DC power from the PV system into AC power consistent with the grid ("Solar Electricity Basics," 2014). To ensure that there is no feedback from the grid to the PV system, a bi-directional interface is used. Electricity created from the PV system can either be used onsite for specific electrical loads or it can be back-feed into the grid when excess power is produced. The bi-directional interface ensures that power is not provided from the grid to the PV system when power production from the PV system is less than the grid. The increase in efficiency from early PV systems to now has caused a vast increase in real world applications.

2.1.2 Photovoltaic Cell Technology

Before developing solar arrays it is important to understand how a solar module produces electricity. Solar modules are made up of semiconductors, most commonly silicone, that absorbs photons from sunlight. These cells are created with p-type and n-type semiconducting materials that create a p-n junction. P-type, or positive type, semiconducting materials have a higher hole concentration than electron concentration. N-type, or negative type, have a higher electron concentration than hole concentration. When a p-type and a n-type silicon are placed near each other a p-n junction occurs, a fundamental process in creating solar cells. In this p-n junction, diffusion occurs as free moving electrons from the n-type semiconductor move across to the holes in the p-type semiconductor creating an energy field. When photons from sunlight are absorbed, their energy is transferred to an electron, generating an electron-hole pair. The electron is excited and moves from the valence band to the conduction band, where it is free from the atom it was paired with. The electron has enough energy it will move across the p-n junction creating a potential difference or voltage. When the solar cell is connected to an external circuit, the electrons travel around to their starting position

("Anatomy of a Solar Cell – How Stuff Works," 2014). During this process an electric current is created which is how solar power is created.

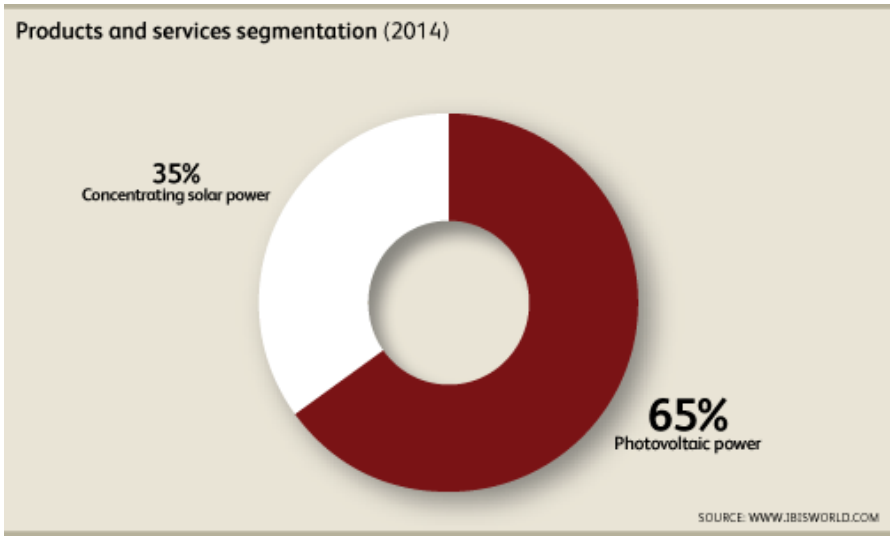
2.1.3 Photovoltaic Materials

In order to develop more economic and efficient ways for solar power to compete with traditional sources of energy, many different methods and materials are being used. Monocrystalline silicon and polycrystalline silicon are most commonly found in photovoltaic cells but second-generation technology known as thin-film solar cells is being developed. Monocrystalline has the highest efficiency in the commercial PV market at 25 percent, making it the most common choice. Polycrystalline is not as efficient as monocrystalline but is cheaper to produce, helping reduce manufacturing costs. Recent technological advances have increased thin-film photovoltaics' efficiency to 20 percent, nearly the same as polycrystalline. These second generations cells are only a few nanometers thick and and can be used between window panes. Their cheap price, relative to crystalline cells, and their versatility make them an increasingly popular choice in future installations ("NREL: Learning - Solar Photovoltaic Technology Basics," 2014). There are a number of third generation solar cells that are currently being developed that offer many promising opportunities for the photovoltaic solar industry.

2.1.4 Concentrating Solar Power Systems

Although photovoltaics are the most common solar power generating systems, concentrating solar power systems (CSP) have become a promising field. CSP's can be used to replace fossil fuels in steam powered plants. The three main systems for energy production are linear concentrator, dish/engine, and power tower systems. Linear concentrator systems harness the suns energy by using large U-shape mirrors to direct sunlight onto tubes that run the length of the mirrors. Inside these tubes is a fluid that holds the thermal energy effectively. This hot fluid is

then used to produce steam that is needed for a conventional steam turbine. This mirror system is able to track the movement of the sun in order to harness optimal thermal capabilities. The dish/engine system uses a parabolic dish to concentrate thermal energy onto a receiver. The thermal energy in the receiver heats up a fluid that is used to drive a piston in a Stirling engine, eventually leading to the production of electricity. The power tower system uses heliostats, or a field of slat sun-tracking mirrors, to focus the sun's thermal energy onto a tower mounted receiver. Electricity is then produced with the same method as the linear concentrated system (Stoddard, Abiecunas, & O'Connell, 2006). The advantage of CSP is the ability for thermal storage, allowing for energy production when there is no sun. The ability for thermal storage allows the plant to provide energy during high demand hours and store energy during low demand hours. The CSP plant can now increase their revenue by selling their thermal energy surplus at a higher rate during higher demand hours ("NREL: Learning - Concentrating Solar Power Basics," 2014). CSP has starting to compete with photovoltaics, increasing its percentage of service segmentation as seen in the graph below.



Concentrating solar power is a relatively new method, compared to photovoltaics, and has vast rooms for improvement in upcoming years.

2.1.5 Future of Solar Power Technology

It is evident that there are numerous advantages of solar power over conventional power-generating systems. As solar development progresses, the systems used for harnessing the earth's energy are getting more efficient and cost effective. The need for decreasing our dependence on nonrenewable resources and reducing our economic impact have been driving factors for the evolution of solar technology. The sun produces more energy in one hour than we use globally in one year, yet solar energy accounts for less than one tenth of one percent of the world's energy production ("Solar Power Energy Information, Solar Power Energy Facts - National Geographic," 2014).

2.2 Industry Background Knowledge

2.2.1 Public Project Organization

Public construction differs from projects in the private sector in a few key ways. The biggest difference is in the source of funding. Public project funding comes in the source of government funds that have been appropriated specifically, endowments, or special taxation for that specific purpose, whereas, private projects can be funded through existing capital or direct loans taken from an external source. The other big difference comes in the projects taken up in each sector. As far as building construction goes, typically a private project would entail a commercial or retail building where a public project would be dedicated to a municipality such as a hospital or police station (Hinze, 2011). These projects also differ in the problems they may face and how they are dealt with. Funding for public projects is more of a struggle, because there are politics involved. There must be a majority of people in support of the project in order for the funds to be appropriated. The projects are often not funded fully or given a sufficient budget to sustain what is needed. However, on the positive side public projects are not affected as adversely

as ones in the private sector in times of economic hardship. Although the economy consistently fluctuates, public projects are seldom impacted substantially by its swings due to the the projects' slow progress (Hinze, 2011).

Despite their many differences, private and public projects generally follow the same course of action throughout their lives. Construction projects are broken up into four main phases; planning, design, bidding, and construction. The planning or procurement phase entails the owner (being the municipality or government agency in the public sector), the engineer, and the financial source working together to lay the groundwork for the project. This includes proposing a budget, selecting a site, getting permits, and drafting contracts. This phase is perhaps the most critical because proper preparation is essential to the longevity of the project. The design phase is very labor intensive from the engineer's side. This is where all formal blueprints, shop drawings, and/or CAD drawings of the project are laid out in accordance with the agreed requirements of the job. Once the designs are completed by the engineer, they advance to approval by the owner. This phase is also used to acquire any necessary insurance for the project, typically for liability purposes.

After the designs have been approved, the project goes up for bid. This means that the project specifications will be put out for different contractors to make an offer on the price they can perform the project for. Often times in public projects such as road and highway construction, this automatically goes to a government owned entity such as the Department of Transportation (DOT). However, this is not always the case. Depending on the project, the government might not have the personnel to perform the tasks required for completion. In this case a Public Private Partnership is formed (See section 2.1.2). For many projects there will be a bid for both a project

manager and a general contractor. Some companies and firms may offer both services; however, often this is either not true, or it may be cheaper to award the contract to separate entities.

The final phase is construction which encompasses the entire physical portion of the project from initial site development to the final steps of erection of the project. During this phase the engineer and owner have very little input; it is really up to the project manager and contractor to complete their portion of the project. The owner and engineer do, however, make periodical visits to the site to ensure the plans are being followed precisely and are in accordance with the owner's intent.

2.2.2 Public-Private Partnerships

A Public-Private Partnership (PPP) is an agreement between private and public sector entities. Typically for a service such as a city hiring a private contractor to build a municipal facility, there would be a wide range of instances where a PPP is present. There are a few factors that define a PPP and draw the line between a partnership and just a business relation. First, there must be two or more parties, each capable of handling their own business individually. Next, they must have a stable and working relationship where they continue to work side by side over a period of time, as opposed to just making a business transaction once a year. Each party must bring something into the mix and get something out of the partnership; no one party should only give to the group while another reaps the benefits. In order for this type of relationship to work there must be a fair balance between the two. Lastly, there must be a shared responsibility of all logistics and events that take place under the partnership (Public-Private Partnerships: Managing Risks and Opportunities, 2008).

There are many benefits of establishing a PPP that are not typically available in the private or public sector alone. The collaboration of these two sectors allows them to bring their own

unique assets together to make the best of what they have. The Public sector, or the Government, gains in a lot of tangible benefits from a partnership with a private party. A project's flexibility, timeline, and technology are vastly increased. Public funding is generally a major setback to any project. A lot of projects are often under-budgeted, limiting their technological capabilities and setting back their timelines when they run out of funding, thus hindering the project's progress. The parties are also able to work alongside one another throughout the project which allows construction and design to happen almost together rather than having them perform in a back and forth sequential progress. They establish what needs to be done and then do it rather than contemplating options and talking about it for too long. The public and private entities also have expectations of one another not to hold the project back, which keeps either party from wanting to make ongoing changes to the project (Public-Private Partnerships: Managing Risks and Opportunities, 2008).

PPPs also enhance government collaboration and its ability to meet a solution through an innovative approach. Public personnel are too often set in their ways about managing a project or solving problems based on what has always been done. When working alongside professionals from the private sector, who have more flexibility, they are able to see a different approach and how different methods of engineering and project management will affect the outcomes. The cost and quality of the project will change with a PPP, and often the government will take the bidder willing to do the job for the lowest price. However, in a PPP a private party will be much more concerned with the quality of the project because price is less of a concern in the private sector. Therefore, a good balance between price and quality will affect the project for the better. The government also avoids much of the risk of the project by bringing in a private partner because

they no longer are responsible for most of the construction aspects of a project (Public-Private Partnerships: Managing Risks and Opportunities, 2008).

The private party benefits from this relationship as well. When the government begins the bidding process it is more likely to draw out bigger and more extravagant investors, allowing them to set up relationships with more influential people who could bring them future work. By taking on a project for the public sector, a private contractor can easily advertise their name, while benefiting from less of a financial burden. It is almost like free advertising; the government pays for them to construct something for the public which they can put their name on and gain a great reputation from the public eye, so long as their work is quality (Public-Private Partnerships: Managing Risks and Opportunities, 2008).

2.2.3 Request for Proposal (RFP):

A Request for Proposal is a solicitation typically made through a bidding process by a company or agency interested in the purchase of a service or product towards potential suppliers to submit business proposals. It creates a pool of interested vendors from which to purchase services. The RFP presents preliminary requirements for the service and varies in the exact structure and format of the supplier's response (Haithcoat, n.d.). The number of responses to a RFP is indicative of project feasibility. Some key components of an RFP ensure that it informs suppliers that an organization is looking to procure and encourages them to make their best effort. It requires the company to specify what it proposes to purchase. It ensures the supplier knows that the selection process is competitive. A wide distribution and response should always be allowed. The RFP follows a structured evaluation and selection procedure so that the organization can demonstrate impartiality. Procurement specifications include background info, contract terms and conditions, installation and documentation requirements, and cost proposal. Detailed

specifications for Solicitation of Proposals include requirements for documentation, training, and maintenance; present conceptual design and explain desired functionality; emphasize desired applications; allow flexibility and creativity within functional guidelines (Haithcoat, n.d.). RFPs provide a detailed description of desired information products, and it only lists functional requirements, not technical processes (Haithcoat, n.d.). The vendor chooses the best methods: what's needed to meet customer's needs keep RFP loose-knit so requirements do not exclude potential vendors. It includes timeline, milestones, and benchmarks for tracking project progress.

The layout details for returned proposals entail multiple requirements. They must define all requirements and make sure vendors know the customer's expectations. They must provide the expectations of content and format of returned responses, as well as set the due date for return of vendor proposals. The customer can not submit too many RFPs. The first cut of vendors is based on responses by due date. These cuts then continue through the process with detailed evaluations of the vendor's services.

A common question asks what should be expected in a vendor proposal. The vendor should provide detail in response to user requirements. It should also contain specifications of proposed system configuration. The statement of qualifications for the vendor includes, qualifications of project manager, review of past projects, and a financial statement (Haithcoat, n.d.).

2.2.4 Request for Qualification (RFQ):

A Request for Qualification is a standard business process which is intended to invite suppliers into a bidding process to bid on specific products or services. An RFQ usually includes the following information during the bidding process: price per item, payment terms, quality level

per item, or contract length (Mhay & Coburn, n.d.). RFQs will typically include detailed specifications of items or services so suppliers know they are bidding on the same thing (Mhay and Coburn, n.d.). It helps to keep the report detailed, and the more detailed it is, the more accurate the quote will be and comparable to other suppliers. It could also be used as a legal binding document for suppliers (Burns & Kang, 2012). Suppliers have a set time to return the bidding if they want to be awarded the item or service. Bidding can also go through multiple rounds in order to find the most appropriate price (Burns & Kang, 2012). The RFQ allows different contractors to provide a bid, and the best one will be selected. This increases competition and significantly increases the bidding.

2.3 Government Solar Power Incentives and Programs

2.3.1 Federal Incentives/Programs

There are several Federal based tax incentives for the installation of Photovoltaic Power Cells. A Federal tax credit of 30% of the cost of the technology and installation is available to commercial, corporate, and residential entities that install electricity only cells that are 0.5 kW or larger that generate 30% or greater efficiency (DSIRE, 2014). There are also a Variety of Grants and Loans available through the Federal Government offering between $2,500 and $3 million to a wide variety of project sizes in all sectors in order to aid the growth of Solar Power in the US (DSIRE, 2014). The US Department of Agriculture is one of the leading agencies in these programs, primarily by offering incentives for rural communities to begin solar projects of their own (DSIRE, 2014).

2.3.2 State Incentives/Programs:

The Commonwealth of Massachusetts has been pushing to spread the implementation of solar power in recent years. The first big government program, the Solar Carve-Out, was enacted to provide incentives for public, commercial, residential, and non-profit properties that helped expand the solar energy capacity across the state. This program provided funding to projects in Massachusetts that had a maximum capacity of 6 MW, were connected to the utility grid, and were operational after the program's start date of January 1, 2008. It also aimed to make the financial incentives available transition between rebate-based incentives to SREC-based marketable incentives. This project was highly successful, and met the State's goal of producing 250 MW of solar power installations in 2013. The Solar Carve-Out II/SREC II program was enacted in April of 2014, having the same requirements and objectives as the first program, just on a much wider scale. This program aims to produce 1,600 MW of solar power installations by 2020. Which would provide enough energy to power 97 percent of Boston's residential buildings annually (Mass EEA, 2014).

The Commonwealth Solar II program offers rebates for installing solar technologies into residential, commercial, industrial, public, and institutional buildings using a licensed professional. These rebates are calculated by multiplying a base rate of $0.25, by the amount of power generated by the panels installed per watt up to 15 kW. There are also add-on rates to supplement the base rebate for those that qualify. Such as the Moderate Home/Moderate Income Adder($.40/watt), Company Component Adder ($0.05/Watt), and Natural Disaster Relief Adder ($1.00/watt). However, funding for this program has ended much sooner than expected, and the program just recently added an extra $3 million in order to smooth out the transition into ending the rebate program (Mass CEC, 2014).

The State of Massachusetts also offers Grants, sales tax exemptions, and other tax credits to those who invest in Photovoltaic Cells. The Green Communities Grant Program offers case by case incentives for local governments that follow outlined steps to becoming more "green," including reducing their energy use by 20% in 5 years, and adopting a policy to using only fuel efficient public vehicles. The Renewable Energy Equipment Sales Tax Exemption excuses any residential purchase of photovoltaic technology from state sales tax. Massachusetts also offers a State Income Tax Credit of 15% of the total cost, for a maximum of $1,000 to individuals who purchase energy systems for residential use (DSIRE, 2014).

2.3.3 Local Incentives/Programs:

Local Incentives and Programs are among the most relevant and effective forms because they are specifically tailored to accommodate the people in that area. There are a two primary ways that local programs work, by providing financial assistance, or demonstrating the benefits of investing in this technology. Providing Financial assistance works in the same way as it does on the Federal and State level, the government or other investor (private, commercial, etc.) will help to fund projects with different loans and grants of different amounts intended for projects of various sizes and sectors. Massachusetts has many instances of this for different regions, counties, cities, and towns across the State from municipal utility company and government investors. Such as the Cape Light Compact Residential Energy Efficiency Rebate Program, and the Taunton Municipal Lighting Plant Residential PV Rebate Program (DSIRE, 2014).

Local initiatives may not have equivalent funding, or financial incentives as State or Federal Programs, however the tangible effects of these programs carry more weight. When the Local Government takes initiative and leads by example by implementing these technologies on Municipal, and Publically owned property, then the residents in the area can see the effects up

close. This is the case of the New Bedford Solar Initiative, and others like it. Rather than just advertising financial assistance and pushing to implement these technologies, it has been properly used by the Local Government for the residents to see. Until people have seen the benefits of making an investment in this type of technology they can be skeptical, that is why it is so critical for them to see that it works and has real tangible benefits to gain.

2.4 Solar Marketability

2.4.1 SRECs

Due to the pricey and risky nature of renewable solar energy, photovoltaic markets rely heavily on governmental support policies. In order to foster the growth of solar energy the US government has adopted the SREC program to provide states and industries with incentive to adopt solar energy as their primary power source. SREC stands for Solar Renewable Energy Credit and represents a form of reward for producing a set amount of Kilowatt-hours. Every 1000 Kilowatt-hour (KWh) produced by an eligible solar facility, one SREC is rewarded (Burns, 2012). The value of an SREC is determined by the market subject supply and demand constraint, and it can be sold to electricity suppliers. The suppliers buy these SRECs in order to meet their requirements given to them by the Renewable Portfolio Standard (RPS).The RPS is the most common method for passing a renewable energy support policy. It requires electric suppliers to collect a certain percentage of their electricity from solar generators. If these suppliers fall short of their standard, the market is capped by a fine, more specifically a Solar Alternative Compliance Payment (SACP), which they have to pay for every SREC they fall short of (Bird, 2011). These programs only exist in states that have Renewable Portfolio Standard Legislation.

In Massachusetts the Department of Energy Resources (DOER) launched their first SREC market in January 2010, referred to now as SREC-1 (Bird, 2011). SREC-1 originally had a 400

MW capacity limit, but since this was reached early in 2013, and certain projects continued to qualify for the SREC-I program, so on April 25 the SREC-II program was launched (Bird, 2011). This new program's purpose was to lead Massachusetts to its new goal of 1600 MW of solar energy by 2020 (Bird, 2011). Facilities under these two programs are provided 10 years of SREC production under respective program rules.

2.4.2 Net-Metering

Net-metering is a government created billing mechanism that credits investor-owned utilities for the excess electricity they produce. When solar photovoltaic systems produce more energy then used by the owner, net-metering occurs. This offset of electricity usage creates large savings for the installer. If the owner's consumption exceeds the generation, then the owner pays for the net amount ("Net Metering," 2015). If the owner produces excess energy then they are credited for the net excess energy production. Net-metering laws vary across the country depending on state legislation.

2.4.3 New Bedford Solar Initiative

In 2010, the New Bedford Energy Office was developed to promote energy efficiency and establish sources of renewable energy. The preliminary goal was to develop 10 MW of solar energy within 5 years ("New Bedford Ramps Renewable Energy - Energy Manager Today," 2015). The City has implemented roof-mounted solar arrays on several school buildings in order to reduce electricity costs. New Bedford has also created solar installations on brownfields, environmentally contaminated land that is otherwise unusable. The city has entered into power purchasing agreements with multiple companies, allowing them to generate immediate profit and reduce upfront costs. These projects will save the city millions over the course of the contract.

The New Bedford Energy Office launched the New Bedford Solar Now Program in 2011 as a way of increasing solar power and educating the community. The focus is to promote energy efficiency in buildings, develop solar in the residential sector, and educate the community on the benefits of solar ("New Bedford Builds Foundation for Energy-Centric Economic Development," 2014). Within this initiative, New Bedford is focusing on stimulating green job growth in the city. They have provided job training and created incentives for New Bedford-based companies to flourish. New Bedford's immense success over such a short period of time has made them a leader in the solar market.

Chapter 3: Methodology

This project presents a case study of the New Bedford Solar Initiative (NBSI), that has allowed us to produce a set of requirements and guidelines that will help more cities successfully adopt solar technology, and help combat the growing energy costs. First, we researched all relevant topics that were needed as background information in order to develop an understanding of all the components involved in these types of projects. All the research conducted resulted in the previous section of this report. We continued on to investigate New Bedford in order to find why they are leading the way with their successful implementation of solar energy systems. Our efforts have determined what factors have impacted this city's success, how their methods can be replicated in the future, and how they compare to other methods seen across the U.S. As a result, we created a set of guidelines that can help other cities begin their own solar programs, while enhancing New Bedford's image as a progressive center for renewable energy. We have done this through coordinating with town officials in the energy office to understand their strategy, by interviewing the solar energy companies as well as government entities involved, and by compiling all the data we collected into one project.

3.1 What were we looking for?

The research of this project focused on identifying the steps that made the NBSI successful. We had a greater focus on the methods used for the acquisition of solar power from companies, than the technology itself. One of the primary steps was to identify the factors that contributed to the implementation of the solar project in its early phases. This allowed us to develop a list of common prerequisites for establishing a solar initiative. It is essential to identify the methods that have been successful concerning funding, politics, and business partnerships. We did so by communicating with companies involved, city officials, and subject matter experts who

are either consumers or potential customers of solar power. It is important to identify any factors that are essential to the long term success of these projects.

By identifying the methods that have resulted in successful solar power implementation, we were able to identify consistencies that are essential for a city's success. It is also important to examine the downfalls and setbacks that both the New Bedford Energy Department and the companies involved have faced in the solar production process. Understanding previous shortcomings will mitigate the chance of future occurrences, as a result expediting the process for areas that aim to recreate this initiative. Therefore, we examined all contributing factors needed to design and implement a city's solar power initiative.

3.2 Who was involved?

Our team has been coordinating with the New Bedford Energy Office, a team that successfully implemented the NBSI in five years. Working with this department has allowed us to gain an in-depth understanding of their specific process. Our primary point of contact, and sponsor, through this project has been Scott Durkee.

Scott Durkee is the current director of the New Bedford Energy Office. He oversees all energy projects within the city and continually works to implement more sources of renewable energy. He was one of the leaders in the New Bedford Solar Initiative which produces more than 50% of the energy required by New Bedford's municipal buildings. This results in New Bedford saving over $700,000 a year (U.S. Department of Energy, 2014). He is currently working on developing more sources of renewable resources for both municipal and residential use.

Mr. Durkee and the New Bedford Staff have a great background in project management, as is evident in their ability to successfully implement these types of projects. They also have experience working with the other politicians, engineers, and businesses allowing us to see the

results of successful business relations. We also contacted different sources that were involved in varying aspects of the project which has allowed us to gain a better understanding of the factors that contributed to it's success.

3.3. Sources of Information and Data Collection

Our primary sources of information have been through interviews with key project personnel, and the review of project portfolios. We have been working with our sponsor to network with engineers, political figures, and businesses that contributed, from the early stages of contract acquisition to the current stage of solar energy production. We also requested any relevant paperwork covering the project such as RFPs, RFQs, PPAs transcripts from key meetings, and portfolios from our sponsors. This data has been instrumental in developing our systematic guidelines.

3.3.1 The Sample

We ended up conducting four different interviews with solar energy companies, government agencies, and members of municipal energy offices. First we conducted a phone interview with SunEdison, a solar energy company that funded the New Bedford Solar Initiative through their PPA. Next, we met personally with members of Blue Wave, another solar energy company, which served as the project manager throughout the process and coordinated with all the contractors involved to execute all required work for the project's installation. We then conducted consecutive phone interviews with solar municipality energy directors.

3.3.2 Structured Interviews

We have been in contact with the key solar energy companies and government entities involved in the New Bedford Solar Initiative and conducted structured interviews with those in charge. Both SunEdison and Blue Wave are very powerful companies that we interviewed. These

interviews have served as a guide to steer our project in the desired direction as well as gather pertinent information from knowledgeable sources. We always conducted background research on each of these interviewees to see what their expertise is and what information they can provide for us, so that we could cater our questions to their knowledge. Once we determined what they could help us with, we structured specific questions directed at their impact on the overall project. We asked these companies and departments involved in the project about any setbacks they had while installing solar panels or what they would do differently next time to make the project run more efficiently.

When performing the interviews we recorded them with an audio device so that we could be at liberty to pick and choose what pertinent information we would like to include, while not having to worry about losing any of it. We began our interviews by providing them with a brief overview of what we were trying to accomplish to give them a sense of the information that would be relevant for our project. We then conducted our interview using scripted questions approved by the WPI, then moved into any questions we thought of in the process that we wanted to know more about. We asked questions like, "Why did you get involved in solar energy?", "How can the success of New Bedford's municipal sector transfer over to the residential sector?", or "Did New Bedford's use of Power Purchasing Agreements make it an easier process compared to other solar installations?". Once all our interviews were complete, we reviewed the information that has been gathered and decided what is the most important for our project. We then compiled that information, and looked for similarities among responses in order to form the guidelines.

Chapter 4: Results and Discussion

This project involved the analysis of interviews and a case study to develop guidelines on the best practices to help Massachusetts municipalities establish solar power initiatives. Throughout our interview process, we encountered a tremendous amount of detailed insight about the process of installing solar energy from some very knowledgeable sources. We then had to analyze all the data we had collected, which entailed transcribing each of the recorded interviews and looking for similarities in them that were consistent with a lot of the background knowledge we had gained on the project. Upon analyzing these interviews, several themes emerged which would be the primary points that the guidelines revolved around. These themes were components of the initiative that each person we interviewed discussed and that we noticed to be a big portion of what New Bedford had done differently. The themes we determined are as follows:

1. Establishing an Energy Department to oversee the city's consumption needs as well as innovating new solutions for the future
2. The use of Power Purchasing Agreements in order to fund large scale projects with minimal upfront costs to the municipality
3. Zoning bylaws greatly impact an area's eligibility to enact a large scale solar project
4. The use of Request for Qualification bidding process outweighs the use of a Request for Proposal

Then, based off these themes, a set of guidelines was produced that describes the progression of the vital steps needed to enact a project of this nature and to be successful in producing results. These guidelines were produced by reviewing both the process used in the New Bedford Solar Initiative, and the data collected through our interviews with companies involved. The guidelines are based off of the process used in the NBSI, which is that of a regular Power

Purchasing Agreement, however it was supplemented by the collected data by highlighting particular areas that played a key role in New Bedford's success.

The purpose of this chapter is to describe the results of our analyses and also provide a summary of the contents of the guidelines. For more detail and further reading please refer to the formal copy of the guidelines attached in the appendix.

4.1 Analysis of interview data

We conducted interviews with project developers, managers, financers, and municipalities; the data we compiled from these interviews helped us develop some common themes to success in starting a solar project. We have included data from these interviews below, leaving out only the names of the companies and people involved.

4.1.1 Interview with Financing Company

We conducted an interview with a director of sales for an energy financing company. When speaking with him he said that he and his company have had most experience in solar energy, as it has been their largest market. They are the largest developer of the solar energy market around the world. One of the biggest problems in the solar industry is finding financing to begin or even complete projects, so his company specializes in providing financing to acquire solar energy. A majority of their work has been in the municipal sector, with a lot of experience in housing, private universities and community colleges. Out of all our interviews, this company was the most familiar with the procurement process.

When asked about the company's involvement with Power Purchasing Agreements (PPA), our interviewee gave us a lot of helpful information. His company pioneered the PPA model in order to expedite the procurement process and make it easier to purchase solar energy via third party financing. He told us that solar is a huge tax equity business, so they bring in third party

financing to provide tax equity so that they can take care of the financing so they can sell electricity to municipalities with no upfront cost. The company makes returns on development actions, so municipalities can purchase solar energy at a below market rate. Basically, it's a win-win for everyone.

We then asked him about his company's involvement in New Bedford. He told us that they had acquired a project for another solar energy company and provided the financing for projects on behalf of New Bedford. His company mainly provides financing so that other companies can worry about managing and installing the solar panels. His company operates a handful of projects serving New Bedford amounting to 14 Mega Watts. He also mentioned how New Bedford is the largest PPA purchaser in MA, purchasing well over 20 Mega Watts. The company is still involved with New Bedford through numerous projects serving the city, including a 6 Mega Watt project in Plymouth the New Bedford is purchasing all the credits for. In another project, Sullivan's Ledge, New Bedford teamed up with our interviewee's company and another solar energy company to redevelop an EPA (Environmental Protection Agency) superfund site that used to be a landfill. This was the first superfund site used in the northeast. His company's work has really catapulted New Bedford into the forefront of solar development.

We also asked him about how his company does permitting; whether or not they used third party entities. He told us that they try to use local help as much as possible, if the scale of the project allows it; for instance, civil engineers, environmental consultants, and financers. He mentioned how environmental permitting is a huge step that solar projects must go through. This usually slows a lot of projects down because you have to wait for the EPA and a bunch of other environmental protection boundaries. Going through the EPA and documenting adds a lot more

work, so if the project is small enough, it makes sense to stay local; however, larger scale projects require going through the EPA and other large agencies.

One of the more important responses we got from him was when we asked him how the use of an energy office in New Bedford might have helped the city in its success with acquiring solar power. He said it definitely was a key component in expediting the whole process. New Bedford is a large enough city that it is able to have its own energy office, which allows it to have an energy department director who is knowledgeable about the whole process of acquiring solar energy. Smaller municipalities don't have those types of resources, so they have to use an EPW (Environment and Public Works Committee) director or delegate that position. In that case, there is more education necessary to go through. This, he said, definitely slows down the process, because you have to wait for them to get up to speed in their knowledge of how the process works. Since New Bedford has an energy director who knows the PPA process, net metering, and how things go, it makes everything move a lot smoother.

When asked if most cities he has worked with are using PPAs, he responded by telling us that PPAs are the gold standard. With PPAs there is no upfront cost to the customer, since it is a long term energy investment. This allows the municipalities to push the risk to the developer. His company is an expert at developing projects, so they thrive on this. They've helped a lot of state colleges and housing authorities to receive funding to go and buy 50 Kilo Watt systems.

When we asked him if there was anything other municipalities could do in the future to expedite the solar procurement process, he gave us some helpful advice. He informed us about a buying consortium for energy services, which we would later interview and find a lot of helpful information about. This buying consortium aggregates purchasing power to the market. They do this by putting out a competitive procurement on behalf of their customers so that they can move

faster throughout the contracting portion and, in turn, expedite the development process. This allows them to do permitting and stuff like that much faster. They are a non-profit company and one of the largest buying consortiums for municipalities and non-profit organizations. Their work alongside our interviewee's company has helped many municipalities acquire solar energy, where they normally wouldn't be able to get it so quickly and easily. We also learned that one of the biggest roadblocks that municipalities have is finding financing for a project. A lot of times, companies come in and promise to provide funding for the project, while they don't realize they are overextending themselves. Once they realize they have too much on their plate, they have to pull out, and the city is left with no funding. What this company that we interviewed does is provide financing where other companies fell through on their promises to finance. One piece of advice that the company director told us was to find a sure financing partner. Make sure they are not overextending themselves and are able to follow through on what they say they can provide.

After this interview, we discussed the main points and decided that there were a few critical ideas that were worth emphasizing. The use of an energy office in New Bedford really played to the city's advantage in speeding up the process of establishing solar energy. There is so much that goes on in the process from finding funding for the project to adhering to environmental restrictions to purchasing solar energy credits, so having someone who specializes in energy department and already knows how the whole process works really helps move the process along. Another important point that we picked up on was how important the use of PPAs are in purchasing solar energy. The PPAs convenience to municipalities by providing no upfront cost, as well as passing the risk to the developer, really makes it easier for municipalities to purchase solar energy, as well as speed up the process significantly. This interview, as well as our research in other places has shown us that one of the biggest obstacles to purchasing solar energy

is the financing portion, so if municipalities can get through this part of the process swiftly and painlessly, they are already well on their way to success.

4.1.2 Interview with Project Developer

We interviewed a developer for our next interview. This company has been around since 1990's when industry was deregulated. They only work in the nonprofit sector including hospitals, schools, municipalities, etc. They go out to competitively bid every 3-4 years to find a company they can procure large amounts of solar from. The company has a single solar partner through 2016 through a contract to purchase a specific amount of solar power at a set price. The company negotiates contracts on the behalf of their customers, which expedites the process by allowing municipality to purchase power from this company instead of going through the entire procurement process. They offer their projects on behalf of the Mass Clean Energy Center and negotiate a competitive price with a large developer to get the best price for solar. This company also deals with reviewing costs and creating contracts with developers, and the nonprofit (municipalities) pays this company directly. A large scale developer is involved in procurement of solar power directly for the municipality.

4.1.3 Interview with Project Manager

The next company we interviewed served as the project manager for the New Bedford Solar Initiative. When interviewing them, we were able to get a better understanding of a project manager's involvement in this sort of project. Its job is to balance the project, while working between the financial party and the municipality and to manage all the contractors and subcontractors hired for the job. They also deal with some aspects of the permitting process and other parts of procurement. They also told us about some of the individual sites that they put solar arrays on for New Bedford, including a location that had previously been used as a landfill. This

was very interesting because of the permitting process they had to go through with the EPA, because the site had previously been a superfund site.

A couple of the responses we found to be the most helpful to our research were that they thought that New Bedford having their own energy office was helpful because of the expertise they offered in the solar industry. They thought that New Bedford's methods of establishing this project were very strategic and concise, such as their use of a consultant prior to the project in order to help lay the ground work for what needed to be done and how they should do it. Also, we asked about how the use of Power Purchasing Agreements affected the project. They responded by telling us that they are a vital element to the establishment of projects of this magnitude. Without a source of funding like PPAs, there would be no way for that money to be made available for public projects. We asked about any roadblocks that they may have had in the project. The one response we got that really stood out was that the zoning bylaws in particular areas were much too strict, to the point that it would be nearly impossible to construct a solar array in that city or town. This is a great consideration when choosing a site to build on. Overall, the interview with this company offered a lot of insight into the makings of a public solar project and was definitely one of the most helpful interviews we conducted throughout our project.

4.1.4 Interview with Municipality Energy Manager

We interviewed a Worcester energy department manager to get a better insight into the point of view of the municipality in establishing solar energy. He began by telling us about some notable projects that the city has done and how they did it. We asked him if there was any movement in the city to increase the use of solar energy. He told us that there is a much bigger drive than there used to be, including in the residential sector. Massachusetts has the second oldest building stock in the country, so it makes it hard to put solar panels on roofs. One thing that

they did in Worcester to combat this issue was use a product that seals the roof, kind of like a dry lock material used in basements. With this material you have a 20 year warranty and essentially have a new roof, and it costs half as much as a new roof. Worcester is under contract to do 11 new facilities.

Being a very old and congested city, Worcester doesn't have the space to expand and find land to install solar arrays, so we asked him if this lack of space was a problem. He told us that this is a main obstacle that the city faces. They plan on installing a solar array on a local land fill, which is really innovative. He mentioned how a lot of hilltops are ideal, since they are conservation lands. They originally looked at these for wind energy, but wind energy in Worcester is very marginal, so that would be a good place to expand solar energy to.

We asked him what some issues might have been that Worcester ran into in installing their solar energy. He told us a number of them, including the failure of financing companies to follow through. A company came in and told the city they would provide financing for their solar project; however, later the company realized that they had overextended themselves and had to tell the city that they wouldn't be able to follow through on the project. This really delayed their project. Our interviewee told us that getting a good company that you can depend on to complete the project is challenging. The solar market is still new, so some companies are inexperienced in the process and don't know what they are getting themselves into. He said it is important as a company to not overextend yourselves and be able to finish everything you start so that you can build good credit and a sterling reputation.

When we asked him whether Worcester used an RFP or and RFQ, he told us how they used an RFQ and outlined the advantages of it. Although similar to and RFP, the RFQ makes more sense because the RFP has a lot less latitude. An RFQ has a lot more discretion. The city

can see who successfully responds to the RFQ and meets the qualification criteria. Although an RFP (Request for Proposal) can be used to follow, sometimes an RFQ is all that is required to determine an appropriate candidate. He said that 92 of Worcester's largest facilities were affected by an RFQ. He also mentioned how the energy office in Worcester consists of a staff of 14, but in recent projects in the past, only 2 members consistently worked on certain projects.

We asked him about what his department's experience has been in the use of consultants for projects. He informed us that when they did use them when they first started doing solar projects. They used consultants to develop the RFQ and to develop responses. However, they learned more about the process by putting the RFQ together, so after that, they managed things internally.

Our last question for him was what he would suggest to do to make the process of acquiring solar better. He told us that it depended on whether you were doing a discreet or large-scale project. For either case, he said you should audit facilities to get and upfront cost. Based on that, decide whether or not you need a performance contractor for larger projects or a consultant if you are doing a more discreet project. It goes faster if you keep it internal; however, at some point it becomes too big to manage internally, so you need a contractor. He said it is important to do an assessment of whether it is financially and technically plausible or not. The worst thing you can do is to start something you can't finish; that kills your reputation. He said it is important to build credibility by doing good work and finishing what you started every time.

A couple major points that we took away from this interview was how more and RFQ is used over and RFP and how convenient it is to use, as well as how important it is to manage finances before you start a project. Our interviewee really made us realize how much more an RFQ is used over and RFP in the municipal sector. While we have gotten different perspectives

from other players in the installation of solar energy, it is interesting to see what is important to focus on in the municipal sector, and his mentioning why RFQs are used so much more than RFPs gave us some good inside knowledge to help our report.

4.2 Themes Common to Success

4.2.1 Establishing an Energy Department

The establishment of an energy department is one of the vital first steps toward success in a city. In order for a municipality to be able to effectively manage its energy consumption needs while simultaneously implementing new and innovative ways for improvement, there must be a full time staff of officials dedicated to this cause. The department must also be headed by someone with sufficient experience and knowledge in public project management and implementation. Having a leading figure with this experience is what makes a good department into an excellent department. Getting someone who is well versed and knowledgeable in the process required to oversee initiatives of this nature will greatly expedite the process because it cuts out the time that is usually taken to educate the public officials on the details of these projects. It also ensures competency and integrity, reducing the number of third parties that must be consulted, which may not always have the city's best interests at heart when giving guidance. Rather, there is a figure who is capable of making decisions with little input from other parties not organic to the municipality itself. When interviewing a representative from SunEdison, the financial partner involved in the projects in New Bedford, they could not have agreed more, "Having someone like Scott Durkee who is familiar with the PPA and procurement process, makes business a lot smoother. It makes everything much simpler when you have someone on the other side of the table that understands all the details of each aspect of these types of projects and is willing to work toward the best solution for everyone." This was a key aspect that was a

recurring theme in many interviews that were performed, making it one of the most important themes to stress in the guidelines. Having a department devoted to managing, and improving upon a city's energy demands can be one of the most critical aspects to the success of the entire process. The cost of establishing this department might prove difficult to allocate at first, but the return on this investment will be worthwhile after it has begun to produce results. After 5 years of hard work, New Bedford has installed over 16.7 MW in solar capacity, saving the city around $700,000 per year (U.S. Department of Energy, 2014).

4.2.2 The Use of Power Purchasing Agreements

Power Purchasing Agreements are an excellent source of funding for initiatives like this. For projects of comparable magnitude to those in New Bedford, PPAs are really the most practical way to pay for the projects. There are an abundance of State and Federal programs that provide loans and grants, specifically for the installation of solar and other alternative energy technologies. However, almost all of these programs are intended for smaller scale projects or do not provide sufficient funding for large scale projects. The other alternative, of course, would be to fund the projects completely through the local government's budget. This is simply not feasible, as it would require a significant amount of funding that would have to either be allocated from other sources or greatly raise taxes. The upfront financial burden of installing solar would be too great to undertake a project like this onto a political agenda. This is why the use of PPAs is really the most ideal way to fund projects of significant magnitude. In a PPA, a financing company will come into the project and provide all the funds needed in order to successfully execute the project. In return, the financial party then owns the project and agrees to sell the power back to the municipality at a negotiated price. They will also benefit from the tax

incentives provided as a result of the project, which the municipality is exempt from to begin with. This ensures that all parties benefit from the establishment of the project.

4.2.3 The Impact of Zoning Bylaws on a Project's Success

Zoning bylaws are a large portion of determining where a project can or cannot be established. Zoning bylaws are specific construction restrictions and specifications to a local area. Zoning bylaws are put in place for many purposes, varying from safety to maintaining the separation of different sectors (commercial, residential, and industrial). Since solar energy production is a relatively new and consistently evolving technology, it is hard for laws to be revised enough to ensure that the standards allow for current technology to be implemented effectively. There are many areas which have zoning bylaws that greatly exceed the standards of others, making it much more costly to implement projects there. This is a huge determining factor when selecting a site to build on.

4.2.4 The Use of RFQ vs. RFP

The final similarity we found was that during the bidding process, the use of a Request for Qualification (RFQ) style bid was much more effective than using a Request for Proposal (RFP). An RFQ is a competency-based bidding process which takes a deeper look into the quality of the work that will be provided by awarding a contract to a particular company. The RFP process is more concerned with the cost of the project, and it does not require as many details to be attached to the bid. With an RFQ the project owner can be sure that they are getting quality work for the price they are offered and are able to weigh the benefits of paying a slight amount more for a more qualified party. All the representatives interviewed also noted that it is important to never select the lowest priced bid. This often results in the party's inability to perform the project at the given process, resulting in a breach of contract or substandard work. It is a better practice to select

a bid in the middle of the range of prices because they often provide quality work at a reasonable price, making them much more reliable.

4.3 Guidelines

After reviewing all collected data and identifying common themes that stood out between interviews, a set of guidelines was drafted that can be used by municipalities to enact a similar type of initiative to produce successful results. These guidelines were broken up into eight sections, organized in chronological order. The sections of the guidelines are as follows:

1. Acquiring a Consultant
2. Request for Qualification/Request for Proposal
3. Evaluating and Accepting Proposals
4. Preparation for Installation
5. Federal and State Incentives
6. Comply with Local, State, and Federal Requirements
7. Construction and Commissioning of the System
8. Operation Monitoring and Power Purchasing Agreement Completion

The guidelines are concluded with two final portions outlining “Best Practices” and “Lessons Learned”, which outline key successful methods and factors that can be detrimental or a hindrance to projects. For more information see the formal guidelines attached at the end.

4.3.1 Acquiring a Consultant

After the municipality has decided to pursue a large scale solar project, they must complete an agency-wide solar energy screening, and potential project sites have to undergo a solar feasibility study. From here the process of solar acquisition can begin. Experience has shown that municipalities who use consultants have been greatly successful. Technical and legal

consultants are essential for moving the project and overcoming barriers that are inevitable in the procurement process. Consultants must be dedicated, committed, and, most importantly, put the municipalities best interest first. Once these key players are selected, a complex timeline must be created to enable progress.

Technical consultants are vital in the forming phases of the project. They are experts in many areas of the project and in details that municipalities would not be able to perform on their own. Legal consultants are primarily used throughout the procurement process to overcome various legal obstacles that may arise. Tasks accomplished by these consultants would primarily concern contracts, the bidding process, and the PPA. It is highly beneficial to seek out a consultant that has experience working with solar energy and PPAs, because they would be familiar with all the details of the project. The most beneficial part of hiring a consultant is to have an expert that can review the specifications and details of the agreements that have been made with other companies to ensure that the municipalities are making smart decisions to make up for their lack of knowledge in the solar industry.

The funding needed to acquire these external consultants can seem burdensome to the city officials that originally look into enacting a program like this. However, in many states there are programs dedicated to providing funding for instances such as this. Massachusetts is one of the leading states in advocating for more alternative energy programs. The Solar Carve-Out I and II programs have provided many opportunities for municipalities to apply for funding through the State.

4.3.2 Request for Qualification/Request for Proposal

After preliminary details have been sorted through with the technical and legal consultants, the legal consultant will assist the municipality in preparing documents and executing

the bidding phase of the project. This involves preparing either an RFQ or RFP depending on the scope of the project, and advertising to companies for them to submit a bid. Companies will submit bids to the municipality which is essentially a portfolio that provides a snapshot of that company's services. This includes projections covering financial capabilities, project timelines, net-metering opportunities, performance guarantees, environmental impact, and cost escalation rates.. In a project of this nature it is typical to see separate bids for partners in several categories, including a development, finance, installation, and utilities.

4.3.3 Evaluating and Accepting Proposals

The process of evaluating and accepting the right bid is a task that is difficult and tedious, but this decision is one of the most critical ones that will be made in the forming of a project. As the industry grows, bidding gets more competitive. It is important that all bids are reviewed to ensure that the right companies are selected to fit the project. The first bid to be submitted, usually the cheapest, are not always the best choices because they may lack the quality found in other bids. There are three common methods that can be used to evaluate bids and decide which might be the best for the project; these are known as the best fit method, the technically acceptable/low price method, and the low price method.

The best fit method uses weighted criteria, judging which aspects of the project are most important to the project's success. The applicants are then analyzed based on this criterion to determine which company should be awarded a contract. This method is very useful when searching for the most qualified candidate; however, it can also be the most expensive approach to choosing a company. The technically acceptable/low price method first evaluates candidates based on their ability to perform the project based on their qualifications, and then it makes a decision based on a suitable price. This method offers a reasonable balance between qualification

and price; however, it may eliminate some more qualified candidates that ask for a higher price for their services. The low price method selects candidates based solely on the projected price they offer. Often times, the lowest offered price is accepted using this method, which has proven to have its flaws. Sometimes the lowest price can be the result of a company either being under qualified, compromising the quality of work, or the company could be offering a price that they cannot deliver, which would lead to a breach of a contract later down the road. While this method may be the most financially appealing route, it may produce more problems later on in the project.

4.3.4 Pre-Installation

After the bids have been selected and contracts have been awarded, the beginning phases of construction are set in motion. This is the time where the companies prepare to begin construction by first acquiring all the necessary paperwork and materials needed. This begins with reviewing the site selected, along with the local zoning bylaws associated with that site. This allows the contractor to figure out what permits will be needed in order to carry out the duties of this job and apply for them prior to construction. Various inspections also must be performed throughout this phase. For example, if the project involves rooftop arrays, the roofing must be inspected to ensure it is sufficient to the needs of the solar panels. This phase is routine to any project; however, it is one of the most important, because how well prepared the project is ahead of time translates directly to the success of its implementation later on.

4.3.5 Federal and State Incentives

Federal and State incentives are a huge contribution to municipal projects. The financial partner ultimately owns the technology installed after construction; therefore, they get access to all the benefits associated with these government incentives. The majority of these incentives give

the company tax credits, which helps to optimize their profits. The Federal government offers the Federal Investment Tax Credit, which provides a tax credit for 30% of the total invested capital for a project. Similarly, Massachusetts offers the Renewable Energy Property Tax Incentive, which provides a tax exemption on the added value to property from renewable energy sources installed. Incentives like these vary from state to state. These are just a couple of the many incentives offered by the government to aid in the implementation of renewable energy.

4.3.6 Local, State, and Federal Requirements

The project manager and contractor must work together to ensure the designs are compliant with all building codes outlined for on the national, state, and local level. There are national standards which require certain specifications for design and construction, which are primarily concerned with safety. In addition to these, every state has its own standards that add on to the national standard. These are essential to the unique conditions found in every state, such as the climate and natural disasters. For example, in New England, designs have to take the weight of snow loads into consideration, and in California, they must consider the possibility of an earthquake. The engineers involved in these projects are ultimately liable for any design flaws which may result in the failure of a system. Similarly, the Contractor is liable for performance standards. Local requirements are slightly different; these are usually just zoning bylaws. Due to the nature of zoning laws, these are not as critical to overall public safety, so if there are some aspects of the design that are non-compliant with the by-laws, special permits can be applied for to allow for exceptions through the local authority.

4.3.7 Construction and Commission of the System

At this point in the project, the municipality's role has essentially been fulfilled. The bulk of remaining work lies on the developer. However, it is important for the municipality to remain

in constant communication with both the project manager and contractor during the construction phase in order to ensure the project is running according to plan. Any changes in work must be approved by either the municipality or financer. The utility provider will also be brought in during this part of the project, for interconnection between the solar panels and the grid. This part of the project is likely to run into roadblocks so the municipality should provide support in order to expedite the process.

One of the final steps is the commissioning of the system. After construction the developer will perform extensive checks to ensure the photovoltaic system is working correctly, and they will calculate the power output from the system. The will conduct an overall review of the work performed and make sure that all specifications and requirements of the project have been met. After the inspections have been complete, the final project goes to the municipality and financier for approval. Once the project has been approved it is open for operation.

4.3.8 Operation, Monitoring, and PPA Completion

The developer will continue to be responsible for the condition of the photovoltaic cells. This includes monitoring energy production, routine inspections, and maintenance. It is common though, for the developer to contract these responsibilities to an outside party.

The Power Purchasing Agreement will be set in place for an agreed amount of time. The average length of an agreement is about 20 years, which is about the amount of time that the tax incentives are valid for. When the contract runs up the municipality has a few options on what to do with the project. The first and most likely option is to remove the system. After 20 years the technology will be very outdated and less efficient, which makes it difficult to justify keeping the system in operation. The second option is to extend the PPA for another agreed amount of time; however, this would require new replacement panels in order to increase efficiency and profits in

the future. The last option would be for the municipality to purchase the technology from the financer and take over the operation themselves. The feasibility of this option depends upon the circumstances that the municipality is in 20 years in the future.

4.3.9 Best Practices and Lessons Learned

The final portions of the guidelines are dedicated to supplementary points that proved to contribute to projects in either a positive or negative way. It is important to also take these points into consideration in order to be sure that the process can be optimized and that potential obstacles can be mitigated. Some of the best practices include conducting research in order to know what to expect when pursuing a solar project, maintaining constant communication between parties through all phases of the project, using companies that are experienced in Power Purchasing Agreements, and the use of solar technology. Similarly, lessons learned makes the reader aware of common issues such as breach of contract, micromanagement, and site selection and suitability. Many of these points are simply good practices that are ethical and common in many forms of business, or they reinforce portions of the guidelines. Ultimately, this section serves as a final list of helpful suggestions as an extension of the scope of the guidelines themselves.

Chapter 5: Conclusion

When first developing the project, the focus was to create a deliverable that would have real world impact. The goal of the Interactive Qualifying Project at WPI is to apply research that applies science and technology to social issues. Knowing New Bedford's advancements in the solar industry, our team decided to do a case study on New Bedford to identify how they were so successful in a relatively short amount of time. Through our contact in New Bedford, Scott Durkee, we began the process of understanding solar procurement. During our first meeting we realized how extensive the process was and realized there were numerous companies involved in the process. Research and developing an extensive list of contacts concluded the first phase of our project.

With the help of our sponsor, we began making contact with companies and government agencies that are involved in the solar industry. Our group created interview questions that focused on explaining the process, ways to expedite the process, and roadblocks that were encountered. Once the interview questions were improved by WPI, we began conducting interviews. Communicating with companies that were involved in different aspects of the procurement process gave us unique insight that helped us grasp the necessary steps. The interview process allowed us to gain real world communication skills and experience working with large companies. Our team learned to be objective through the interview process in order to properly analyze the data collected. This phase had the most practical application and was the key learning experience in our project.

In the third phase we created the guidelines that are the deliverable for the project. Our goal was to create a document that could be used by municipalities in Massachusetts looking to implement solar power. These guidelines will give the reader a better understand of the process

including those involved, the benefits, and best practices for success. Our team based these guidelines on the method that proved successful for New Bedford. We also added other methods that were found to be successful through our interviews. The guidelines do not detail every possible way for solar procurement but instead focus on a specific way common to municipalities. Although specifics change depending on the project, the general concepts are consistent. An important aspect of this phase is identifying the parties that would potentially use our guidelines and tailoring them to fit their needs. We focused on creating documents that were factual and comprehensive while still being easily marketable.

When the guidelines where created, they were relevant to the current laws and practices. It is important to note that as technology develops and governmental policies change, the solar industry will change. Many aspects of the procurement process may stay consistent but some are surely subject to change. For example, the grid will not be able to support an infinite amount of solar energy being supplied to it. A problem that solar experts see as an issue in the near future is an overload to the grid capacity from all the new sources of renewable energy being created within the state. Experts are working to solve this problem, along with the question of how to store extra energy that is produced by solar cells, but is not immediately used. In the future, our team hopes that municipalities looking to invest in solar will use our project as a resource for understand the process and identifying the necessary steps. The combination of insights from government entities and private companies creates a balanced look into the current solar industry, as well as determining what it will look like in the future.

At the start of this project, our team looked to create a project that would make an impact on society. We wanted to work with knowledgeable professionals in the field and gain experience. We identified the need for greater development of renewable resources, identified a

city that demonstrated success in the renewable energy market, and created a way to aid other cities in the implementation of renewable energy. Worcester Polytechnic Institute is based on the pillars of "Theory and Practice" and through this project we have integrated our ideas into a practical solution.

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Appendix A: Guidelines

Guidelines to Aid Massachusetts Municipalities in Solar Procurement

Worcester Polytechnic Institute

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Scott Durkee, Director of the City of New Bedford Energy Office

Adrienne Hall-Phillips, Assistant Professor WPI School of Business

Paul Mathisen, Assistant Professor WPI Civil and Environmental Engineering Department

Photos provided by Zachary Patten of BlueWave Capital LLC.

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Glossary of Terms

- **Department of Energy Resources (DOER):** Develops and implements policies and programs aimed at ensuring the adequacy, and cost-effectiveness of Massachusetts' energy supply in order to create a cleaner energy future. They develop different energy strategies to promote reliable solar instillations and lessen dependence on nonrenewable energy.
- **Engineering, Procurement, and Construction Contractor (EPCC):** A company that is contracted to provide the engineering, procurement, and construction during a project. In the solar industry, they are involved in all the different phases of construction.
- **Ground-mounted system:** A photovoltaic system that is installed in an open parcel of land. They are usually used in large scale installations and can be adjusted based on the location of the sun. These are commonly found in municipalities with large unused areas including landfill sites.
- **Massachusetts Clean Energy Center:** A government funded program that invests in companies, businesses, and municipalities to promote clean energy. They offer funding and rebates for those who support the development of clean energy and the establishment of a clean energy workforce.
- **Massachusetts Renewable Energy Portfolio Standard:** An obligation that states that distribution utilities must provide a certain percentage of their electricity production from qualified renewable resources. This percentage must come from a list of state approved renewable energy sources and is regulated by the DOER.
- **Net-metering:** A government created billing mechanism that credits investor-owned utilities for the excess electricity they produce. When solar photovoltaic systems produce more energy then used by the owner, net-metering occurs. This offset of electricity usage creates large savings for the installer. If the owner's consumption exceeds the generation then the owner pays for the net amount. If the owner produces excess energy, then they are credited for the net excess energy production. Net-metering laws vary across the country depending on state legislation.
- **Power Purchasing Agreement (PPA):** An agreement between two parties, an energy producer and an energy consumer. The producer, more commonly known as the developer, is in charge of installing and operating the photovoltaic system and the consumer purchases the energy at a predetermined price. The PPA specifies when the project will begin commercial operation, schedule of delivery, payment, and terms. This reduces the upfront capital costs for the consumer and can generate positive cash flow almost immediately.
- **Request for Proposal (RFP):** A solicitation by a company or government entity in order to obtain proposals to supply a commodity, in this case solar energy. This is usually done through a bidding process in which the solicitor develops a set of requirements that must be met by the solar developer. This method relates to one specific project and has a limited scope.
- **Request for Qualification (RFQ):** The solicitation of a developer based on their experience, proposed implementation, proposed budget, and technical understanding. The solicitor evaluates the companies qualifications and determines their eligibility.

Whichever company is chosen for the RFQ will continue with the solicitation process. The qualified company can then be used for successive project. This method can be used for larger solar initiatives with a broader scope.

- **Roof-mounted System:** A photovoltaic system that is installed on roof-tops. A large amount of municipalities of large, unobstructed roof-tops where panels can be installed and used to generate energy for the building. Roof –top selection is based on several characteristics including: roof stability, weather sealing, roof conditions, obstructions, shade and other characteristics.
- **Solar Carve Out Program:** Under the Massachusetts Renewable Energy Portfolio Standard. Designed to create incentives to support solar photovoltaic instillations across Massachusetts. It was established to aid in generating 400MW of solar energy in the state, which has currently been reached. Solar Carve Out II was created to further expand the initiative.
- **Solar Feasibility Study:** A company will assess different sites for their solar capabilities, generate recommendations for potential sites, evaluate the potential access of solar to the sight based on shade and other factors, and estimate the performance of an instillation at a particular site.
- **Solar Renewable Energy Credits (SRECs):** Awarded by the state to each solar system or facility every time they produce 1000 kilowatt-hours of renewable solar electricity. The solar facility must be registered by a state regulatory agency. The Solar Carve-Out Program in Massachusetts creates a compliance obligation for utility companies to produce a certain percentage of their energy from renewable resources. This generates a market for generating SRECs for utilities to purchase.

Introduction

This document provides a set of guidelines developed through background research and first hand interviews with municipality energy directors, solar developers, and state offices. The intent of these guidelines is to provide an overview for municipalities interested in generating a renewable energy program, specifically in solar power. The focus is to give the municipality an overview while demonstrating potential ways to expedite the process. As the Massachusetts solar market continues to grow, more municipalities will indentify the need for developing solar instillations. Legislative support and technological innovation have enhanced the feasibility of solar power as a sustainable source of energy.

It is important to note that these guidelines were developed with several assumptions. Before beginning the process a municipality must undergo an agency wide solar energy screening. This screening will evaluate the potential of the agency's sites to host a solar instillation. This will allow the municipality to identify the best sites and evaluate the number of arrays that can be installed. These guidelines assume that the municipality will use a Power Purchasing Agreement.

Although we have talked to government officials and private companies about how they undertook the process and used their direction, this is a private study, and in no way does our research represent the views, beliefs, or opinions of these officials or companies. Laws, regulations, and incentives that we researched may vary; therefore it is important to check with your local policies.

Section 1: Acquiring a Consultant

Once a municipality has completed an agency wide solar energy screening and potential project sites have undergone a solar feasibility study, then the process of solar acquisition can begin. Experience has shown that municipalities who use consultants have been greatly successful. Technical and legal consultants are essential for moving the project and overcoming barriers that are inevitable in the procurement process. Consultants must be dedicated, committed, and most importantly put the municipalities best interest first. Once these key players are selected, a complex timeline must be created to ensure measurable progress.

Technical Consultants

The use of technical consultants has been essential in several municipalities throughout Massachusetts due to the complexity of the solar acquisition process. Their experience with the SREC program, the net-metering program, insurance, and other technical aspects makes them essential to the municipality. Important aspects when working with the municipalities include: financial analysis, energy audits, fatal flaw assessments, site selection, and primarily the evaluation and selection of installer proposals. With consultant guidance, the municipality can send out a Request for Proposal or a Request for Qualification to acquire a developer based on numerous criteria. Consultants are essential in negotiating the contract with the municipality and the developer. Their expertise is used to determine accuracy in engineering components and proper pricing. Technical consultants are essential when it comes to several key aspects in the process.

Contractors experience with the SREC program, the net-metering program, insurance, and other technical aspects makes them essential to the municipality.

Legal Consultants

External legal consultants are used throughout the procurement process. Each project will have its own specific legal hurdles related to contracts, building regulations, zoning, and insurance. They are

used throughout the entire process but they are critical during the PPA negotiations between the municipality and the developer. The selection of a legal consultant is the responsibility of the municipality but it would be very beneficial to select a company with prior solar energy experience.

Financial Procurement of Consultants

In a majority of municipalities, financial assistance is acquired from state and federal programs. Specifically, the Department of Energy Resources has developed several programs to fund municipal development of solar arrays. The Massachusetts Solar Energy Carve Out I & II Programs have created opportunities for municipalities to apply for funding to offset the cost of consultants.

Section 2: Request for Qualification/ Request for Proposal

The municipality, normally with guidance from the technical consultant, will send out a Request for Proposal (RFP) or a Request for Qualification (RFQ) depending on the intended scope of the project. Once the request has been sent out, a company will develop and submit a proposal, including pricing, contingencies, and a tier pricing structure.

1. Developer proposals are evaluated based on:
    a. developer experience
    b. financial capabilities
    c. projected project timeline
    d. net-metering opportunities
    e. performance guarantees
    f. environmental impact
    g. cost/escalation rate

It is essential to weigh all these aspects and not simply use the first or cheapest company. In order to ensure success it is important to work with a company that is proven to be successful in the industry. As the market grows exponentially, there will be more companies competing for this spot. Using the right solar company for a specific project is essential to ensure success. Below is several categories of companies that are commonly involved in the process.

Developer

They are in charge of working directly with the municipality in the implementation of the project. The developers are the ones who respond to the RFP/RFQ, demonstrating that they meet criteria set forth by the municipality. The municipality will work with the consultant in developing requirements, as mentioned earlier in the guidelines. The developer will be working closely with the municipality throughout the entire project or group of projects.

Financer

Financing is either done through an independent company or is done internally through the developer. Many of the larger developers have the ability to internally finance the project but may still send out the contract to be bid on by external financers. The financing company is able to receive

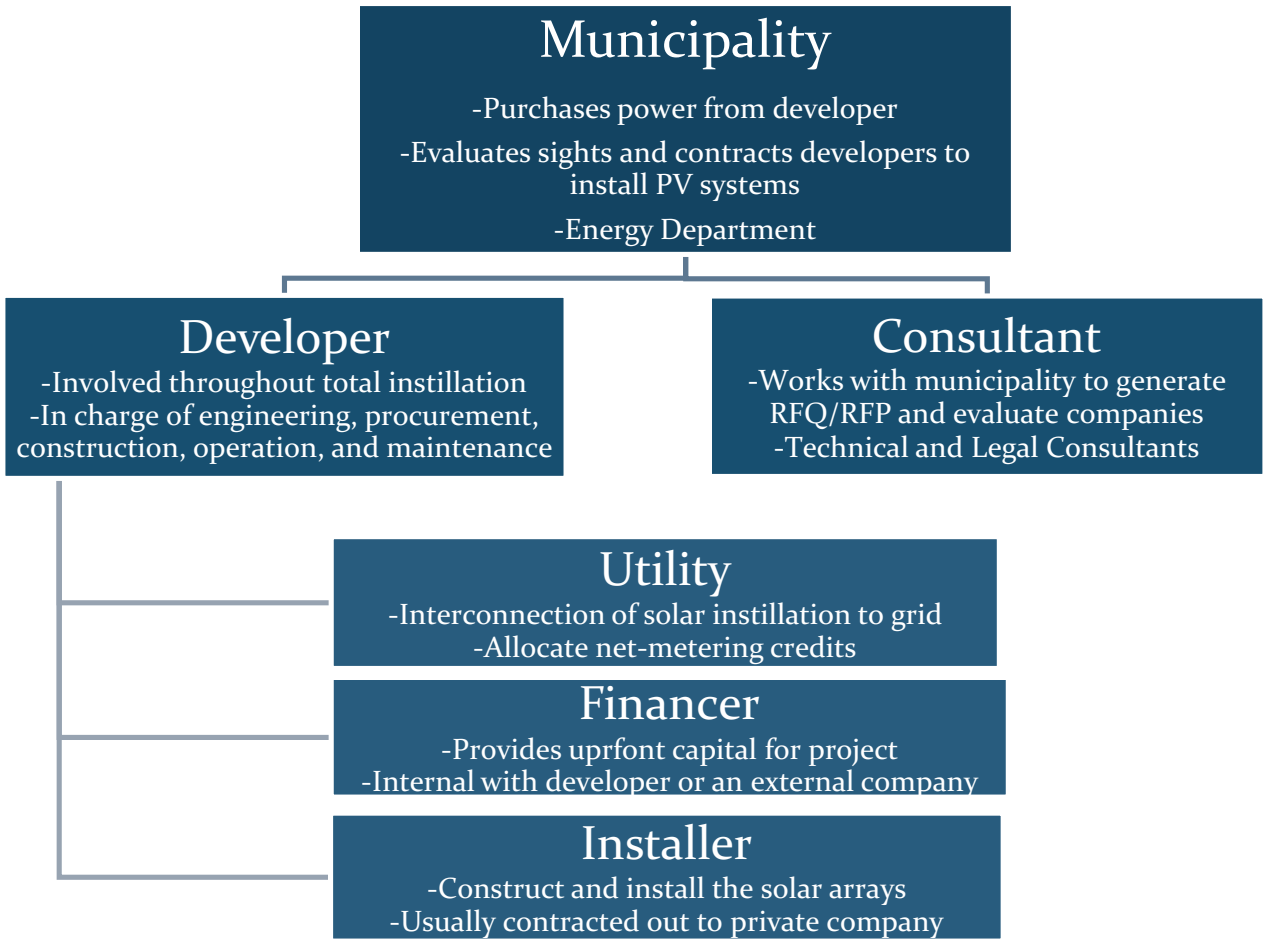
federal tax credits for solar that public tax-exempt entities cannot receive. Sufficient and reliable financing is essential for project success because the solar panels need to be physically installed before the municipality begins to save money. Many projects have failed in the past due to poor financial backing.

Installer

They are involved in the development of the physical photovoltaic panels. In a majority of instances, they are contracted by the developer to construct and install the solar arrays. In the past, several municipalities have required the developer to use installers local to the area.

Utility

They receive the electrical power generated from the solar arrays. They have the difficult responsibility of applying the non-steady energy supply to the grid effectively. It is essential that the developer and municipality work closely with the utility companies as they interconnect the panels to the grid.



Section 3: Evaluating and Accepting Proposals

Once the RFP/RFQ is sent out, the municipality and consultant must evaluate the proposals. There are three common methods that can be used for evaluating proposals:

1. Best Value

Each proposal is evaluated based on weighted criteria. These criteria are broken up into different categories that are essential to a successful project. These categories are evaluated quantitatively so that the best proposal may be selected. One challenge to this method of evaluation is that there may be a subjective approach to the evaluation.

2. Technically Acceptable, Low Price

In this form of proposal evaluation, the municipality will evaluate the technical aspects of the proposal first. They will consider experience, references, previous PPA's, and many other aspects that demonstrate their technically ability. Once the municipality has determined which companies meet the technical requirements, they are then evaluated based on price. This method is beneficial for selecting companies that have the credentials to perform the task efficiently.

3. Low Price

This method is the simplest form of proposal evaluation, in which the lowest cost proposal is used. For several municipalities, this method has proven to not be as successful as the other methods. When municipalities simply select the cheapest

proposal, it was common for the contract to be breached. The cheapest proposal does not necessarily have the highest rate of success.

Selection of Award Group

Once the proposals have been evaluated, a short list of the most qualified companies is created. Those on the short list must keep the terms of their bid until a contract is signed. All companies on the short list will be notified and negotiations will begin until the municipality has selected the award group. The final step is to award the best candidate the contract and prepare to begin the next phase. It is important to inform the other companies who created proposals that they are not selected.

Section 4: Pre-Installation

Zoning

This pre-installation step is dependent on the specific municipality's zoning regulations which consistently vary from place to place. Building-mounted and ground-mounted systems have separate zoning bylaws that constitute where they need to be installed.

Permitting

A majority of the permitting is normally completed by the solar developer and applied to the overall financial budget.

Inspection

Multiple inspections are needed throughout the entire solar installation process. In the early phases it is essential to evaluate the potential sites for installation. Roof-mounted arrays must be located on structurally sound rooftops with minimal equipment that will interfere. It is important for the solar array be in close proximity to 3-phase power lines for utility connection. The amount of shade is also very important to the decision process. Similar factors are taken into consideration for ground-mounted installations. Once the solar arrays have been installed, there will be an inspection of the final installation.

Section 5: Federal and State Incentives

Incentives on the federal and state level are available in two different forms- funding and tax credits. Funding comes through Federal or State grants and loans to finance small projects. The Commonwealth Solar II program offers rebates and funding that can help throughout the procurement process in ways like offering stimulus to pay for the use of an energy consultant for a city to advise the project. However, State and Federal funding and grant programs are not sufficient to finance large scale projects such as the project in New Bedford. Therefore these guidelines will focus more on the tax incentives. Tax credits are very important for large scale projects because they allow the project developers to increase their profit and accelerate their return on investment. Typically in a large-scale project, the financing partner will take ownership of the tax benefits, greatly reducing the amount they must pay in taxes both on the Federal and State levels (dependent on the State). A Federal tax credit of 30% of the cost of the technology

Tax credits are very important for large scale projects because the allow the project developers to increase their profit and accelerate their return on investment.

and installation is available to commercial, corporate, and residential entities that install electricity only cells that are 0.5 kW or larger that generate 30% or greater efficiency. Massachusetts also offers tax incentives on the property where the systems have been built. The Massachusetts Renewable Energy Property Tax Incentive offers tax exemption from added value to a property from installing renewable energy sources.

Federal Investment Tax Credit (ITC)

This is one of the strongest incentives for the developer to invest in solar power. This federal program was created to support the developing solar industry and to provide market certainty for solar developers, installers, and financiers. The companies involved are able to receive a 30% income tax credit for the total capital cost of the project. The Solar Energy Industries Association (SEIA) has successfully extended this tax credit until the end of 2016 enabling the solar industry to flourish. After the end of 2016 the credit will drop to 10% unless a decision is made by Congress to extend the program at its current capacity. This program has been extremely successful in lowering manufacturing and installation costs, lowering our dependence on non-renewable resources, and boosting the economy while creating jobs.

Modified Accelerated Cost-Recovery System (MACRS)

The MACRS was established to help businesses recover investments through annual deductions. Solar equipment is eligible for a five-year cost recovery period, which reduces tax liability and accelerates their return on investment. The depreciation value starts at the total cost of the installation minus one-half of its ITC. Accelerated depreciation gives companies greater incentive to invest in the solar industry.

Massachusetts Renewable Energy Property Tax Incentive

This program offers a tax exemption to a property that has installed or is installing renewable energy sources on the state and local level. The tax exemption is valid for up to 20 years after the technology is installed to a property. This is a critical incentive for large-scale projects, like those seen in the New Bedford Solar Initiative, because when adding this type of technology to property it can become a burden to deal with. The immediate inflation of property value and the taxes that come along with it can be troublesome for the companies that reap the benefits of their existence, especially when the profits are not immediate. This tax exemption allows for the companies to profit from installing this technology without worrying about added costs on top of the initial investments for a significant amount of time. This information is relevant to 2015 and is subject to change.

Section 6: Local, State, and Federal Requirements

The project manager and developer must work together in order to ensure their design is compliant with the building codes for both the state and local area. State codes will be the baseline standard for requirements concerning types of materials that can be used, the allowable size of the project, and other specifications. Locally there will be another set of zoning laws according to the city's ordinances. These include design specifications such as the percentage of land that may be developed or the required distances between the developed land and the road or adjacent lots. Each zoning law has a purpose and must be adhered to. Occasionally the project's requirements are not compliant with the zoning laws for complicated reasons, in this instance the solar company would have to apply for special permits, which after review, certify that the exception does not compromise safety or the functionality of the area around the project.

Laws

Each state has its own set of laws regarding contracts, construction, permits, and other aspects of large projects like this. The purposes of these laws are to ensure that human safety and rights are protected. This is done through mitigating the methods used for construction to prevent pollution, having structural requirements to prevent failure, and other requirements of this nature. It is up to the project manager, engineers, and contractors to ensure all these requirements are met. Should something go wrong, most of the liability would fall upon the engineer and contractor.

Ordinances

Locally, there are zoning bylaws for every municipality, which dictate construction on a more specific level than state regulations. Zoning laws are more concerned with lot spacing, percentages of land developed, building height, and separation of commercial, industrial, and residential sectors. Just like on the state level, the same parties assume responsibility for satisfying the needs of these laws. It is common for a design to break some of the bylaws, which would require a special permit for construction. This requires a separate application and inspection of the plans to make sure the intent of the law is not greatly compromised.

Regulations

Regulations are consistently change at the local, state, and federal level, so it is essential that the municipality and developer stay up to date. Many aspects are closely regulated such as SREC's, net-metering, and the total amount of energy supplied to the grid.

Section 7: Construction and Commissioning of the System

During the construction phase, it is important for the municipality and the developer to maintain consistent communication and ensure deadlines are being met. Each phase of construction will have specific deadlines that the developer must meet to satisfy the contract with the municipality. There will also be incentive deadlines that greatly impact the profitability of the project. The municipality and the developer will be working closely with the utility provider during this phase. The interconnection process will most likely run into roadblocks, so it is important to provide support to expedite the process.

The final phase in the procurement process is the commissioning of the system. The developer is in charge of calculating the energy output and determining if the system is operating to the design specifications. The developer will also conduct an extensive check of the photovoltaic system in attempt to identify potential safety issues or substandard energy production. During this review they ensure the project's requirements and specifications have been satisfied, they review the budget versus the estimated cost of the design, and ensure the design adheres to all legal aspects of the project. It is essential for the municipality to ensure the accuracy of the reviews in order to protect themselves. Once the system has been approved, the municipality can begin purchasing power at the rate designated in the contract.

Section 8: Operation Monitoring and Power Purchasing Agreement Completion

The developer is in charge of operation monitoring, as stated in the Power Purchasing Agreement. Upon completion of the project, the developer's primary responsibility is to ensure sufficient and efficient energy production. This includes the long term monitoring of the systems energy production, maintenance of the panels, and the application of incentives. It is common for the developer to contract these responsibilities to an outside company that will monitor the systems. The municipality will purchase the energy produced at the yearly price outlined in the PPA.

Upon completion of the project, the developer's primary responsibility is to ensure sufficient and efficient energy production.

Once the Power Purchasing Agreement ends, usually lasting for 20 years, there are three options. The first is the removal of the system which will be a likely result. Technology will advance drastically over the course of 20 years and the panels will be very outdated and less efficient. The second option is the extension of the PPA for a new contracted amount of time. This option means that no new panels need to be installed resulting in continued profit. The final option is for the municipality to take over the project and continue operation and maintenance. The method selected will be dependent on the circumstances 20 years from now.

Best Practices

Below is a list of tasks that have consistently been found in a majority of projects throughout our research. There have been projects that have been successful without applying certain lessons. It is important to consider each step when developing a municipality's solar initiative.

1. Research: It is essential to develop a strong knowledge base to understand many of the complicated concepts.
2. Develop an Energy Department: Several municipalities have created energy departments that have specific focus on improving the environmental sustainability of the city or town. It expedites the process to have staff working on the development of solar specifically.
3. Use a consultant: Their knowledge and experience is invaluable to the process. They will be able to evaluate proposals to determine if they are plausible or not. .
4. Communication: Throughout the entire process there must be consistent communication between the municipality and the developer. It is important to have frequent meetings to discuss the progress and ensure that contract obligations are being met. There also needs to be interconnection between state government, local government, and the utility companies.
5. Energy Consortium: Companies, such as Power Options, buy large amounts of energy and sell to municipalities at a set price. If a municipality is small, they might choose to acquire solar power through a private company.
6. Experienced companies: It is important to work with companies that have had success in the field. This is especially important when a city is trying to install solar arrays on superfund sites. Their experience with the legal framework and working with government environmental agencies makes them very useful.
7. Energy Manager: The municipality needs someone who can successfully put solar power on the political agenda. They must have a great understand in order to explain the process accurately to the key decision makers.

Lessons Learned

Several issues that slowed and even terminated solar projects were reoccurring throughout our research. Below is a brief list of issues that the municipality and solar developer should be aware of.

1. Breach of Contract: When either the municipality or the developer does not meet requirements set forth by the PPA then the project could be terminated.
2. Price of Electricity: There may be instances where the municipality does not agree with the price set forth by the developer. Many times the price may seem attractive but it could potentially increase dramatically in later years.
3. Cost of Removing Panels: Once the end of the lease term has been reached, the panel owners are in charge of the removal, if necessary. These cost estimates may cause potential issues.
4. Environmental Issues: There may be an opposition to the installation depending on its environmental impact. Many strict laws have been put into place to ensure that negative impacts on the environment will be reduced as much as possible.
5. SREC Market: Many other states have faced the issue of having surplus SREC's, causing the price to drop drastically. Massachusetts has put into effect many programs to reduce the chances of a similar issue occurring.
6. Location Availability: Some municipalities may not have the proper space for installing panels. Preparing locations to fit the criteria may create additional costs that reduce the profit for the municipality.
7. Micromanagement: Attempting to control too many aspects of the project will cause it to move slowly. You must be able to trust the developers ability to complete the task because a majority of these companies have far greater experience.

Closing Thoughts

Any city looking to convert their municipality's sector into a solar energy operated system faces a long and complicated process with a lot of steps. In order to guide a city interested in implementing a solar power initiative similar to New Bedford's, we have consolidated all the information we have gathered throughout our research into one document that outlines the procedures necessary to obtain and produce solar energy for municipalities in Massachusetts. We have gathered information from multiple sources including municipality energy directors, developers, government programs/regulators, and financing companies in order to develop a perspective on the process. Their different roles in the process helped us to better understand how this procedure works, and how to do it efficiently and successfully. Clean renewable energy is the future, and although it might be an unknown and daunting task to convert municipalities over to solar energy, our research hopefully demonstrates how previous initiatives have already paved the path and that running a city or town on solar power is a very achievable goal.

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Appendix B: Structured Interview Questions

Overview:

At Worcester Polytechnic Institute (WPI), all students complete an Interactive Qualifying Project (IQP) that is a requirement for graduation. The purpose of an IQP is for future engineers to connect science and/or technology with social issues and human needs. The focus of our IQP is to perform a case study on the New Bedford Solar Initiative (NBSI) and identify ways for other cities in Massachusetts to develop their own solar initiative. We will be working with the New Bedford Energy Department to understand the steps they have taken. Our approach will be to gather information on the NBSI through the use of interviews, surveys, and secondary data provided by the NBSI. Interviews will be conducted with several companies that were involved in order to examine the production process, as well as lessons learned. We will also survey the residents of New Bedford to understand their experience with the solar initiative. The resulting product of this case study will be a formal written report that meets WPI's requirements, highlighting New Bedford's unique accomplishments in developing the initiative. Our team will produce a set of guidelines on how the NBSI could be replicated and an infographic that can be used to educate the New Bedford residents on this initiative and the effects it has on them, as well as the benefits of installing solar panels on their own homes.

Any survey responses collected will be solely for the purposes of this project. No specific or identifiable data will be released, and all collected responses will be secured for team and advisor review only.

Standard Interview Questions:

1. What was your involvement in solarizing New Bedford?
2. Why did you get involved with solar energy?
3. Is the company still involved with current or future solar projects?
4. Did the establishment of an energy office in New Bedford expedite the process of developing solar power?
5. Did New Bedford's use of Power Purchasing Agreements make it an easier process compared to other solar installations?
6. Do you think there are ways for cities to expedite the process of acquiring solar power?
7. How can the success in New Bedford's municipal sector transfer over to the residential sector?
8. Were there any roadblocks that came up when working with New Bedford, and if so, how did you overcome them?

Appendix C: Interview Summaries

The following section contains summarized transcripts from all the interviews conducted throughout the case study. All names of individuals, and companies have been eliminated for legal purposes.

Financer Interview:

Introduction:

International company with success across America, China, Chile, etc.

Pioneered solar PPA- a model that has been used in other areas for a long time, SE was one of the first to take that model and apply it to Solar Energy in the mid 2000's

Both in Private and public sector- mostly public (municipal and state)

Financer's involvement in New Bedford: provided financing for projects developed on behalf of New Bedford. Participated in large RFP in New Bedford. Handle a great deal of projects related to New Bedford now. They are great to work with.

What is the company still involved in in NB: 6 MW project in Plymouth, 3rd project in NB.

Do you use third parties to acquire permits?

Use local Civil/electrical engineers. Always uses local environmental consulting outfit.

Did the establishment of an energy office in New Bedford expedite the process of developing solar power?

Definitely, smaller municipalities will have something similar but having someone dedicated to this having the appropriate education makes everything easier because they understand everything required, and are more helpful to work with.

A big problem with public sector projects is that there are a lot of misconceptions, a lot of times municipalities will hire a third party consultant that don't always have the best interests at heart.

Energy Procurement

PPA is Gold standard. Smaller cities don't have resources that New Bedford might have. In developing solar projects PPAs are necessary.

Do you think there are ways for cities to expedite the process of acquiring solar power?

Other Company- a buying consortium for energy, they take municipal and not for profit sources and sell them for best rate prices (not for profit company administered by Mass Clean Energy)

They put out a RFP for a solar partner a few years ago, this expedited the procurement process which gets projects straight to negotiating and gets the ball rolling.

How can the success in New Bedford's municipal sector transfer over to the residential sector?

It's a very different industry, the exciting part is the community solar in Mass it is easier to acquire a community solar project off site, a lot of people do not have a lot of land to provide, or the proper roofing type which makes it hard to install.

Residential buildings don't always have the proper roof or structure to support solar panels.

Where there any roadblocks that came up when working with New Bedford and if so, how did you overcome them?

Not that he knows of, he wasn't directly involved in negotiations, their energy department's experience was a great help

Many projects in Mass have a hard time finding proper funding, however SE came in and provided funding for New Bedford which helped, a lot of places do not properly vet the financing partner then plans fall through ex. some companies will advertise extraordinary financing packages but not actually able to carry through with their offers.

Anything Else: Get in touch with Other Companies. Talk to engineering firms. We can visit a site, or talk to a customer if requested

Project Manager Interview:

What was the involvement of your company?

Solar development project management- using their expertise to bring the right people together from construction and finance to develop the structure of the project as well as dealing with the permitting.

In New Bedford, this company was able to use their prior experience with municipalities and working with brownfields and superfunds, which was critical in the development of Sullivan's ledge project.

Is Your Company involved in the management and upkeep of the solar sites afterward?

The EPC involved in maintenance in some instances, however the owner of the site will typically contract another party for that sort of work.

What other projects is your company involved in now and in the future around the state and in New Bedford?

Developed 50-60 MW in the state to this point, looking to another 100 MW in the next two years, about half of those projects are in good light to be executed.

Do you feel like having an established Energy Office in NB was very beneficial to the process?

The New Bedford Energy Department's knowledge and commitment in the field was highly beneficial and expedited everything.

One thing that New Bedford did to help establish this office was to hire an outside consultant to show them what needed to be done, vet and designate people to work in the energy office. The state even offers funding to bring in an energy consultant to improve current methods within cities. (Department of Energy Resources DoER- look up energy consultant grants as well as state, fed grants).

Worcester Energy Manager/ consultant, should get in contact

There is a future for communities owning these solar facilities if they were to purchase them further down the road when the tax benefits have dissolved.

PPA's- how were they effective?

Places most of the risk/responsibility on the developer, alleviates the risk on the other parties, All the other parties come together and work on the procurement and execution of the project then the municipality buys back the power at a reduced price, while all the other entities get a cut of the profits.
Trust in the developer is vital, there is a lot of diligence involved because of the politics, expertise comes in to play as well because there have been instances of developers buying into projects offering rates that were too good to be true then the entire project ends up falling apart and the opportunities are lost.

Other ways to expedite the solar process?

Having an energy manager, leadership at the local level that puts the issue on their political agenda and ensures it happens, Utilizing incentives and benefits on the state level that are offered. MA has an excellent market for Solar today.

Parties need to have an understanding of how much time they need to do their jobs, Developers need to be given enough time to execute but not too much. (diligence)

Proper zoning bylaws to accommodate these types of projects, amending bylaws take time. Being selective of the areas that can be easily developed without legal hindrance. More interconnection between state, local, and utilities could improve this to ensure the process is made easier and the regulations fit the bill in many more places.

Some laws and regulations are ridiculous and refer to worst case scenarios- these standards could be lowered and made more reasonable from an engineering point of view.

Department of Public utilities is in charge of overseeing these regulations.

Residential Solar
Most common method is a form of PPA, which involves leasing your roof. Loaning programs are in development because customers will ultimately save more in the long run for owning their own systems.

Community solar- buying in to an offsite system which you can pull energy from at a lower rate than is offered otherwise. (for customers that typically do not have the proper setup for their own systems)

Roadblocks in the Project
Superfund site was very difficult to procure permits and etc. Many legal rings of fire to jump through, working with PRPs (potentially responsible parties), EPA, Owner of the site, financer etc. was difficult to coordinate and satisfy all parties' expectations.

New Bedfprd- Making sure the community development was equitable, making an effort to keep work local and hiring nearby entities to further stimulate the area.

There were far more positives than negatives in this projects. This is a good example of a priority that everyone benefitted from and there was no opposition.

The savings to the town are simple, economic and community development- job creation, is the hard part. Building an office vs. Building a solar site- the office provides more jobs for the same investment price. 80% of the money invested in these projects leaves not only the state but the region and the country. Using local entities keeps the money in circulation nearby.

Talk to DoER, Mass Clean Energy Center, Solarize Mass, Green communities divison

Final Remarks:

New Bedford found a developed based on Qualification and engaged the developer in a PPA and gave them a lot of room to do what they needed to do

RFQ over RFP is critical in ensuring success.

Worcester Energy Manager Interview:

Previous/Current Work on buildings installing Solar Panels:

They were able to put solar on two buildings. Based on how successful they were, they decided to pursue further installation. Some problems are that the infrastructures won't support solar panels. Some roofs are old and unfit to install on. In order to update the roof and cut the cost by not having to install a new roof they found a couple companies that offered a sealing product, almost like a dry-lock, that would seal existing roof in place (up to 20 year warranty with parts and labor). Use white

color for most efficient solar output; white allows for 50% higher solar emissions. It costs half as much as a new roof. Under contract to do 11 new facilities.

Currently working on the landfill, little over 80 megawatts. Possibly largest array in Massachusetts.

What are most arrays worked on?

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