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AIDS PROJECT WORCESTER:
ENERGY COST REDUCTION APPROACHES

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Submitted to:

Professor Rajib Mallick (advisor)

Professor Robert Krueger (co-advisor)

In Cooperation with

Joe McKee, Executive Director, Martha Akstin, Marketing Director

AIDS Project Worcester

Yi M Dong

Richard Nazzaro

Alexandra Sanz-Guerrero

Xiaolin Zhen

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Advisor Signature

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Co-advisor Signature

Authorship

Key:

Yi M Dong-YD

Richard Nazzaro-RN

Alexandra Sanz-Guerrero-AS

Xiaolin Zhen-XZ

	Drafter(s)	Proofreader(s)
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Abstract

For the past 10-15 years, the HIV/AIDS population in Worcester increases by 15% annually. As a non-profit organization which supplies non- medical services to those affected by HIV/AIDS; AIDS Project Worcester, Inc. (APW) has a demand for greater funding. In order to sustain the client services, lowering operating costs is necessary. Installing a new roof and implementing green technology, like solar panels, are ways to reduce energy costs. We found by implementing 35 kW photovoltaic system, APW is able to save $960 per month, which is 42.3% of their energy bill.

Executive Summary

Federal funding for AIDS Project Worcester (APW) is stagnant. With a 15% annual increase in clientele the agency is becoming concerned about the ability to sustain future client services. (Adhikari, 2010) In order to sustain the client services, lowering the operating cost is a must. Installing a new roof and implementing green technology, like solar panels, are ways to help APW lower their operating cost. To do this, we researched different types of flat roofs and a variety of photovoltaic systems. We found by implementing a 35 KW Photovoltaic (PV) system, APW is able to save $855.5 per month, which is 42.3% of their energy bill.

Goals and Objectives

As a continuation of from a previous project our project goal was to provide recommendations for green improvements and funding sources to finance those improvements to APW. To achieve the project goal, we set the following objectives:

- Explore roofing options that can either replace or repair the current damaged roofs at APW
- Discover methods to help APW save money
- Investigate funding resources for green technology implementations in the building
- Provide three recommendations (one for building owner, one for APW, and one for both of them) with cost-benefits analyses.

Findings

Finding One: Potential Roofing Options

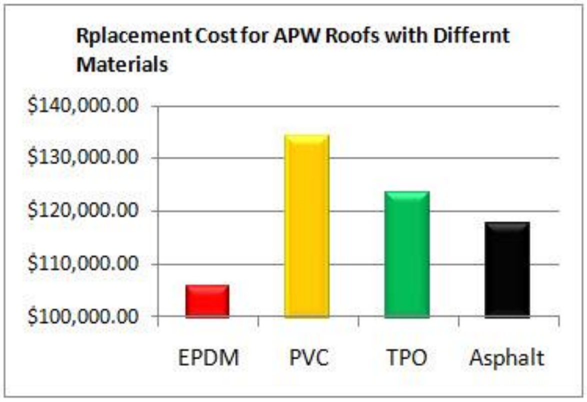

Figure 1: Replacement Cost for APW Roofs with Different Materials

The roofing recommendations were primarily based on price, color, market existence/durability as well as the ease of maintenance. As seen in Figure 1, we compared replacement costs for APW roofs using three different materials, and we found that a PVC roof is the least expensive. We also looked at other factors such as the color, market existence/durability and the maintenance of the roofs shown in Table 1. To summarize, in terms of lowest initial investment cost, EPDM will be the best option. However, in terms of high energy saving and relative lower price, TPO will be a better choice than PVC. Nonetheless, EPDM will make the optimal compromised choice in the long term. The reason to this decision is because, when the PVC or TPO roofs damaged, the entire roofing membranes have to be removed and replaced. However, an EPDM roof can be just repaired if it is damaged.

Table 1 Comparison of the Physical and Mechanical Characteristics of the EPDM, PVC and TPO Roofs

	EPDM	PVC	TPO
Years of existence in the market	40+ years	40+ years	~ 15 years
Durability	Okay	Good	Have not found any problems
Maintenance	Easy	Complicated	Complicated
Costs	Low	High	Medium
Common Color in the market	Black (not a cool roof)	White (cool roof)	White (cool roof)

Finding Two: Potential Green Technologies and Energy Cost Reduction Programs

A: Photovoltaic System

We determined to recommend Photovoltaic (PV) systems as the sole green technology recommendation because the federal and the state provide enormous incentives in solar installation. Component B in Figure 2 is the best location, and the maximum usable area for the installation is no more than 4000 ft^2. We also conducted a PV system estimate for the roof as seen in Table 2. As discussed previously, the maximum PV system size is no more than 4000 ft^2, thus a 60kW system is the maximum for APW roofs. As for the PV system recommendations, a 10kW system would be to the building owner due to the least expensive investment costs; a 60kW system would be suggested to APW

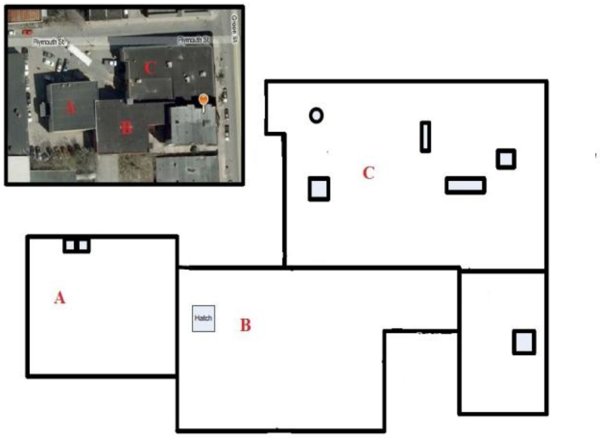

Figure 2: Roofs of the APW building

exclusively because of the highest amount of energy savings in long-term; for a system that provides equal benefits to the building owner and APW, a 35kW system would be the first choice.

Table 2: PV Power Systems Estimate

System Size (kW)	Energy Bill covered	System Energy Generated (kWh/month)	System Area (ft^2)	Total Costs (Before Incentives)	Total Costs: After Incentives	APW's Payback Period (Years)	Comments
10	12.22%	1368.75	628	$91,496.76	$21,733.61	7.4	Landlord
20	24.44%	2737.5	1256	$138,735	$33,410.35	5.7	
30	36.66%	4106.25	1884	$189,946	$46,483.62	5.3	
35	42.77%	4790.625	2512	$212,062	$51,793.58	5.0	Compromised
40	48.88%	5475	2512	$242,432	$60,004.85	5.1	
50	61.10%	6843.75	3140	$285,192.3	$70,107.59	4.8	
60	73.33%	8212.5	3768	$341,612.8	$85,011.90	4.8	APW
70	85.55%	9581.25	4396				Too Big
80	97.77%	10950	5024				Too Big

B: Fix Rate Energy Program

An alternative plan which can provide immediate saving on APW's electric bill is by signing up for a fixed-rate price program. Instead of purchasing directly from National Grid, APW/customer is purchasing the electricity from other electricity suppliers, which act as the intermediary man between National Grid and APW.

After evaluating several electricity providers, we felt that it would be best for APW to purchase electricity from Glacial Energy of New England, Inc. The reason we had decided to go with them was they were the only company that provided a lower rate than National Grid. Currently APW pays $0.08102/kWh from National Grid directly. By switching their provider to Glacial Energy the estimated rate per kWh would be $0.0798. That is a $0.00122 savings which adds up to the $1,127 (9%) savings annually. Not only does Glacial Energy of New England, Inc offer a more competitive energy rate than National Grid, but through their "We Care" program they will give APW around $150 a year. This $150 can buy APW 10 test kits.

Recommendations

We made three sets of recommendations as seen in Table 3. The first set was for the building owner based on the lowest initial investment costs. The second set was for APW based on the most energy savings. The third set was the compromised recommendation based on unbiased benefits to both parties. Making any decision means having to tradeoff for something else. In the case of installing PV panels, the landlord would receive incentives which only applied to the property owner. Nonetheless, he would be the person who needed to pay for the investment initially. Despite APW would receive great energy savings in the long run, in order to pay back the investment made by the building owner, the agency would have to increase their rent evenly for a period of time. To this point, both the building owner and the agency would have to create an extended long-term lease agreement.

Table 3 Recommendations

Recommendations		Recommendations	Initial Investment Costs	Costs after Incentives	Payback Period before tax incentives	Payback Period after tax incentive	Monthly Energy Costs Saving
Building Owner	Roofing Option	EPDM	$105,290	None	None	None	None
	PV System	10 KW System	$91, 496.	$53,620	31.2 years	7.4 years	$244.4
APW	Roofing Option	TPO	$123,185	None	None	None	$694.35
	PV System	60 KW System + Glacial Energy	$341,612.8	$204,064	19.4 years	4.83 years	$1466.5
Compromised	Roofing Option	EPDM	105,290	None	None	None	None
	PV System	35 KW System+ Glacial Energy	$212,062.10	$125,697.22	20.7 years	5.05 years	$855.5

Conclusion

The previous student group worked to figure out the energy leakage sources of the APW building. Our team's task was to provide the technical ways that will reduce APW overall operating costs. The technical way included finding the optimal roofing option, the most efficient PV system, and the best fixed rate energy supplier. An EDPM roof, 35kW PV system, and signing up with Glacial Energy as a fixed rate provider proves to be a good compromise to both parties involved. The initial cost of this system is high, but after incentives drops approximately 75% and pays for itself in about five years. It is our expectation that the outcome of the project will lead to a reality and contribute as a reference for companies and organizations that are interested applying sustainable technologies in their current buildings.

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Chapter 1: Introduction

Even though appropriate cutbacks in federal funding may reduce bureaucratic waste, it will greatly threaten non-profit organizations such as; AIDS Project Worcester (APW) with reduced or stagnant funding. Since December in 2007, the United States' economic downturn has decreased funding for non-profit sectors (Nonprofit Finance Fund, 2010). From the initial interview with Joe McKee the executive director from APW, we learned that about 64% of the funding sources for the agency come from the federal government, which are derived from Massachusetts Department of Public Health and Boston Public Health Committee (McKee, 2010). With increased demands of services and tight funding, APW executive directors have to consider substantial changes to sustain their services.

In fact, non-medical agencies such as those who serve HIV/AIDS communities do receive stagnant funding despite the increase in clientele. It is estimated that more than one million people are living with HIV in the United States and that more than half of a million have died after developing AIDS (AVERT, 2008). The Center for Disease Control (CDC) has reported that HIV prevalence in high-poverty neighborhoods rates "*more than double* national average" (Wright, HIV in Poor U.S. Neighborhoods as Intense as Developing World, 2010). In Worcester, 14.1% of the families are living below the poverty line, compared to the 9.2 % of the national average. Worcester has a high poverty population compared to the overall state's average. The poverty rate in Worcester grows as the recession continues (AmericanTown, 2010).

Major non-profit organizations, such as APW, have concerns about the high-cost medication issue and been paying appropriate attention to inform their community about HIV/AIDS. With collaboration of current facts and programs, APW has effectively educated the local residents to prevent the spread of HIV/AIDS. In order to fulfill the mission of the agency, APW invested 88% of every funding dollar to its clients leaving them with 12% for expenses, which was directed towards salaries, rent, and utilities (McKee, 2010). Since last year, with the dedication to expand the community the agency serves, APW has increased its investment on client services to 92% of every funding dollar (Akstin, 2010).

Nonetheless, APW recently received stagnant funding in context of a 15% annual increase in clientele. APW realizes that they would have to sustain the services with current stagnant funding. This realization drove APW to reassign a significant portion of money used on the operating costs and inevitably reduce the energy cost of the building. By reducing the energy costs, more funding will be readily available for the increase in clientele.

A previous APW-sponsored student group conducted a building assessment in order to determine the sources of energy loss. After reviewing their project, we recognized that the heat loss of the building is mostly caused by the damaged roof, the deficient heating ventilation and air conditioning system as well as the frail building envelope (e.g. windows and doors) (Adhikari, 2010). In addition, since APW does not own the building, potential green benefits to both APW and the building owner should also be considered. For that reason, an extension of the project was necessary.

Both the recommendations on the building improvements as well as the funding sources are critical in the extended project. It is a must to fix the structural problems inside the building. This project is targeting a non-profit organization which has a separated ownership of the building. Therefore, the goal of our project was to provide recommendations for green improvements and funding sources to finance those improvements to APW.

To achieve our project goal, several objectives were first accomplished. First, we explored roofing options to be able to replace or repair the damaged roof at APW. Second, we discovered methods that could be applied to APW to save money. Third, we investigated funding options for construction of green technologies. We then concluded our project by providing three recommendations with cost-benefits evaluations to the building owner and APW.

It is our expectation that the outcome of the project will provide incentives to both the landlord and APW and thus lead to a reality. The project will also contribute as a reference for companies and organizations that are interested in applying sustainable technologies in their current buildings.

Chapter 2: Literature Review

The primary goal of this project was to provide recommendations of energy saving methods to lower operating costs and find funding sources to finance those improvements to APW. The literature review is designed to demonstrate the importance of our project through specific driving forces, notably the HIV/AIDS epidemic in Worcester and the financial shortage that prompted APW to make budget changes. By exploring different roofing options and green technologies that are compatible, we are able to provide recommendations on how to reduce APW's operating costs.

The section begins with the significance for the project and continues on to the HIV/AIDS epidemic in the United States and Worcester. The findings from the previous group are important to the extension of the project since they uncover the structural and energy problems within the APW building. We also discuss APW's financial landscape, fundamentals of flat roofs, specific green technologies and end with solar incentives. Without understanding different flat roof types and distinguishing the benefits and drawbacks between replacing a roof and repairing it one cannot make an objective decision. Given the financial realities, APW continues to examine several methods for the reduction of its operating costs.

Reducing the energy bills is the only option to sustain APW's future client services. A building update will be a must in the near future since the external and internal systems of the building are wearing down. Realizing the non-profit organization's situation and the separated ownership had created some complication when applying for appropriate funding to the project; our group is dedicated to provide suggestions to help reduce the operating costs for APW.

2.1 The Significance of the Project

Reducing the energy bill is an important consideration to sustain APW's future client services. Currently in 2010, \$0.92 of every funding dollar given to APW has gone to client services. Last year \$0.88 of every dollar went to client services. While APW is choosing to increase the money they spend on their clients there is a \$0.04 decrease in funds to pay for 22 workers' salaries, utilities bills and other office essentials. From APW's 2010 Audited Financial Report we saw that in 2009 \$114,407.00 was spent on building operation and maintenance while in 2010 \$120,622.00 was spent (P.L. Jones & Associates, 2010)., Without an increase in money APW will not be able to help their future clientele.

A building update will be a must in near future since the external and internal systems of the building are wearing down. The current commercial location (85 Green Street, Worcester, MA) was built in 1914. APW started renting the building in 1987, which was newly renovated at the time. Over the 23 years that APW has rented this building, updates have been made such as; new and more efficient ballast and light bulbs and an overall staff behavioral change in energy consumption. These few changes have lowered energy consumption but have not made up for all the money wasted through the roof. The current roof a top APW has not been replaced since they moved in 23 years ago. "The average life span of the current roof is 30 years" (John Aucella from Sturdy Home Improvement, 2010). Last year's student project group found that most of APW's heat loss was through the old and inefficient roof, a thermal imaging camera was used in order to prove this. Since the current roof is leaking as much as it does, APW spends a higher amount on their heating costs in order to maintain a comfortable working environment for employees.

The results of our project will reflect the desires of both the building landlord and APW. The context of this project comes from the lack of increase in funding from the government and other sponsors. There was a decrease in funding provided to APW, which can be seen in their 2010 Audited Financial Report. It showed that in 2009 the total revenue was $1,770,584.00. In 2010, $1,553,669.00 was APW's total revenue, which was a decrease of $216,915.00 overall. As stated above, even with this decrease in funding, their building operation and maintenance fees continued to rise. Also from the audit we were able to see an increase of $10,050.00 in rent per year. Because of increases such as those mentioned before and a decrease in funding, $0.08 of every dollar is spent on workers and other building/office needs. If building updates, smart, and green technologies could be applied and installed to this building then everyone could be happy. With a new roof installed on the building, leaks would be addressed and APW's electric bills would be reduced because of the better thermal efficiency. If green technologies could be installed a top of APW their energy bill has the potential to be reduced, which in turn allows more money to be spent on client services. By providing APW with three of our best recommendations we will be able to lower their overall operating costs while also benefitting their landlord (P.L. Jones & Associates, 2010).

2.2 The HIV/AIDS Epidemic

HIV/AIDS is currently an epidemic that affects every American today. Currently in the United States every nine and a half minutes someone has been infected with HIV. As of 2008, there was an estimated 1,400,000 Americans infected with HIV/AIDS, this number has only continued to increase. According to the APW Website, there are over 1,500 people affected by AIDS in the Worcester Area. Organizations like APW that give support and teach prevention are detrimental to the fight against AIDS. APW is the only HIV/AIDS organization in all of western Massachusetts. Their help and support is detrimental to the fight against AIDS.

2.2.1 HIV/AIDS

Human Immunodeficiency Virus (HIV) is a virus that attacks an individuals' immune system, which is the body's automatic defense against infections, which inevitably renders it useless. This means they are less able to fight off common everyday germs that would normally not make someone sick. HIV destroys the immune system by attaching itself to healthy white blood cells and replicating itself throughout the body. Acquired Immune Deficiency Syndrome (AIDS) is the late stage of HIV. Doctors' currently diagnose someone with AIDS once their immune system is so weak that it is no longer able to fight off the illness even with the help of medication. This diagnosis does not come at a certain time for everyone. It depends on how healthy the individual is and how well their combination of medication can fight off the disease. Infections that take advantage of the weakened immune system are called Opportunistic Infections; these infections are inevitably what the person dies from, not the actual HIV/AIDS virus. Unfortunately there is no cure or vaccine to help protects against HIV/AIDS.

Medication currently offered by the Food and Drug Administration (FDA) only helps to prevent the onset of full blown AIDS. Medications such as Combivir, Emtriva, and Epivir help to do this. Anti-viral medications and a healthy lifestyle can greatly improve someone's quality of life; these treatments however do not work for everyone who is infected. Some medications may cause unfavorable side effects causing their doctor to try another medication combination. With medications and a healthy lifestyle it can take years before HIV breaks down a person's immune system and turn into AIDS (National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention , 2010).

2.2.2 HIV/AIDS in the United States

An estimated 1,400,000 people are currently infected with HIV/AIDS in America. Despite the total number of people living with HIV in the United States the annual number of new HIV infections has remained relatively stable. Even with current facts and statistics at nothing more than the click of a mouse, infections continue to increase at an alarming number.

The Center for Disease Control and Prevention (CDC) in July 2010 stated, “More than 18,000 people with AIDS still die each year in the United States.”[3] Since the disease first became prevalent around 1977 through 2007, more than 576,000 people with AIDS purely in the United States have died. These numbers do not reflect the overwhelming number of people in Africa who have died from this ruthless disease (National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention , 2010). “A study done in 2007 showed that of the people living with HIV/AIDS 46% of them were black/African American; 32% white; and 20% Hispanic/Latino…” (International HIV & AIDS Charity, 2010)This study does not relate to sexual orientation, only to race. There is still an increase in the amount of infected people, but a shift in who is becoming infected. HIV/AIDS was introduced into the black communities as the “white gay male disease.” (Pittman-Lindeman, 1989). The data provided previously in this section shows a shift in who is becoming infected and that it does not discriminate. To this point, we understand that HIV/AIDS affects millions of people every day, it does not discriminate who it will/who it will not affect; it attacks anyone who comes into contact with it in an unsafe way.

2.2.3 HIV/AIDS in Worcester, MA

A study has revealed that HIV prevalence in high-poverty neighborhoods is *more than double* than that of the nation overall (Wright, HIV in Poor U.S. Neighborhoods as Intense as Developing World, 2010). Since Worcester has a high poverty population compared to the overall state’s average. This fact is something that highly affects the area in which we live.

“Sexual violence is one of the reasons that Worcester ranks first in the state for the highest percentage of women who have been diagnosed with AIDS, according to AIDS Project Worcester.” (Welsh, 2009). HIV/AIDS numbers are on the rise in people stricken by poverty, unfortunately Worcester has a high poverty population compared to the overall states average. In fact, Worcester has grown to become the third largest city in New England, and about 14.1% of the population was below poverty line (P.L. Jones & Associates, 2010).

According to APW, the organization's client-base has increased by 15% annually (Udit Adhikari et.al, 2010). Also, in accordance of the initial interview with APW, they have noticed that 48 new clients have been added to the 500 client-base. Each year, APW screens about 1,100 patients for HIV/AIDS exposure. Within this number, approximate ten positive results are interpreted annually. Surprisingly, APW received ten positive interpreted results for the first half year of 2010. This number is doubled compare to that of previous years. It is unsure for now, whether these ten interpreted results implies the improvement of APW promotion, or the increase of the number of the infected HIV/AIDS cases. If the number of the clients continues to increase at the same rate, it is predicted the client base for APW will reach 600 by end of 2010.

2.3 APW, Funding sources for APW's client programs & Financial Shortage

APW is the second largest AIDS Service Organization in New England. With its 23 years in existence, APW is considered the main AIDS Service Organization in Worcester County. APW is a crucial part in the fight against AIDS in central Massachusetts. To better serve clients in central Massachusetts, APW offices in Worcester and Southbridge. They offer a wide range of services to support various needs of the people living with HIV/AIDS and to those who are at high risk of contracting the disease. There are two main areas that APW focuses on; client services and prevention services. All of these services are offered to any client in need. In attempt to accommodate for every possible person, APW offers services in English, Spanish, American Sign Language and other languages. APW has helped 513 people infected with HIV/AIDS and more than 1,500 affected persons, as of 2007 (AIDS Project Worcester , 2008).

Non-profit organizations like APW sustain their services through government funding as well as private donations. The general mission for non-profit organizations is to maximally supply their mission outputs with funding. For APW, 64% of their operating funds are derived from Massachusetts Department of Public Health and Boston Public Health Committee. The remaining 34% of the APW operating funds come from small grants from philanthropic entities, donations, direct appeals and fund raisers. The funding received has been used maximally on the clinics, education, and special events, thus APW has been practicing their mission properly. APW possess a budget of $1,700,000. Each year, APW takes a few thousand dollars in the budget and spends them on the services, which consist of the clinical services and self-services. APW used to invest 88% of their funding on the client services leaving them 12% for self-services. Since this year, APW has increased their investment on the client services to 92%, leaving them only 8% on self-services. These self-services include employee salaries, utilities and rent.

The main concern for APW is how to support additional patients in the agency. With funding for APW to be stagnant, the agency is becoming concerned about the ability to sustain future client services (Udit Adhikari et.al, 2010). More money is required to help with the increased clientele. To sustain the services with current stagnant funding, APW has realized it is best to reduce their operating costs. Instead of reducing the money used on employee salaries, APW believes it appropriate to reduce operating costs from non-human factors such as energy costs. We will now examine the physical characteristics of the APW building.

2.4 Structural and Energy Assessment of the APW Building

The current APW building was constructed in 1914 and renovated in 1985 (Udit Adhikari et.al, 2010). The Heating, Ventilating, and Air Conditioning (HVAC) system of the building was installed over 25 years (Udit Adhikari et.al, 2010). The efficiency of the HVAC system is only 70%. Low efficiency of the energy system results in high energy bills. Only after the energy becomes efficient will it reduce the energy bills of APW. In order to approach this issue, a previous WPI student group conducted an energy audit of the building as well as a behavioral audit to the APW employees. An energy audit enables a person or team to evaluate and locate where its inefficiencies are.

2.4.1 Energy Audit of the Building

The previous audit resulted in a thorough building inspection. The building inspection was a three-part energy audit, which included:

1) “Walk-through” inspection of the building envelope
2) Heating, Ventilating and Air Conditioning (HVAC) systems performance evaluation.
3) Thermal images Conduction of the “unseen” energy losses in the building, while paying special attention to the windows, doors, emergency exits and the roof.

2.4.2 Findings of the previous study

Thermal images conductions of the building envelope and the HVAC systems evaluations enabled our team to pinpoint the sources that lead to the deficiency of the building. Thermal images were able to determine the “unseen” energy losses in the building. The HVAC systems evaluations allowed the previous student team to determine when the systems were operating and, more importantly, how they were working in relation to the other units (Udit Adhikari et.al, 2010).

Thermal images were taken in windows, doors, roof and emergency exists. Results drawn from the thermal images were as followed (Udit Adhikari et.al, 2010):

- **The entrance of APW**: there is roughly a 10^{O}F difference between the walls surrounding the door and the glass door itself. This is one source to introduce the air leakage.
- **The emergency exit stairwell**: the door is not sealed properly.
- **The roof over APW's office space**: Poor insulation on this roof. The previous group conducted a thermal image on Feb 17, 2010, which was a snow day. However on Feb 23, 2010, the snow melted because of the heat leaking through the insulation.
- **The roof of the APW building (location 2)**: in addition to poor thermal insulation, this roof consists of water puddle that l floods APW's interior building during heavy rain period.

According to the thermal images, the majority of the heat loss of the building laid upon the damaged roof. In order to help reduce the heat losses of the building and eventually reduces the energy bills of APW building, the roof issue needs to be fixed.

The majority of the energy loss came from the building deficiency. The combination of the insufficient HVAC systems and the damaged roof not only brought unnecessary extra amounts of energy costs, but also provides a threat to the employees as well as patients in the building. APW understands the importance to have the problems solved; however, they do not have money to solve these problems on their own because only 8% of their every funding dollar goes to self-services. In fact, the self-services do not include structural maintenance since the agency is not the building owner of this building. To this point, the problems become complicated to solve.

2.4.3 Problems with the Building's Envelope

Non-profit organization status and separated ownership of the building have added some complication to the project. Since APW is a nonprofit organization and does not pay taxes, the organization cannot directly benefit from many federal government funding sources that offered tax credits or tax incentives as opposed to rebate or other cash payout. In addition, APW does not have the ownership of the building; they are only a long-term tenant to the building owner. Since the tax incentives only apply to property owners, tenants like APW are not eligible for receiving the benefits. But this affects the property owner's qualification for receiving tax-rebate, since they pay taxes every year.

The old and inefficient HVAC system does provide many issues to APW. During the winter the system keeps the kitchen boiling hot, but does not work well in many of the offices. Updating and replacing the HVAC system would be less of an investment than replacing the damaged roof. However, while the offices and kitchen may seem uncomfortable to walk into, it is not hazardous. Since the damaged roof does provide a threat to the staff and clientele of APW, it is the main focus of our project. Not only does the damaged roof prove to be slightly dangerous to work under, it must be redone if green technologies are to be placed atop the building. For these reasons we are currently ignoring the HVAC system and putting all of our attention on the roof.

Any improvement added to the building can be potentially eligible for funding on two levels: one is for non-profit organizations; the other is for privately-owned buildings. While exploring the available funding source, our group realizes that private building owners and APW are eligible for receiving various supports in different manners. Non-profit organizations, like APW, are eligible for receiving aids from United States Department of Treasury toward the investment in the power generating technologies (U.S. Department of Treasury, 2010) while individuals and business will get assistance from Massachusetts Technology Collaborative Renewable Energy Trust for developing the solar or wind turbines at their facilities (Massachusetts Technology Collaborative Renewable Energy Trust, 2010).

Realizing that non-profit organization situation and the separated ownership has created some complication when applying for appropriate funding to the project; our group is dedicated to provide suggestions to help reduce the operating costs for APW. From the findings provided by the previous student group, we understand that we can start to approach the problems created by the damaged roof. Getting familiar with the fundamentals of flat roofs will help us to better understand the importance of our project.

2.5 Fundamentals of Conventional Flat Roofs

With the findings from previous group, we learned that the roof produced most of the heating imbalance problem of the building. Repairing or replacement of the roof is a must. However which decision we should choose? That is still a question. In this session, we will explore fundamentals of flat roof. Common flat roof types, price and quality comparisons between replacement of a roof and repairing of the roof and a general life span of roof will be discussed in this session.

2.5.1 Components of a Roof

As seen in Figure 3 below, a roof consists of the supporting structure and the weatherproof member, which is usually the outer layer. The supporting structure of a roof usually comprises of beams that are long and of rigid material such as timer. The outer weatherproof layer of the roof shows great variation depends on the availability of material. In between the weatherproof membrane and timer, there usually are three layers, in order from bottom to top they are: Deck, Vapor Control and Insulation. If a roof needs to be repaired, it will leave the existing roof in place, cover it with a recover board product and/or additional insulation, and then a new membrane is installed. However, if a roof needs to be replaced, the existing roof is removed down to the deck and the whole system is replaced. The roof must be fixed if the interior of the existing roof is wet, or if there are already two layers of roofing in place (Ennis, 2010).

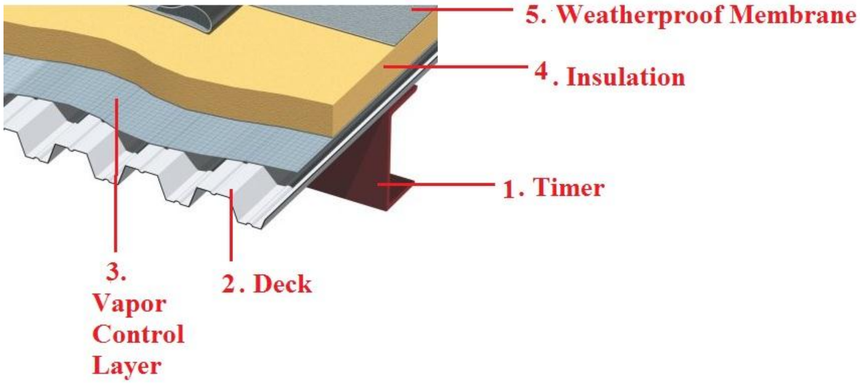


Figure 3: Components of a roof

(Photo courtesy of Tegralmetalforming.com)

2.5.2 Conventional Flat Roofs

The most commonly used conventional flat roofs, listed in the order of durability and costs are asphalt, single-ply membrane, build-up, and metal. The price ranges from $0.50 per square foot for asphalt roof to $6 per square foot for metal roof. Each type of roof has its advantages and drawbacks, thus a material selection for a roof is very important. What matters most is that the roof has a long life and provides high level of performance (e.g. thermal efficiency and air leakage performance) (Kingspan, 2010). Table 4 lists the common roof materials used in New England area. Asphalt roof is the least expensive roofing material; however it does not have high durability level. Ethylene-Propylene-Diene monomer (EPDM), Polyvinyl Chloride (PVC), and Thermoplastic Polyolefin (TPO) roofs are two types of single-ply membrane roofs. Single-ply membrane roofs have a longer life span compare to asphalt roof. Also single-ply membrane roofs have a higher performance to resist UV radiations. Build-up roofs (BUR) are one of the oldest and most reliable roofs, however the drawback of BUR is that they are very heavy. Metal roofs are the most durable conventional roof materials; however material roofs are the most expensive among all the conventional materials (Green Affordable Housing Coalition, 2005).

Table 4 the Common Flat Roof Materials

Flat Roof Types	Pros	Cons	Price	Life Span
Asphalt	-least expensive	-not durable -easy to have leakages	$0.5/sq. ft	10 years
Ethylene Propylene Diene Monomer (EPDM)	-low price -will support green roof (commonly used)	-hard to install well	$0.6/sq. ft – $1.25/sq. ft	10-20 years
PVC	-high resistance to puncture and impact -good low-temperature flexibility and high temperature tolerance	-hard to find leaks. If there are leaks, the entire PVC roof has to be replaced	$0.6/sq. ft – $1.25/sq. ft	10-20 years
TPO	-popular choice for "green" building -high heat resistant (comparable to EPDM) -high heat-weldable (comparable to PVC)	- easy to get sun damage - installation process is not easy	N/A	10-20 years
Build-up Roof (BUR)	-very reliable in installation	-very heavy -smelly -hard to find the source of leaks	N/A	10-30 years
Metal	-very durable -light weight -labor efficient during installation -very long life span	-expensive	$1.5/sq. ft – $6/sq. ft	20-50 years

Single-ply Roofing Membranes

During our investigation, we eliminated asphalt, BUR and metal roofs and determined to perform an in-depth research on single-ply roofing membranes (e.g. EPDM, PVC and TPO). We determined to eliminate asphalt roof because the current roof of the building is made of asphalt material. Asphalt is an inexpensive roofing material, however it damages easily. A Build-up Roof is one of the oldest and most reliable roof types, but the drawback is that it is very heavy and will produce a lot of loads to the interior of the building. A metal roof is very efficient in large buildings. However it would not be feasible to install a metal roof on a three-story agency like APW that is approximately 16,127 square feet of area. Single-ply roofing membranes are the potential outer membrane options for APW.

Single-ply roofing membranes have grown popularity over the past 30 years due to their flexibility, relative ease of installation and competitive prices (Madsen, 2005). Single-ply membrane roofs can be generally categorized into two groups- thermosets and thermoplastics. According to National Roofing Contractors Association, thermoset membranes incorporate principal polymers that are chemically cross linked or vulcanized (ScienceJrank, 2010). Membranes that are vulcanized also may be referred to as "cured." One characteristic of true thermoset polymers is once they are cured, they only can be bonded to similar materials with adhesives (National Roofing Contractors Association, 2010). Different from thermoset membranes, there is no chemical cross linking in thermoplastic membranes. These membranes can be repeatedly softened by heating or hardened when cooled. Because of the materials' chemical nature, thermoplastic membranes typically are seamed by heat welding with hot air or solvent welding (National Roofing Contractors Association, 2010). Thermoset materials are generally stronger than thermoplastic materials due to the chemically cross-linked bonds, and are also better suited to high temperature applications up to the decomposition of temperature. However, thermoset materials are more brittle (National Roofing Contractors Association, 2010). One example for thermoset membranes is EDPM; the most common thermoplastic membranes are PVC and TPO (Madsen, 2005).

Option One: Ethylene Propylene Diene Monomer (EPDM)

Since 1960s, EPDM roofs (as known as rubber roofs) have been popular in the US markets due to its lower initial prices and ease of installation. Within the United States, EPDM accounts for over 1 billion square feet of new roofing annually and represents approximately 35% of the entire roofing market (EPDM Roofing Association, 2010). EPDM roofs are available in black and white colors. Black EPDM has a smooth surface similar to natural gray slate and does not contain surface granules that can eventually be lost on other materials (EPDM Roofing Association, 2010). To produce the white colored EPDM membranes, in addition to the oils and the polymers used to make an EPDM membrane, another ingredient is added to the mix to enhance UV resistance. In the case of a black membrane, carbon black is added, which converts UV rays into heat. With white membrane, in lieu of carbon black, titanium dioxide is typically used to reflect UV rays and prevent it from attacking the polymer (EPDM Roofing Association, 2010). EPDM membrane thickness ranges from 30 mils (0.030") to 100 mils (0.100") with the most common thicknesses being 45 mils (0.045") and 60 mils (0.060") (RoofHelp, 2009). One advantage is that it comes in giant rolls that can cover large areas without any seams. A roll can be 20 feet by 100 feet covering 2,000 sq-ft (EPDM Roofing Association, 2010). Properly installed EPDM rubber roofs should last between 12 and 25 years. Of course, one of the most important factors in a roof's life expectancy is the quality of workmanship. If the roof is not properly installed, then its lifespan will be shortened (RoofHelp, 2009). EPDM cannot be mixed with asphalt products. The asphalt can corrode the newly installed EPDM material, thus one has to make sure it does not come in contact with the old roofing (Zacharia, 2006).

Option Two: Polyvinyl Chloride (PVC)

PVC roofing in one of the best single-ply mem1branes and has a long history of excellent performance. According to roof informational center ROOF 101, PVC roofing membrane is a layer of sheathing that provides additional insulation, protection, and sound-deadening features, and is placed over an existing flat or shingled roof (PVC Roofing benefit, 2010). PVC roof is the ultimate roofing option for flat roof for the following reason: long existence in the roofing market, simple installation and virtually free maintenance.

PVC roof was first introduced in Europe in 1960’s, arrived in America in 1970’s. The PVC roof market has rapidly grown since it was first introduce in America. Today, PVC makes up approximately 10% of roofs in the United States, especially within North America where low-sloped roofs are more common. PVC roofing membrane is made of thick, flexible UV resistant thermoplastic materials. PVC roofing will provide up to 80% solar reflectivity which results in less of a heat island effect and lowered cooling cost. White is the common color for PVC roof since it reflects the most sun's heat. However, different colors are available. Colors like tan, grey or cream are recommended due to their high reflectivity of the sun. The installation process is quick and simple because the membrane is created by process of heat welding seam technology, thus provides excellent flexibility. PVC roof is free of maintenance due to its resistance to water and dirt. Rooftop soiling and contamination should not be a worry when considering a PVC roof. PVC roof has an average life span of 15 to 20 years; some premium products may have longer warranties. PVC roofing will fit any flat roof shape, and is considered a fire safe material. Even though PVC is resistant to many of outside damages, the fact that it disposes high toxicity while being manufactured and is not recyclable. Heavy rain and snow will damage the PVC roofing membrane, so they are in less demand in the areas with very long winters (PVC Roofing Systems: Benefit & Issues, 2010).

Option Three: Thermoplastic Olefin (TPO)

TPO roof membrane is another example of most commonly used single-ply membrane in today's market. TPO membranes are considered as a product that combines the properties of both EPDM and PVC roof. TPO roofing membrane was first introduce in United State 15 years ago. Today, the use of TPO membrane is becoming more common. TPO membranes single-ply roof membrane constructed from ethylene propylene rubber that have the average life span of 15 years. TPO roofing has characteristics like a PVC roof, which are high resistance to heat, UV degradation, and many chemicals. TPO membrane also had high level of reflectivity (Level of reflectivity). This allows TPO membrane to meet the U.S. Environmental Protection Agency's ENERGY STAR performance levels. Furthermore, the overall reflectivity will help to reduce energy use. In addition to that, TPO roof is environmental friendly and recyclable. TPO roof membrane is available in white, grey and tan with thickness of 45 mils and 60 mils. For being a relatively new roof it is sometimes difficult to find a roofing installer with good experience installing TPO roofs. Its inability to resist flame and cold weather, and short history in the market will require more consideration. (Ralph M. Paroli, Terrance R. Silmmoons, Tom L. Smith, Bas A. Baskaran, Karen K.Y liu, Ana H Delgado, 2006)

2.5.3 “Cool” Roofing

As reported by Bay Soundings, a Florida quarterly news journal, “*the so-called “cool roofs” have two important surface properties – a high solar reflectance, or albedo, and high thermal emittance, the ability to radiate energy away from the surface after it is absorbed”,* (Hoppe, 2010). As we discussed above, EPDM roofs are commonly in black color, which has low reflectance and high thermal emittance. However for thermoplastic membranes such as PVC roofs and TPO roofs usually come in white color. Figure 4 shows a clustered column chart for different color of single-ply membranes. The Solar Reflectance values and Thermal Emittance values are referenced from IB Roof Systems (IB Roof Systems, 2010).

	White	**Tan**	**Gray**	**Red**	**Brown**	**Evergreen**
Solar Reflectance	0.87	0.366	0.163	0.243	0.079	0.073
Thermal Emittance	0.88	0.87	0.88	0.88	0.87	0.88

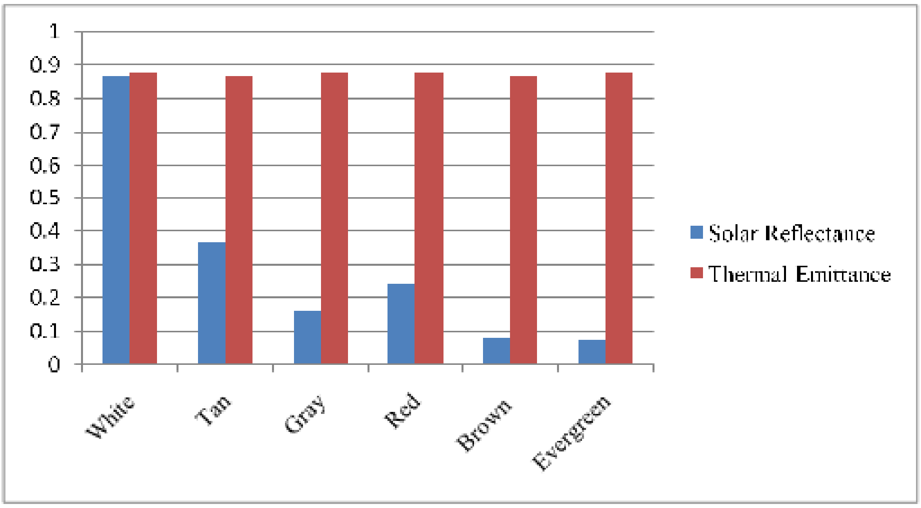


Figure 4: Solar Reflectance and Thermal Emittance for Different Colors of Single-ply Roofing Membranes

According to Figure 4, if the Thermal Emittance was controlled around 0.87 and 0.88, the solar reflectance for white colored membrane can be as high as 0.87. Dark colors such as Brown and Evergreen have much smaller Solar Reflectance values. Figure 2 does not show the Solar Reflectance and Thermal Emittance values for a black colored membrane, however, one can predict that the difference between the Solar Reflectance and Thermal Emittance would be the highest among the color rating chart. The smaller the difference between Solar Reflectance and

Thermal Emittance of the membrane is, the cooler the roof is, which leads to higher energy savings.

2.5.4 Roofs of the current APW Building

The current roofs of the building are made of black asphalt material in three components of the building A, B and C (Luukko, Roofing Inspection 11/11/2010, 2010). Figure 5 shows a picture of the roofs and the roofing sizes. APW does not own the building, and it does not occupy all the space in the building. In fact, the agency (as shown in B and C) shares the building with ReStore Habitat for Humanity (as shown in A and B) and AllCare Pharmacy (as shown in B). Spot D, as shown in the picture is a hotel that connects to the building. According to the previous study and our investigation during the roofing inspection, we discovered that the leakage of the roof happened in component C of the building, which is the roof above the APW kitchen. Component C needs to be taken care of in near future. Although component A and B look new to the naked eye, they do have buckles on the outer membrane.

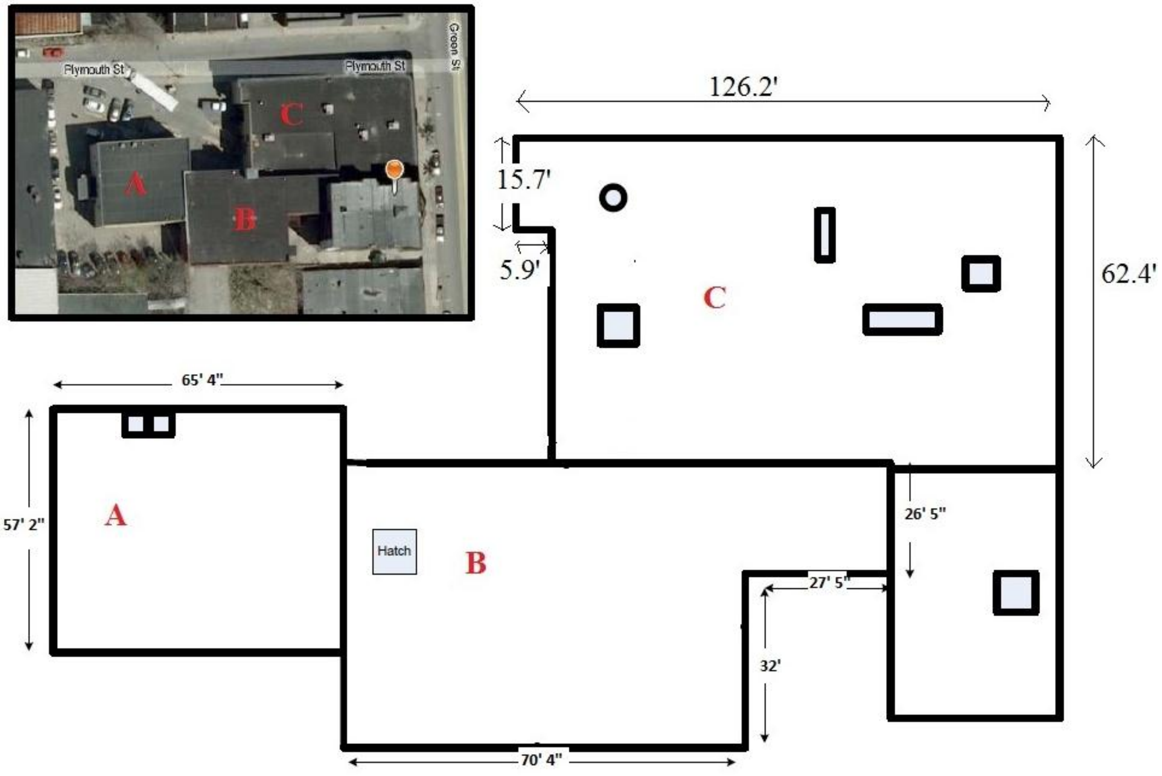


Figure 5: the APW Roofs

From the roofing inspection with John Aucella from Sturdy Home Improvement, we learned that current roofs usually have a life span of 50 years. Mr. Aucella made an assumption that the life for the current roof was about 30 years (John Aucella from Sturdy Home Improvement, 2010). Based on our research on the different flat roof materials, we learned that asphalt roofs have a life span of ten years, which means an asphalt roof will wear out after the ten year's capacity. APW is hoping to save money by reducing their energy costs; we will start to address the problem by suggesting options for the roof issue. There are two approaches to the roof issue, one is to fix the roof and the other option is to replace the roof. It is known that a roof repair will be much less expensive; however in the long run getting the roof replaced will be more cost effective and beneficial to the agency in the long run. Although the current leaking roof could be repaired, it is strongly recommended to replace the current roof, the reason being that the solar panels will last an average of 40 years. Through our research and discussion with contractors, the roof only has a few years until it reaches its life capacity.

2.5.5 Replacement vs. Repair of a roof

The previous student group proved that the damaged roof accounted for major heat loss at APW. A roof repair or replacement is strongly recommended in order to improve APW's building. While finding the most affordable roof for the building owner, price comparison and researching different types of roof is needed is a necessary step. Most of the time, consumers only care about the project's initial installation cost. However, that is not a sufficient price estimate. Future maintenance and replacement cost should also be considered if the property ownership lasted for a large amount of time. A report is presented at the RCI 21st International Convention. It introduced a new approach to roof life cycle analysis. The methodology used to calculate the roof life cycle cost for an entire roof replacement is:

$$LCC = IC + MC_{pv} + RC_{pv} \quad \text{(Hoff, 2006)}$$

The equation gives the information as follows: Life Cycle Cost is equivalent to the sum of Initial Cost, present value of the maintenance cost and present value of the replacement cost. If the roof is newly constructed, there will be less demand on the maintenance expense while the initial installation cost is going to be much higher than repair cost. Even though roof repair will be less expensive up front, more money will be put into maintenance due to the age of the roof. Age and functionality are inversely related, so as the age of roof increases the functionality decreases. Understanding a roof's life cycle cost will help us better determine an enhanced roof for APW. This will be the tool we use to find cheapest roof for APW while the quality of the roof will also be considered.

2.6 Green Roofs, Solar Power and Wind Generator

Technology updates are the most efficient way to save money and energy in the long run. Updating new technologies that provides more efficient energy is considered the intensive ways of going green. Installing a green roof, solar panels, and wind turbines are consider to be the most effective long term saving investments that helps APW produce energy, thus lowering the energy bill and save money.

2.6.1 Green Roofs

One of the long-term recommendations is installing a green roof in APW building. A green roof is a roof or building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. Figure 6 shows the different sub layers of green roofs.

Subsystems that are responsible for drainage, plant nourishment and support, as well as protection of underlying waterproofing system are required in a well-designed green roof in order to sustain damage due to erosion (Whole Building Design Guide, 2010). Several methods can achieve these functions. For example, the drainage may consist of plastic sheets, fabric mats, or granular mineral layer. The plants and media can vary with climate and plant community. Also, many waterproofing roof materials are compatible with green roof installations. These include but are not limited to PVC, TPO, EPDM, modified bituminous sheet membranes (e.g. SBS membrane), liquid-applied rubberized-asphalt, and coal tar pitch (Whole Building Design Guide, 2010).

There are two types of green roofs: extensive and intensive. Extensive green roofs are 6 inches or shallower, usually containing plant mosses or sedums. Intensive green roofs are between 8 inches and 16 feet, usually containing trees or shrubbery. Intensive green roofs can become quite deep and merge into more familiar on-structure plaza landscapes with promenades. Extensive green roofs can be established on roof slopes up to 33% while intensive green roofs can only be installed on roof slope up to 3%. The price for green roofs varies. However, extensive green roofs provide a dramatic cost reduction compare to intensive green roof. Commonly, the range for extensive costs between $14 - $25/sq.ft, the range for intensive costs about $25 -$40 and up. (Greenroofs101, 2010) The reason for the price difference is based on the material and technology used.

During our research, we found that there is only one green roof Installation Company in Massachusetts: Apex Green Roofs. We also found that there were no incentives in Massachusetts when installing green roofs.

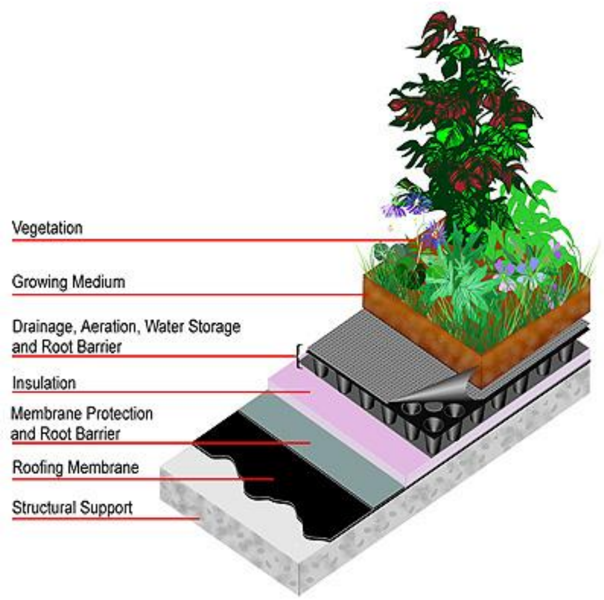


Figure 6: Green Roof (Photo Courtesy of fibreglasseal.co.uk)

2.6.2 Solar Power

Solar power is the conversion of sunlight into electricity either directly using photovoltaic (PV), or indirectly using concentrated solar power (CSP or solar thermal). The size of the PV system is generally determined by the roof size, budget, and what percentage of your electric bill you would like to offset (Sunlight Solar, 2010). Solar power will generate energy as long as solar panels receive sunlight. However, factors like weather conditions and shade caused by obstructions to direct sunlight, the angle and position at which the solar panels are installed could affect the overall output. Solar Panels perform at optimal peak performance when facing the sun directly. Solar panels will save a lot of energy in the long run thus lowering the energy bills (Nadel C. , 2010). Although installing solar panels is one of the most beneficial ways to help APW save money, the cost for installation is very high.

Type One: Solar Electric Systems

Solar electricity is also known as Photovoltaic or (PV) for short. PV systems can be mounted on a roof or on the ground. They can directly convert the sunlight to electricity for residential buildings or commercial facilities. How do solar electric systems work? First a series of photovoltaic cells are grouped together to create solar panels. Then a series of panels are linked together to create an array. Light from the sun strikes the PV panels and makes Direct Current (also known as DC) electricity. DC electricity is the same kind of electricity that batteries produce. Since the residential buildings and commercial facilities run off Alternating Current (AC) electricity, a system called an inverter is required to install in order to convert the DC electricity from the panels to the AC electricity in the residential buildings or commercial facilities. As a note here, the PV panels are usually installed on the roof while the inverter is usually installed in the garage or basement. It is better to install the inverter as close as possible to the circuit breaker panel. The electric panel distributes the electricity throughout the residential buildings or commercial facilities' wiring and outlets. The utility grid will allow the solar electric system owners to store excess electricity on it during the day and then draw upon the power in the evenings. In common, the grid is like a 100% efficient battery backup (Sunlight Solar, 2010). Figure 7 depicts the solar electric system process.

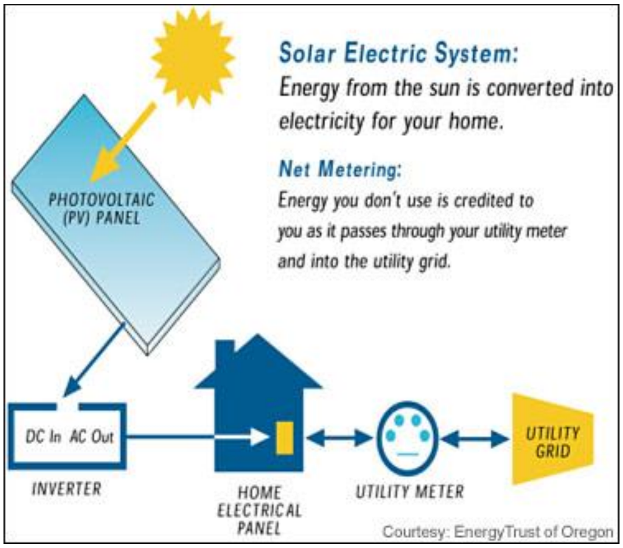


Figure 7: Solar Electric System (Photo Courtesy of Sunlightsolar.com)

Type Two: Solar Thermal Systems

Solar water heating has always been a very effective method to heat water for use of bathing, hand washing and home heating. The solar water heating system starts with a flat plate solar collector with coils of copper pipe inside them. Inside the collector, there is a liquid (typically a non-toxic, food grade propylene glycol) which are usually heated up by the copper pipe. With the newest collectors, the temperature of the liquid can reach up to 200 degrees. When the liquid is hot enough, it flows down to heat the water for the building through a heat exchanger. Since the liquid needs to transfer heat to the water, it needs to circulate back up to the collectors to heat up again. The good thing is that, the liquid never comes in contact with the hot water for the building. The heated water is not necessary used immediately, instead, it is kept in a large storage tank, and so the hot water you are using in the morning may have been solar heated from the previous day (Sunlight Solar, 2010). Figure 8 depicts the solar electric system process.

The initial investment of solar energy equipment can be expensive due to the expensive semiconductor materials used in the manufacturer of PV panels; however, installing solar energy equipment in Massachusetts will receive generous incentives from the government. For example, you might be able to get rebates, low-interest loans, state and federal tax credits to help lower the high investment cost (Trusty Guides, 2006).

Figure 8: Solar Thermal System (Photo Courtesy of Sun Wind LLC)

2.6.3 Wind Generators

Energy generated from wind is called wind power; is considered as another means of generating power. Energy produced from the wind is caused by moving air masses. One of the advantage wind power has over solar power is that energy will still be created during poor weather. Wind power works best in the fall, winter and spring, so a large amount of energy is generated within the year. However wind turbines are often disliked by the residents because they kill birds and generate significant noise for the neighbors. The average cost wind system is about $20,000, and will reduce the energy bill by 50 to 90 percent (Energy Grid Could Make Offshore Wind Power More Reliable, 2010). Wind turbines and microturbines are the most efficient tool to generated power throughout the year, but the fact that it creates very loud noise makes it not suitable for residential areas such as where APW is located.

2.6.4 Summary: Comparison of Green Roofs, Solar Power and Wind Power

Green roofs, solar power, and wind power are three types of green technologies that we thought could be potentially beneficial in helping APW lower the operating cost. However having all three of the technologies implemented at one location did not seem like a wise decision. So determining which one of the energy generators was most suitable for APW required a strong thought process. Green roofs reduce the usage of energy, but do not generate any energy. Wind turbines generate a significant amount of energy; however it would not be accessible in APW's location because it is in an urban area. Solar energy seemed to a better method compared to the other two since it can generate energy, and does not cause any inconvenience to the neighbors.

2.7 Massachusetts Commercial Solar Incentives

The Federal Government and the State of Massachusetts promotes the installation of solar panels through incentives such as tax credits, five year accelerated program, and SREC's. Below is a summary of commercial solar incentives.

2.7.1 Federal Incentives

Federal Business Energy Investment Tax Credit

On October 3, 2008, the President signed the Emergency Economic Stabilization Act of 2008 into Law. This legislation contains a number of tax incentives designed to encourage both individuals and businesses to make investments in solar energy, including 8-year extensions of the section 48 business solar investment tax credit (ITC) and the section 25D residential solar ITC.

For the Business Solar Investment Tax Credit (IR Cod 48), it is said that the bill extends the 30% ITC for solar energy property for eight years through December 31, 2016. The bill allows the ITC to be used to offset both regular and alternative minimum tax (AMT) and waives the public utility exception of current law (i.e., permits utilities to directly invest in solar facilities and claim the ITC. The five-year accelerated depreciation allowance for solar property is permanent and unaffected by passage of the eight-year extension of the solar ITC (Solar Flair, 2010).

Modified Accelerated Cost-Recovery System (MACRS)

Five Year Accelerated Depreciation

About: Under the federal Modified Accelerated Cost-Recovery System (MACRS), businesses may recover investments in solar power systems through depreciation deductions.

Value**:** The cost basis for deductions is calculated from the Turnkey Project Cost reduced by half the value of the Section 1603 Grant, explained above. This value, then, is the same as taking 85% of the Turnkey Project Cost.

Schedule:

Year 1: 20%

Year 2: 32%

Year 3: 19.2%

Year 4: 11.52%

Year 5: 11.52%

Year 6: 5.76%

Eligibility**:** Solar photovoltaic system must be owned by a for-profit corporation that pays taxes to the IRS.

Application Procedures**:** Deductions can be taken during your typical tax filing period.

Frequency**:** Every year for the first 6 years. If tax deductions cannot be used in these years due to a lack of taxable income, they can be rolled-over to subsequent years.

Program Details**:** See *IRS Publication 946, IRS Form 4562: Depreciation and Amortization*, and *Instructions for Form 4562* (Solar Flair, 2010).

2.7.2 State Incentives

Commonwealth Solar Rebate

The Commonwealth Solar Rebate is for grid-tied photovoltaic systems for customers participating with specific municipal lighting plant facilities and the following Massachusetts utility companies: Fitchburg Gas and Electric Light, National Grid, NSTAR Electric and Western Massachusetts Electric. The base incentive rebate is $1.00 per watt. There is a $.10 per watt adder if the system includes components from a Massachusetts company. The maximum rebate is $1.10 per watt. Only PV projects less than or equal to 10 kilowatts (kW) in capacity are eligible for this incentive, although the rebate amount will be based on the first 5 kW only (MassCEC - Commonwealth Solar II Rebates , 2010).

Commonwealth Solar Stimulus Rebate

The Commonwealth Solar Stimulus Rebate is for grid-tied photovoltaic systems over 10 kW and less than or equal to 200 kW at commercial, industrial, institutional, and public facilities. The rebate is offered only to those customers of Massachusetts investor-owned utilities and municipal lighting plant facilities. Rebates are based on a tiered system: $1.50 per watt for 1-25 kW, $1.00 per watt for 25-100 kW, $.50 per watt for 100-200 kW (Mass CEC, 2010).

Solar Renewable Energy Certificate (SREC)

An SREC is a tradable certificate that represents all the positive environmental attributes of electricity generated from a solar electric system. Each time a PV system generates 1,000 kilowatt hours (1 megawatt hour) of electricity, an SREC is issued which can then be sold or traded separately. In order to qualify for SRECs, projects must be in Massachusetts and must be grid-tied systems under 2 megawatts (DC) (Solar Flair, 2010).

2.8 Summary of Literature Review

As discussed in previous sections, stagnant funding has initiated the difficulties to supply APW's client services. Lowering monthly energy bills is one of the positive actions for APW not to turn away their clients. We learned that the damaged roof as well as the deficient HVAC systems produced the majority of the increase of the energy bills. Fixing the roof and renewing the HVAC systems are necessary. We are proposed to suggest ideas by starting to solve issues on the roof. However, having the roof fixed will only help alleviate the money issue in a short period of time. In order to continue their services in the long run, APW will need to save more money. To this point, installing green technologies in the building will be essential. The goal of our project is to provide recommendations for green improvements and funding sources to finance those improvements to APW.

Chapter 3: Methodology

The goal of the project was to provide recommendations to lower operating costs and find funding sources to finance those improvements for APW. The goal consisted of four objectives: 1) Explore roofing options to be able to replace or repair the damaged roof at APW 2) Identify methods that could be applied to APW to save money and research previous green case studies 3) Investigate funding options for construction of green technologies and 4) Provide recommendations based on the benefits for the landlord and APW. These four objectives were prioritized in the order of sequence of events. For each objective, we have established an organized plan that would enable us to develop recommendations relevant to APW's building context and other needs. We used both qualitative and quantitative research methods for acquiring the information we needed. In Objectives one, two and three we focused our research through archival information from Internet, participant observations and key informative interviews. We believed that those methods would enable us to gather in-depth information on roofing options and renewable technologies In objective four, we utilized statistical analysis such as cash flow diagrams to support our findings. Since objective four was the conclusion to the previous three objectives, it was important to provide our findings with numbers. Using both qualitative and quantitative research methods has enabled us to provide most convincible suggestions to the landlord and APW.

3.1 Objective One: Explored roofing options to replace or repair the damage roof

Exploring roofing options to replace or repair the damage roof at APW was the leading objective of our project. Last year's group proved that the majority of the heat loss was from the damage roof. This loss resulted in unnecessarily high operating costs. The ultimate project goal was to provide recommendations which will help to reduce operating costs; it is essential to reduce heating loss from the roof, and the most effective way to alleviate this issue is to have the roof fixed. To make sure the best recommendation was provided, we used resources such as internet and key informant interviews with roofing specialists. Exploring new roofing options this way was most suitable for our project because we need the most up-to-date information instead of archival information on roofing options.

Certain qualifications were needed in order to provide the best roofing option. We determined to look for roofing materials that have high thermal efficiency, low installation price, and low maintenance costs. To this point, we created a comparison chart with four commonly installed roofs based on our research through internet. New roof's installation price, maintenance price, durability, usability, and green technology applicability were examined closely, and then compared. By summarizing our discoveries, we found that an Ethylene Propylene Diene Monomer (EPDM) roof would cost the least, Metal roofs lasted the longest, and a Thermoplastic Polyolefin (TPO) roof would work best in order to support green technologies. We then discussed our opinions with the roofing specialists. With a combination of professionals' knowledge and our research, we provided APW with the best affordable roofing option.

In addition, interviewing contractors provided us personal perspectives on the different roofing options. In order to find the most trusted roofing specialist, we first researched roofing specialist in the New England area through web-base. "Service Magic" is a free consultant company that provided us a list of contractor's base on our need. Customer rating, community reviews, and company's reputation was considered when we identified roofing contractors for on-site visits. We then narrowed down the list to three of the most highly recommended roofing contractors. The roofing specialists that we chose included; Sturdy Home Improvement, M. J. & Son General Contracting, Kidd-Luukko Corporation. However, before meeting with the contractor we had prepared some questions in order to better understand the roof's current condition at the time and its future plan. During the visits the contractors, John Aucella from

Sturdy Home Improvement, Jayson Booth from M.J. & Sons General Contracting, and Robert Luukko from Kidd-Luukko corporation recommended roof replacement, and that a rubber roof was the most ideal for APW since it is lease expensive, and is suitable for New England weather (John Aucella from Sturdy Home Improvement, 2010), (Luukko, Roofing Inspection 11/11/2010, 2010), (Contracting, 2010). A final estimate report was prepared by contractors within two weeks. The report included total construction cost, labor, and working period. With the information provided by the professional, more materials could be relied in the process of recommending the best affordable roof for APW.

The roof replacement was prioritized first because it was the most appropriate method to initially reduce operating costs. In additional to roof replacement, we will continue explore more about green buildings and new technology. Both objectives were intended to provide long term savings for APW. Different from roof replacement, green building updates are a long term investment. The combination of the roof replacement and technology updates will sustain future client services. However, at this point, roof replacement should be accomplished first since it can immediately reduce energy costs of the building.

3.2 Objective Two: Exploring methods to reduce operating costs

Another objective of our project was to explore energy cost reduction programs for APW. Through the use of existing resources and key informant interviews, we supported and achieved our project goal. The proposed project was conducted with the database from the Internet, case studies, and professionals' interviews from valid organizations. These methods were the most appropriate for the project research because it directly lead to our project goal: to help APW reduce operating costs so as to support client services.

Green roofs, solar power and wind turbines were the three green technologies we believed would be suitable in Worcester area, however, we decided to devote time doing in-depth research on solar power companies because it is not feasible to install green roofs and wind turbines in the APW building (LePage, 2010). We have contacted three solar companies: Advanced Energy Systems Development, Solar Flair and Future Solar Systems LLC. We also found another solar estimate report from Sunlight Solar Energy in the previous report. Not all companies were able to come on a site visit, thus through the interactions with the companies, we provided the roof map and dimensions of the roofs to the solar companies. Once we received the estimate report from them, we compared their suggestions based on the costs, efficiency, balance in cost and efficiency (e.g. cost per wattage of the system they suggested), total energy output, and payback period. We learned how to analyze the solar power systems sin such an efficient way from one of the student report in the WPI eReport database. The report was conducted by Gabe Ayers and Nick Vranos. We realized from their study that a balance in the system cost and the efficiency was important, thus it was crucial to compare the costs per wattage in each system (unit: dollar per watt). To calculate the payback period of a system, we used the equation:

Payback period = initial investment / yearly profit (Ayers V. , 2010)

And the yearly profits were conducted in this way:

*Yearly profit = total energy * unit profit* (in our calculation, we used $0.50 according to the information provided by Advanced Energy Systems' report) (Ayers V. , 2010)

Also, to calculate the total energy, we used this equation:

*Total Energy = Worcester's sun hours (which is 4.5 hours) * 365 days * kilowatt of the solar system* (Ayers V. , 2010)

The solar power systems comparison results were generated the Findings and Discussion Chapter.

In addition, we conducted an interview with Professor Suzanne LePage from the Civil Engineering Department at Worcester Polytechnic Institute as an intension to learn more about green technologies. One outcome from the interview was that Professor LePage suggested us to research on fix-rate programs in Massachusetts. During the interview Professor LePage also gave the name of a different source, Massachusetts Clean Energy Center (MassCEC). The MassCEC is another archival information center to ask about tax credits offered in Massachusetts as well as funding option and professional non-biased advice.

Gathering information from the most up-to-date existing resources, data analysis, case studies, and interviews were considered the most appropriate methods for our project. The methods provided both theoretical and real life indication to support the project. With the energy efficient methods and techniques we have suggested to APW, not only will it save money for them to use for the client services but also increase the building value through the adoption of green technologies. APW has made it clear that money has been, and continues to be the biggest problem with facing the 15% growth in the clientele. Our methods will help APW solve this problem by identifying the best energy cost saving procedure.

3.3 Objective Three: Investigate funding options for construction of green technologies

With a minimal budget, finding funding options are extremely important to APW. Providing funding options for APW and their landlord was an important objective for our project, which made our recommendations seem more feasible. The United States Government has agencies in place which provide funding for the installation of green technologies. Tax credits are also available for building owners. By providing APW and their landlord with funding options was a key objective in providing our project recommendations.

The exploration of funding options by the United States Government proved important to the completion of our project. Since APW does not own their building, this presented us with different ways to apply for grants for green installation. Since APW is a non-profit organization not every grant was applicable but, with the landlords help other incentives such as; tax credits can be applied for to offset the cost of installation. In order to understand what incentives where currently out there, who could apply to which ones, how much they were for, and what technology they applied too.

We focused our funding research on Federal incentives as well as Massachusetts State incentives. In addition, we conducted interview with key informants such as solar companies that we have contacted with solar estimates (e.g. Advanced Energy Systems) and government agency (e.g. Mass CEC).

Providing the funding options for going green that we did was important to this project. By going green APW would be able to lower operating costs by saving money on energy bills. Last year's group found that most energy is lost through their roof. With the installation of a new roof, heating costs would decrease due to a higher thermal efficiency. The funding options provided can turn this project into a reality.

3.4 Objective Four: Provide recommendations based on the benefits for the landlord and APW

The fourth objective of our project was to provide recommendations based on the benefits for the landlord and APW. This objective was completed using amortization charts and a combination matrix for the recommendations. This step was the conclusion of our project and it linked tightly to our project goal – to provide recommendations to lower operating costs and find funding sources to finance those improvements for APW. The purpose of this objective was to allow the landlord and APW to see different solutions that could apply to their current building issue. In this objective, we provided three recommendations based on the benefits to: 1) Exclusively for the landlord (private building owner), 2) Exclusively for APW (the tenant), and 3) Both the landlord as well as APW.

We understand that the investment of this project would be very large, thus the recommendations were based on long-term benefits for the landlord, APW, or the combination of the both. The criteria of the cost-benefit evaluations included the material selection recommendation for the replacement of the conventional roof and the green technology recommendation that is compatible with the roof material.

The recommendations made exclusively to the private building owner were based on the increase in property value after installation and the return on investment. First, we contacted realtors/appraisers for the property assessment. The reason we did this because contacting them was the only way to get a good estimate of the property value before and after the building update. Second, we communicated with the National Association of Realtors (NAR) for information how green technology installation affects the property value. Third, we calculated the landlord’s return-on-investment (ROI) by assuming that he was going to adopt the green technologies in his building. We realized that the return on investment could differ from increased property value to monthly savings on utility bills. Thus contacting the NAR was the best idea because they set the standards for all realtors to follow. Fourth, we researched the most up-to-date Renewable Energy Legislation for information on green technology installations vs. tax cuts. The increase of property value, return-on-investment (ROI) and tax cuts enabled us to provide incentives and recommendations. For a private owner that was not able to access the technology updates, it was important to provide him with this information. Not only did he need to see how much it would cost him to install green technologies, but he also need to know how long it would take for him to profit from his investment

The recommendation exclusively to the tenant was based on long-term savings on operating costs. With the assistance of the Internet, we conducted the saving assessment to show

how much money APW would save and how long it would take to make a return on profit. In this case, if the landlord and the tenant decided to adopt one of the recommendations, they would have to develop a long-term lease as a tool to recover the investment on this project.

The last recommendation would provide equal attention to both the landlord and the tenant. However, the drawback was that, if the landlord and the tenant decided to adopt this recommendation, they would receive fewer benefits compare to the recommendation targeted exclusively on either of them.

3.5 Summary of Methodology

These four objectives were an important part of our project because they provided us the ways APW could save money and increase clientele while we provided him with incentives for implementing green technologies. Our group was able to suggest similar but not congruent methods to gather evidence/data that proved critical for the completion of our project. Qualitative and quantitative methods such as; the Internet, public organizations, participant observations, key informant interviews, comparison tables, and cash flow diagram where commonly used during our project. It was the most suitable that we provided our findings with both qualitative and quantitative methods. By applying these methods we were able to present well-built facts and figures which support the implementation of efficient and green technologies, which will result in the reduction of operating costs and an increase of building value.

Chapter 4: Findings and Discussion

This section presents and discusses our findings through our investigation in the methodology section. This Chapter consists of three sections: 1) Potential Roofing Replacement Options, 2) Potential Green Technologies and Energy Cost Reduction Programs and 3) Recommendations for APW/Landlord. Section 4.1 is the findings for objective one in our project, which will provide potential roof replacement options. Section 4.2 is the findings for objective two of our project. In this section we will compare different photovoltaic (PV) systems and their prices. Nerveless, Section 4.3 is to provide combination of recommendations for APW, landlord and both. This combination includes the best roofing option and the optimal choice for PV system.

4.1 Potential Roofing Replacement Options

This section discusses findings for objective one of our project, which was to explore roofing options that could either replace or repair the current damaged roof of the APW building. In the Literature Review Chapter, we have discussed that a roof consists of structural supporting (e.g. timers) and outer weatherproof membranes. In between the supporting structure and the membrane, there are decks, vapor control layers and insulations (Lee Wallender, 2010). During our investigation, we realized that the entire outer roofing membrane needs to be torn off and replaced. We will recommend the most suitable roofing membrane by looking at the comprehensive advantages of the three types of membranes. In conclusion, we have compared the physical and mechanical characteristics as well as the price among EPDM, PVC and TPO roofs. Of course, one of the most important factors in a roof's life expectancy is the quality of workmanship. If the roof is not properly installed, then its lifespan will be shortened (RoofHelp, 2009). This section divides into two parts: the first part is to compare the prices and properties of the different types of roof membranes; the second part is to discuss the final roofing option in different perspectives.

4.1.1 Single-ply roof verse multiply roof

As Figure 9 shows today’s conventional low-sloped commercial roofing market distribution. From Figure 9 we can see that Build-up and Modified bitumen roof membrane share 42% of the commercial roofing market. However, we eliminated Build-up and Modified bitumen roof membranes and determined to perform an in-depth research on single-ply roofing membranes (e.g. EPDM, PVC and TPO). Single-ply roof was chosen due to their relative ease of installation and competitive price as well as energy efficient feature. Generally, contractors will find it easier, and more efficient to work with, because contractors don’t need to heat up the bitumen. (Buildings, 2005). Installation of singly-ply membrane is often faster which results in lower labor cost. Most contractors would recommend a single-ply roof today.

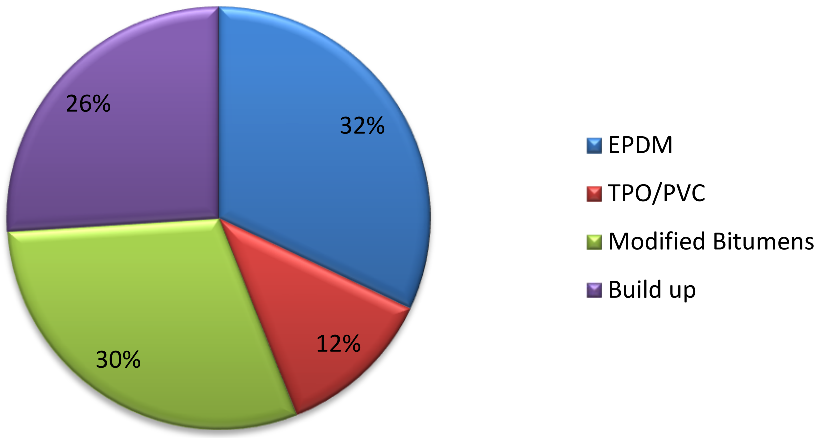


Figure 9: Today's Conventional Low-Sloped Commercial Roofing Market Distribution (Photo Courtesy of Wieru et.al)

4.1.2 Single-ply roof

We have decided our best roof recommendation will be among the three types of single-ply roofs. The three types of single-ply roofing share a lot of similarities. They are designed to meet the requirements as including weather resistance, external fire resistance, internal fire resistance, wind uplift resistance, thermal performance and water vapor transmission. However they each have their own distinctions. EPDM is an example of thermoset single-ply roof. EPDM is favored by people due to their low installation cost and ease of installation. It is relatively easy to find contractors who have had experience working with EPDM, and it is one of the most reliable roofing materials for over 50 years. Contractors from M.J. Son and Study Home Improvement recommended EPDM roof in favor of its low initial price. M.J. Son's final bid was $67,000, where Sturdy Home's final bid was $113,400. There is huge difference among the two companies because M.J. Son did their calculation excluding the tear off cost. If we compare this final price

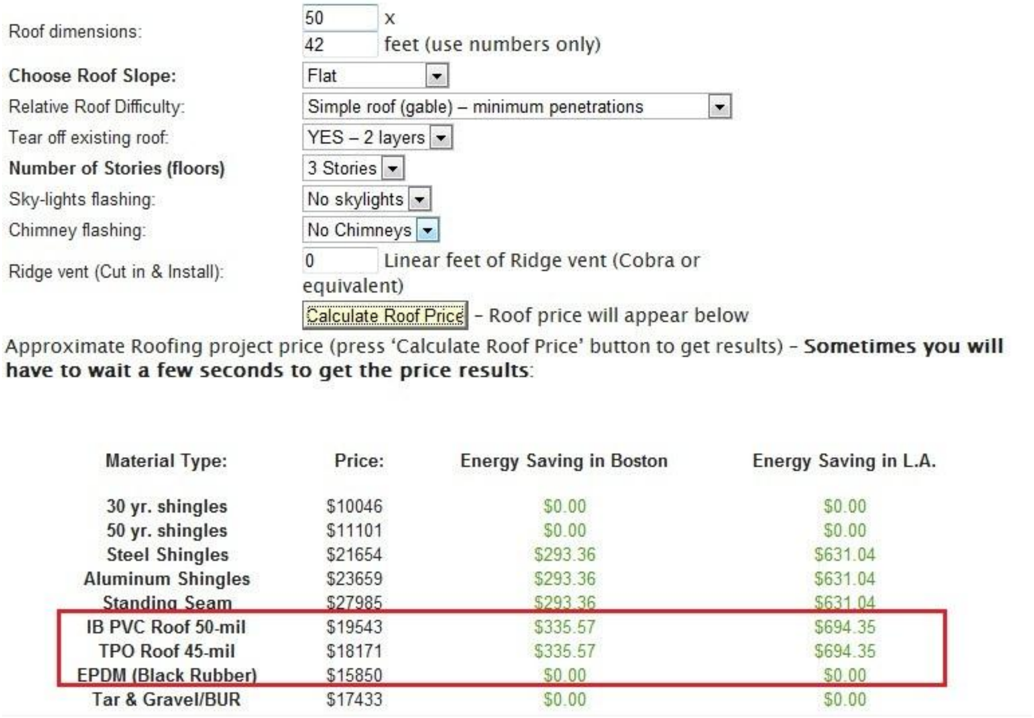
PVC and TPO both rank number one for their lowest maintenance cost and energy saving feature "White PVC roofing systems not only reflect sunlight and solar energy to save building owners up to 40 percent in annual electricity costs. PVC roof is free of maintenance due to its resistance to water and dirt. PVC is resistant to many external damages; however, it disposes high toxicity while being manufactured and is not recyclable. Heavy rain and snow will damage the PVC roofing membrane, so they are in less demand in the areas with very long winters. (PVC Roofing Systems: Benefit & Issues, 2010) TPO membrane also had high levels of reflectivity. (Level of reflectivity) This allows TPO membrane to meet the U.S. Environmental Protection Agency's ENERGY STAR performance levels. Furthermore, the overall reflectivity will help reduce energy use. However, since TPO roof membrane is still in the experimental stage, it is not greatly recommended.it is sometimes difficult to find a roofing contractor with good experience installing TPO roof membrane.

EPDM, PVC and TPO are the three most common roof membranes used in United States. It is complicated to make a selection among those three, since each type of roof membrane had their pros and cons. Time wise; EPDM had very long existence in the industry and has lowest initial cost. However, because PVC and TPO have high levels of reflectivity, more money will be saved for cooling services. Environmentally speaking, PVC is not recommended due to the fact that it is hazardous during the manufacturing process. Choosing among the three roof membranes is dependent on the buyer's perspective of views. Knowing the characteristic of each type of roof is not enough, price comparison is more important to consumers.

4.1.4 Price comparison

Price comparison is a major step when shopping for the best product. Professional online roofing calculation tool ((Roofing Calculator - Free Tool Helps You Estimate Roof Installation Prices & Roofing Materials Cost., 2010) and contractors' estimates are the major sources for figuring out prices for different types of roof membranes. It is important to shop around more than one compnay, because the best deal will be given to those who shop at the most companies.

Prices based on various potential materials were automatically generated from online roofing price calculator by inputting the following information: roof dimensions, roof slope, relative roof difficulty (simple, minimum penetrations), tear off existing roof (yes, two layers), number of stories (three stories), skylight flashing (no skylights), chimney flashing (no chimney) and ridge vent (zero) (Green Building Directory, 2010). An exemption of the form has been shown in Figure 8.The prices generated include costs of materials, roof tear-off and disposal, labor, company overhead and profit. Using this calculator, we can figure out what we can expect to pay a reputable roofing contractor for replacing the APW roofs (Green Building Directory, 2010). Prices on the website are updated regularly; the latest price update was on November 10, 2010. Figure 10 shows the roofing estimate costs in Boston, MA.



Roof dimensions: 50 x 42 feet (use numbers only)

Choose Roof Slope: Flat

Relative Roof Difficulty: Simple roof (gable) – minimum penetrations

Tear off existing roof: YES – 2 layers

Number of Stories (floors) 3 Stories

Sky-lights flashing: No skylights

Chimney flashing: No Chimneys

Ridge vent (Cut in & Install): 0 Linear feet of Ridge vent (Cobra or equivalent)

– Roof price will appear below

Approximate Roofing project price (press 'Calculate Roof Price' button to get results) - **Sometimes you will have to wait a few seconds to get the price results**:

Material Type:	Price:	Energy Saving in Boston	Energy Saving in L.A.
30 yr. shingles	$10046	$0.00	$0.00
50 yr. shingles	$11101	$0.00	$0.00
Steel Shingles	$21654	$293.36	$631.04
Aluminum Shingles	$23659	$293.36	$631.04
Standing Seam	$27985	$293.36	$631.04
IB PVC Roof 50-mil	$19543	$335.57	$694.35
TPO Roof 45-mil	$18171	$335.57	$694.35
EPDM (Black Rubber)	$15850	$0.00	$0.00
Tar & Gravel/BUR	$17433	$0.00	$0.00

Figure 10: Online Roofing Calculator Contents

Average Cost for APW roofs according to MA single-ply membranes price								
	A	B1 (big)	B2 (small)	B=B1-B2	C1	C2	C=C1-C2	Total COST=A+B+C
EPDM black	$26,114	$38,257	$6,642	$31,615	$50,041	$2,480	$47,561	$105,290
PVC (IB roofs 50mil)	$32,694	$48,329	$8,190	$40,139	$63,891	$2,964	$60,927	$133,760
TPO 45mil	$30,250	$44,588	$7,615	$36,973	$58,746	$2,784	$55,962	$123,185
Asphalt	$28,934	$42,573	$7,305	$35,268	$55,976	$2,688	$53,288	$117,490

Figure 11: Average Replacement Cost for APW Roofs

Figure 11 showed the average replacement costs of APW roofs using EPDM, PVC and TPO materials. EPDM is the least expensive single-ply membrane material among the three, the average unit price for roof replacement using EPDM is $ 6.55 / sq. ft; the average unit price for the replacement using PVC is $8.31 / sq.ft. Also, the average unit price for the replacement using TPO is $7.68/ sq.ft. The unit price appeared much higher compared to the unit price listed in the Literature Review. The reason to the high unit prices is because they have added the average cost of roof tear-off and disposal. According to the roofing website tool (Roofing Calculator - Free Tool Helps You Estimate Roof Installation Prices & Roofing Materials Cost., 2010), while somewhere in Alabama, it costs about $20 to dump 1 ton (2000 pounds) of old roofing materials, in Massachusetts and Connecticut, the disposal fees are $90 per ton. Therefore we have to look to pay about $30-50 more per square of tear-off in New England (Green Building Directory, 2010).

As you may have noticed in Figure 8, the results generated from online roofing price calculator also showed there would be energy costs savings if using Steel Shingles, Aluminum Shingles, Standard Seam, IB PVC Roofs and TPO roofs. As we learned from the figure, PVC

Roofs and TPO Roofs would be saving the most among the various roofing options provided by the free roofing calculator. However, we also learned from Figure 8 that EPDM would not result in any energy savings. The reason to the difference in energy savings is because they are "cool" roofing.

Table 5 Summary Comparison Table of EPDM, PVC and TPO Roofs

	EPDM	**PVC**	**TPO**
Years of existence in the market	40+ years	40+ years	~ 15 years
Durability	Least Durable among the three	Good	Have not found any problems
Costs	Lowest among the three	Highest among the three	In the middle
Common Color in the market	Black (not a cool roof)	White (cool roof)	White (cool roof)

4.1.5 Summary of Single-ply Roofing Materials

According to Table 2, EPDM, PVC, and TPO all have their advantages and disadvantages. TPO seems to be a good decision if the years of existence in the market are overlooked. Since it has not existed in the market for a very long time, we cannot make a conclusion whether it is better than EPDM or PVC roofs. EPDM is the most popular single-ply roofs used in commercial buildings in the United States. From the summary results shown in Table 2, EPDM roofs do not have the energy saving feature like PVC and TPO roofs, however EPDM membranes do have a lower market price, thus we will recommend it to the landlord. Because PVC and TPO roofs are members of cool roof that can lower the energy usage by reflecting sunlight, they both can be recommended to APW. However, we believe TPO will be more ideal for the APW as compare to PVC because PVC released toxic chemical called dioxin during the production process, which can be blame for hurting people's health. APW is here to save people's life, we will minimize any possibility that our choice will ended up hurting others. Another reason TPO roof is choosing over the PVC the ease of maintenance. It is almost impossible to repair the PVC roof once any puncture is found, so replacing the whole roof is the only choice once any incident happens. Even though the long term warranty will cover any damages before the warranty end, a PVC roof is still not a good choice if APW is going to have a PV system implemented on the roof.

4.2 Potential Green Technologies and Energy Cost Reduction Plans

With APW's roof having only a few years left, the roof does need to be re-finished before green technologies could be installed. With the roof section completed, the focus of this section will be on green technologies and other energy cost reduction plans. First the potential green technologies will be addressed, then the energy estimates from the energy contractors, and finally we will conclude this section with a separate energy cost reduction plan.

4.2.1 Solar Estimates

To make the best green technology suggestions for AIDS Project Worcester several companies had been contacted. Those companies evaluated different green options to be installed onto APW. The five companies were: Advanced Energy Systems Development, SolarFlair Energy Inc., and Sunlight Solar. The five different companies all brought imperative information for this project. With the help of these different companies our project is now closer to finding an energy reducing solution for AIDS Project Worcester. Before evaluating the PV systems suggested by the solar companies, we have conducted a preliminary calculation on the feasible area and size of the APW roof to install PV systems. The calculations enabled us to decide whether the suggestion by the solar companies should be adopted or not.

4.2.1.1 Preliminary Calculations

Feasible Site and Area

In order to provide the best recommendation on the solar power systems, we first determined the best roofing site out of roof components A, B, C according to Figure 12 as well as the optimal area size. We decided to set roof component B as our target PV system installing area because it will balance the load of the roofs. Roof component C was eliminated preliminarily because a solar array system would not be installed in an area if it was clear. Roof component A was not feasible because the system will result in shear loading on the roof. The remaining roof, roof component B would be the most feasible area to have the PV systems installed. In roof component B, there is a hatch 2 feet away from the far left edge of the roof and the size of the hatch was 4’ * 5’, thus the maximum area for a PV system would be less than 4000 ft^2.

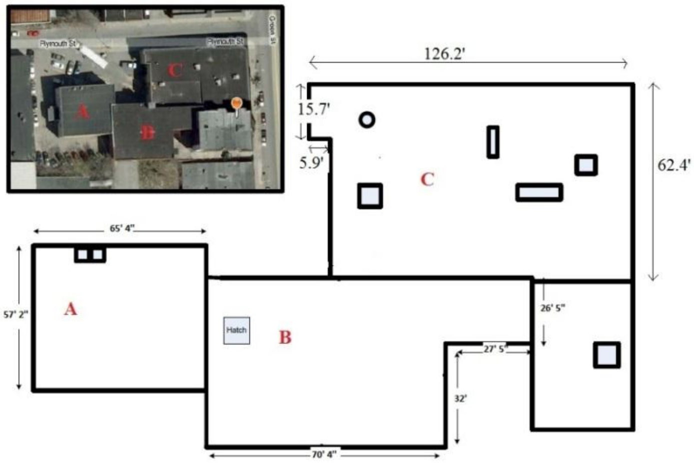


Figure 12: APW Roof

We also conducted a PV system estimate for the roof. Table 6 lists system sizes from 10kW to 80kW that could be applicable to APW. An average panel size is 250W. By dividing the panel size from the system size, we received the number of solar panels for the associate system (Ayers & Vranos, Kilby Gardner Hammond Renewable Energy Case Study, 2010). In Table 6, we assumed that each panel has an area size of 15.7 ft^2, thus we received the area covered from the system by multiplying the number of panels and panel area. The expected energy output is a product of the total size of the system and the expected amount of sun. In this area of Massachusetts, the average number of Sun Hours per day is 4.5. An example solar size of 10kW would have the following expected output per year (unit: kWh)

$Total\ Energy = 4.5\ Sun\ Hours * 365\ days * 10kW = 1368.75kW$ (Ayers & Vranos, Kilby Gardner Hammond Renewable Energy Case Study, 2010)

Equation 1 Total Energy Produced in the PV system

As the average electricity usage per month in APW is 11,200kWh, the energy bill covered would be the rate of the System Energy Generated/ Electricity Usage. As discussed previous, the maximum PV system size would cover no more than 4000 ft^2, thus a 60kW system would maximize the area of the roof, also, about 73% of the energy bill will be covered with the 60kW system.

Table 6 Different PV Systems and their Total Energy Production

System Size (kW)	Energy Bill covered	System Energy Generated (kWh/month)	System Area (ft^2)	Total Costs (Before Incentives)	Total Costs: After Incentives	APW's Payback Period (Years)	Comments
10	12.22%	1368.75	628	$91,496.76	$21,733.61	7.4	Landlord
20	24.44%	2737.5	1256	$138,735	$33,410.35	5.7	
30	36.66%	4106.25	1884	$189,946	$46,483.62	5.3	
35	42.77%	4790.625	2512	$212,062	$51,793.58	5.0	Compromised
40	48.88%	5475	2512	$242,432	$60,004.85	5.1	
50	61.10%	6843.75	3140	$285,192.3	$70,107.59	4.8	
60	73.33%	8212.5	3768	$341,612.8	$85,011.90	4.8	APW
70	85.55%	9581.25	4396				Too Big
80	97.77%	10950	5024				Too Big

Costs and Payback Period

The total price and incentives for the feasible system sizes (10kW-60kW) were calculated with a 250 W panels system that has $3.47 per watt peak (SolarBuzz, 2010). According to Table 6, the total price and incentives increase along with the increase of the system size. The total cost after the incentives were about 60% of the costs before incentives. From Table 6, we see that the percentage of savings from incentives decreased subtly as the system size increases: for a 10kW system, the percentage of savings from incentives can be as high as 41.4%; when the system size reaches 60kW, the percentage of savings from incentives decreased to 40.26% despite the monetary figure of incentives that are much higher than those of the 10kW system. Nonetheless, the 35kW system provided a 40.73% increase of saving from incentives, which was a slight jump compared to 30kW and 40kW systems. As for the PV system recommendations, a 10kW system would be suggested to the building owner due to the least expensive investment costs; a 60kW system would be suggested to APW exclusively because of the highest amount of energy savings in long-term; for a system that provides equal benefits to the building owner and APW, a 35kW system would be the leading choice.

4.2.1.2 Solar Estimates from Solar Companies

During our investigation, we have contacted three solar energy companies: Advanced Energy Systems Development, Solar Flair, Sunlight Solar, Sun Wind and Future Solar Systems LLC. Of the five companies we contacted, we have received price estimates reports from two companies, one was from Advanced Energy Systems Development, and the other was from Sunlight Solar (which was already an existent report from Feb 24, 2010). This section is to evaluate the products recommended by the potential companies. Final recommendations will be based on balance in cost and efficiency, total energy output and length of payback period.

PV Systems and hot water systems were suggested by the companies so far. It is important to decide which of the two systems would be more feasible for APW. Sunlight Solar suggested two PV Systems solar energy options while Advanced Energy Systems Development provided one PV system and one hot water heater system. As we discussed in the literature review, the majority of energy usages in the APW building are from electricity (including the hot water generated in the building). If APW decided to install a hot water heater system, it would not help the building reduce energy costs as much as directly from a PV system because APW does not invest much spending on hot water usage, thus it would not be a feasible option for APW to install a hot water generated system. Thus, we decided to narrow down the solar power system options to PV systems.

Cost vs. Efficiency

The total size of PV systems directly influences the energy bill savings. The solar companies suggested various system sizes: Sunlight Solar suggested two 13kW PV systems from two different brands (Sunpower and Evergreen), while Advanced Energy Systems suggested a 31kW PV system from Schuco. With the calculations from Equation 1, we figured that the estimated percentages of electric savings provided by the systems were: 12%, 12%, and 35% respectively. From Table 7 you can see the larger the system size, a higher percentage of the energy bill will be covered by the system.

Table 7 Percentage of Energy Coverage from the PV Systems suggested by Solar Companies

	Sunlight Solar 1	Sunlight Solar 2	Advanced Energy Systems
System Size	13kW	13kW	31kW
Energy Bill Covered (%)	12.00%	12.00%	35.00%

A balance in cost and efficiency is important when we have different systems with various solar panel numbers. Of the three PV systems, Sunlight Solar suggested installing two 12kW PV systems: one has 42 panels (315W per panel); the other has 65 panels (210W per panel). On the other hand, Advanced Energy Systems Development suggested installing 156 panels with unit panel efficiency of 200W. To break down the numbers, we have performed a cost-efficiency analysis of the different systems. The direct cost provided in the report by Advanced System Energy would not be a good representation for the cost-efficiency analysis of the system. The most important number in regards to cost is the unit price per wattage. The lower the cost per wattage, the higher power output that can be generated by the same initial investment (Ayers & Vranos, Kilby Gardner Hammond Renewable Energy Case Study, 2010). Table 8 shows the unit price per wattage of the systems suggested by the solar companies. According to Solarbuzz, PV systems that have 125 Watts or higher, the average retail price for per Watt Peak in December 2010 is $3.47 (SolarBuzz, 2010). As seen in Table 8, the unit price per wattage suggested by the solar companies we contacted was lower than the average retail price in the United States. However, after we compared the unit price per wattage, we realized that the second system suggested by Sunlight Solar had the lowest unit price per wattage, which was $2.38 per wattage.

Table 8 Cost vs. Efficiency Comparison Table for the PV Systems suggested by Solar Companies

	Sunlight Solar 1	Sunlight Solar 2	Advanced Energy Systems
panel efficiency (W)	315	210	200
Price per Panel ($)	$1,000	$500	$542
Unit price per W ($/W)	$3.17	$2.38	$2.71

Payback Period

Learning about a payback period is very important to a building owner thinking about an investment like PV system installation. As discussed in the methodology section, the payback period was calculated by dividing the initial investment by the yearly profit from the system (Ayers & Vranos, Kilby Gardner Hammond Renewable Energy Case Study, 2010). Our group has performed a payback analysis on the suggested systems. Figure 13 and 14 clearly show that Advanced Energy Systems suggested a system that has a very high initial investment cost; however, grouped with the higher efficiency of the system compared to the other systems, the payback period resulted to be the shortest among the three systems suggested so far.

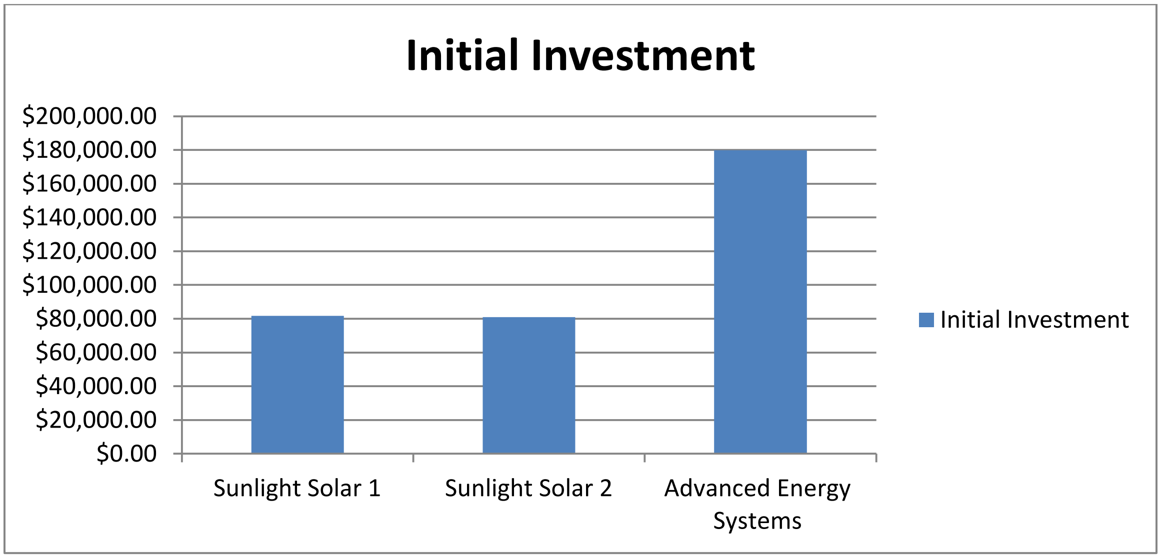


Figure 13: Initial Investment Cost for PV Systems suggested by Solar Companies

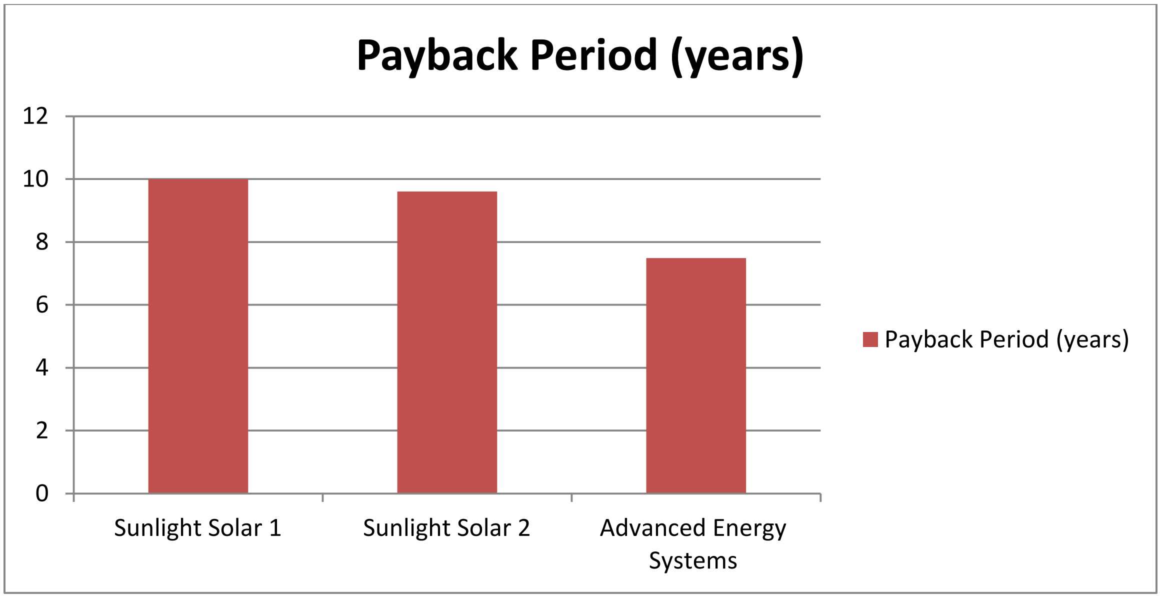


Figure 14: Payback Period of the PV Systems Suggested by the Solar Companies

From the data shown above, Sunlight Solar provided us very competitive direct costs on their systems; the initial investment prices suggested by Sunlight Solar was about half of that suggested by Advanced Energy Systems Development. Another advantage provided by Sunlight Solar was that the number of solar panels would be much fewer than that suggested in the Advanced Energy Systems Development report. The three systems are all eligible for a 30% federal tax credit, accelerated five year depreciation, a Massachusetts business tax deduction and Mass ECE rebates. However, if we were not looking at these incentives but looked at the payback period for the initial investment, we would realize that the payback period for the system suggested by Advanced Energy Systems Development would be shorter than the other two systems suggested by Sunlight Solar.

4.2.1.3 Summary of Solar Power Systems

As we discussed at the beginning of this section, we have provided recommendations on PV system, based on the balance of cost and efficiency, total energy output and length of payback period. However, one drawback of the systems suggested by the solar companies was that, the efficiencies of the systems were much lower than our estimated system, which was 60kW. In order to provide the most reliable recommendation on the PV systems, our group decided to provide solar recommendations based on the system size instead of the companies we contacted. However, after talking to different PV companies, we suggest the building owner to contact the following solar companies: Future Solar Systems LLC, Solar Flair LLC and Sunlight Solar Energy. We recommended these companies because they provide affordable recommendations with simplified power purchase agreement.

4.2.2 Alternative Energy Plan for APW

An alternative plan which can provide immediate saving on APW's electric bill is by signing up for a fixed-rate price program. A fixed-rate price program is another electric supplier that buys the electricity from National Grid and sells it back to their customer at a fixed rate which could be cheaper or more expensive than purchasing direct from National Grid. Some suppliers require a contract which you agree to lock in at a set price per kWh, while others are month to month and price can fluctuate depending on the current market.

There are many different suppliers that provide service in Worcester, MA and are able to serve APW. The server provider we felt that would be best for APW was Glacial Energy of New England, Inc. The reason we had decided to go with them was because in the proposal it was estimated AIDS Project Worcester would be able to save approximately $1,127 annually while receiving an additional $150 annually from the Glacial Energy Cares Program. The Glacial Energy Cares program is a program that was designed to "…drive down electrical costs for businesses and organizations, empowering them to free up valuable funds for growth and development" (We Care). As this does not seem like a huge return annually it is still $150 that APW did not have before this program. Currently AIDS Project Worcester pays $0.08102 per kWh from National Grid directly. By switching their provider to Glacial Energy the estimated rate per kWh would be $0.0798. That is a $0.00122 savings which adds up to the $1,127 savings annually. Glacial Energy seemed to be the most appropriate energy supplier to switch too in order to show an immediate savings which will reduce operating costs.

By switching from National Grid to Glacial Energy as energy suppliers APW will see an immediate savings in their energy bill without signing into any type of contract. This instant savings requires no high upfront cost or other expenses so it seems most feasible for APW in order to reduce operating costs. (Bekar, 2010)

4.3 Recommendations for APW/landlord

Recommendations were made based on the benefits to: 1) exclusive to the building owner 2) exclusive to APW and 3) compromise that benefits both parties. These recommendations were given based on the following guidelines: 1) for the recommendations that are exclusive to the building owner, we will look primarily into the initial investment costs, while still paying attention into the Return on Investment (ROI), 2) for the recommendations that are exclusive to the agency, we looked into maximum initial- and long-term savings for the agency; 3) for the recommendation given equally to the agency and the landlord, we wanted to provide APW with a high energy savings while also providing the landlord with a moderately low upfront cost.

Any decision comes with advantages and disadvantages. In the case of installing solar panels, the landlord would receive incentives which are only applied to the property owner. Nonetheless, he would be the person who needed to initially pay for the investment. Despite this, APW would receive great energy savings in the long run. In order to pay back the investment made by the building owner, the agency would have to increase their rent or make an additional payment for a period of time. A possible way to pay back the landlord from the upfront cost would be to increase APW's for a few months and the landlord could charge a rate of interest. According to APW's accountant Christine Baril, the approximate loan interest rate is 3.5%. So an interest rate of 3.5% will be applied to the final cost of PV system installation after tax incentive, so that the cost is equally shared among the two parties. To this point, both the building owner and the agency would have to create an extended long-term lease agreement.

4.3.1 Building Owner Recommendations

To provide the building owner with an exclusive recommendation, we will look primarily into the initial costs, while still paying attention into the Return on Investment (ROI), increase in property values as well as tax incentives. Roofs and solar panels with the minimum initial cost will be recommended since the landlord is the one responsible for paying the upfront cost. Table 9 presents the first recommendation combination for the benefit of the landlord.

Table 9 the Optimal Roofing and PV System Recommendations to the Landlord

	Recommendations	Initial Investment Costs	Costs after Incentives	Payback Period before tax incentive	Payback Period after tax incentive	Monthly Energy Costs Saving
Roofing Option	EPDM	$105,290	None	None	None	None
PV system	10 kW system	$91, 496.	$21,733.6	31.2 years	7.4 years	$244.4

Implementing an EPDM roof and a 10 kW PV system will cost the landlord a total of $196,786. However, this is the total cost before any of the tax incentive reductions. The landlord will save $69,762.4 after the PV systems' tax incentives, which will then shorten the payback period by roughly 24 years. Using a 10kW PV system APW will only save $244 per month in the energy bill, thus the payback period remains as high as seven and half years. In order to guarantee both parties equally share the cost, we recommended APW to make their payments by including the current interest rate 3.5%. By applying this interest, the true payback period is found. Following is an Amortization chart base on 3.5% interest rate.

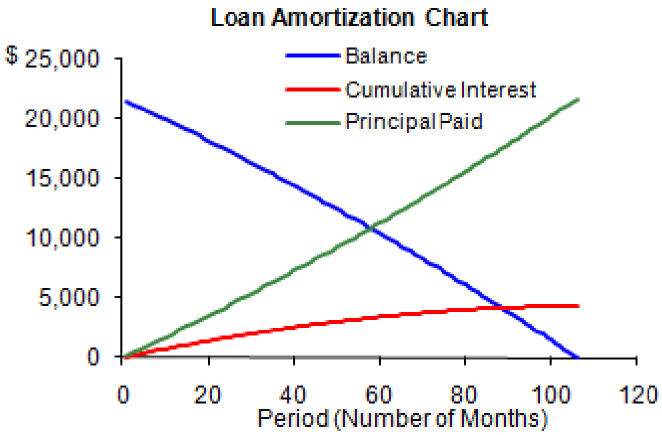


Figure 15: Loan Amortization Chart for a 10kW PV System

Figure 15 shows that with the 3.5% interest rate included, it will require approximately 9 years for APW to pay back the principal value after the tax incentives. By applying the interest rate, the payback period increases two years. Since this 10 kW system only produce 12% of energy as needed, and it requires a long term payback period, a better system will be recommended for the benefit of APW.

4.3.2 APW Recommendations

For the recommendations that are solely for the agency, we looked into long-term savings for the agency. Roofs with the most UV reflectance and PV systems with the most energy productions will be recommended to APW. Table 10 is presenting a specific combination for the benefit of APW.

Table 10 the Optimal Roofing and PV System Recommendations to APW

	Recommendations	Initial Investment Costs	Costs after Incentives/tax reductions	Payback Period before tax incentive	Payback Period after tax incentive	Monthly Energy Costs Saving
Roofing Option	TPO	$123,185	None	None	None	$694.35
PV system	60 kW System	$341,612.8	$85,011.90	19.4 years	4.83 years	$1466.5

A TPO roof plus a 60 kW PV system is the best recommendation for APW. This combination will cost a total $464,797. However, $ 256,600 could be saved after the tax incentives; this also reduces the payback period by approximately 15 years. An average of $1,466 will be saved every month after the initial cost is paid back in full. This is will cover about 73% of APW's energy cost. However, this recommendation may not be beneficial for the landlord due to its high initial cost. Following is an Amortization chart base on 3.5% interest rate for a 60kW PV system.

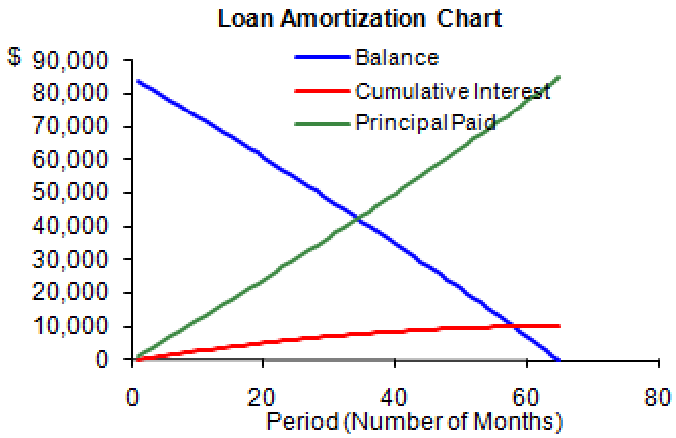


Figure 16: Loan Amortization Chart for a 60KW PV System

Figure 16 shows that with 3.5% interest rate, it will take APW roughly five and half years to pay back the landlord. By making payments including the interest rate, the payback period increases by 7 months. Although this 60 kW system produces a lot of energy, a high initial investment will most likely push the landlord away from wanting this PV system. Implementing a 60kW PV system will increase the initial investment by 73%. The payback period will increase dramatically if there is a 73% increase in the principal value. So it is not recommended to install this huge system to building because it requires long term of interest paying period before APW will be able to see any return on investment.

4.3.3 Compromised Recommendations

In order to make our recommendations effective, it is important to make sure that initial cost and benefit is equally share between landlord and APW. Our goal for this recommendation is to provide APW with a commendable amount of energy production, with a relatively low initial investment cost for the landlord. Table 11 presents the combination of recommendations that favor both APW and the landlord.

Table 11 the Optimal Roofing and PV System Recommendations to both APW and the landlord

	Recommendations	Initial Investment Costs	Costs after Incentives	Payback Period before tax incentives	Payback period after tax incentives	Monthly Energy Costs Saving
Roofing Option	EPDM	105,290	None	None	None	None
PV system	35 kW System	$212,062.10	$51,793.58	20.7 years	5.04 years	$855.5

An EPDM roof and 35 kW PV system is recommended to balance the profit for the two parties. EPDM roof is more suitable as compared to PVC and TPO roof; because EPDM had the lowest installation cost and is a reliable roofing product for over 15 year. The ease of maintenance is another reason for choosing EPDM. A typical reason people choose PVC and TPO over EPDM is for their energy saving feature. However, because our plan is to cover the whole roof with solar panels, thus the new constructed roof will hide below the solar panel. Spending extra dollars on anything that does not provide any benefit for landlord or APW is not ideal.

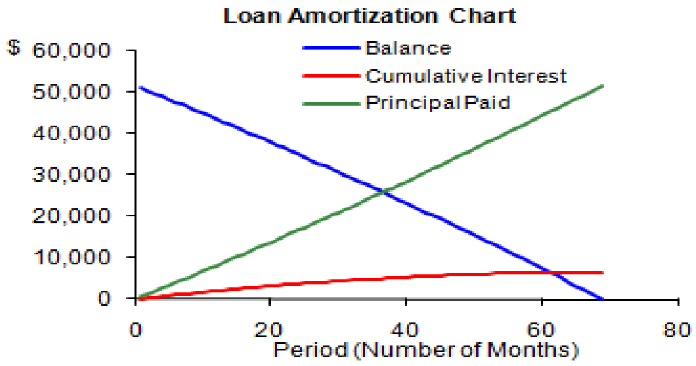


Figure 17: Loan Amortization Chart for a 35KW PV System

Figure 17 shows that with the 3.5% interest rate, it takes about 5.8 years to payback the 35 kW systems. This resulted in an eight month increase in the payback period. Low initial investment cost and shorter payback period is the reason for recommending this system. In other words, APW can save 43% in the energy bill while the landlord could pay a lower upfront cost.

Table 12 Initial Cost and Payback Periods for the Three Recommendation

	Initial Cost before any tax incentive (Dollars)	**PV system payback Period with 3.5% interest (years)**	**Future Monthly Savings**
System 1(Landlord)	196,786	8.8	244.4
System 2(APW)	464,797	5.4	1466.5
System 3 (Both)	317,352	5.8	855.5

By creating different systems based on the benefit for Landlord, APW or both, we found the total initial investment cost, which is the amount the landlord is responsible for at the time of the construction, varies among three systems. Table 12 included the total initial cost before the tax incentive, calculated payback period and future monthly savings. System one had the lowest initial cost among the three systems; however, it takes three more years to pay off as compared to other two systems and the monthly saving $244.4 is so low compared to other system. System two had the highest initial cost among the three systems, while its payback period is roughly the same as system three. The monthly saving for system two is 31.7% greater than system three. However, because the initial installation fee is so high there is a $147,445 that is needed additionally. After applying the interest rate with this high principal value will result in a dramatic increase in the payback period. Any savings will go to APW's pocket only after initial value is fully payback; so the payback period really matters. Thus, system three is the most ideal recommendation because it provides APW with a commendable amount of energy production, with a relatively low initial investment cost for the landlord.

4.4 Conclusion

The sections above provided and discussed our findings throughout our investigation in the methodology section. This chapter consisted of: 1) Potential Roofing Replacement Options, 2) Potential Green Technologies and Energy Cost Reduction Programs, and 3) Recommendations for APW, landlord and both. We were able to provide the best recommendations for each specific party while finding a common ground that provided APW with a high energy savings while also providing the landlord with a moderately low upfront cost. Additionally, the recommendation should provide APW with a savings on their energy bill which they can use to help fight their 15% annual increase in clientele. Our final best recommendation is Glacial Energy's fixed rate program, and EPDM roof, and a 35kW PV system. Fixed rate program provides saving of $106 per month, while a 35kW PV system provides saving $855 per month. This system will save APW an average total of $960 per month after 6 years payback period. However this is not everything, after implementing a new roof, APW is able to prevent any heat loss through the damage roof, but because amount of money saving cannot be calculate, we will assume the actual total saving per month is $960+. After APW fully pay back initial cost for 35kW PV system, future agreements can be made between the two parties to share their long term savings.

Chapter 5: Conclusion

APW needs a way to gain funds in order to accommodate their fifteen percent increase in clientele. Currently $0.92 of every dollar goes towards individuals infected with HIV/AIDS. If this increase stays constant or keeps growing without an increase of funding then APW will be unable to give as much as they do now while still maintaining current operating costs. Green options such as installing green roof s and solar panels help to lower APW total energy cost. We learned that President Obama has requested a budget increase of 4.6% on the U.S Federal Funding for HIV/AIDS in Fiscal Year 2011 (FY2011) compared to Fiscal Year 2010 (FY2010).

Unfortunately this will not satisfy the money needs of APW due to its large increase in the number of patients. The HIV/AIDS epidemic is still on the rise not only in the nation but in Worcester, Ma. High rape rates along with high poverty levels aid in APW clientele increase. AIDS Project Worcester is primarily funded through federal grants. Even though there is a 15% annual increase in clientele, there is not an increase in federal grants. In fact, because of the current economic status of the United States of America, the amount of money granted to APW is decreasing.

Our project goal as stated: to provide recommendations of energy saving methods to lower operating costs while find finding sources to finance those improvements to APW. Objectives of our project included, identifying options to replace or repair the current leaking roof, explore energy reducing options that can be applied to APW, examine funding options for energy reducing options, and finally make recommendations for APW/landlord and a compromising recommendation.

The group last year worked to reduce their energy consumption. Our team's job was to provide the technical ways that will reduce AIDS Project Worcester overall operating costs. The technical way included providing the optimal roofing option, the most efficient PV system, and the best fixed rate energy supplier. Through our research and calculation our final compromise recommendations for the benefit of the landlord and APW. An EDPM roof, 35kW PV system, and signing up with Glacial Energy as a fixed rate provider proves to be a good compromise to both parties involved. The initial cost of this system is high after incentives drops approximately 75% and pays itself back in about 5 years. It is our expectation and our hope that the outcome of the project will provide incentives to both the landlord and AIDS Project Worcester and thus lead to a reality.

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Wright, K. (2010, 7 19). *HIV in Poor U.S. Neighborhoods as Intense as Developing World.* Retrieved 11 4, 2010, from ColorLine: http://colorlines.com/archives/2010/07/federal_study_firmly_links_poverty_and_hiv_in_us.html

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Appendices

Section One: Roofing Contractors Reports

M.J. & Sons General Contracting

150 Middle St.

Leominster MA 01453

PH: 978-860-5632 E-mail: jaysonbooth@gmail.com

PROPOSAL SUBMITTED TO	**PHONE**	**DATE**
STREET	**JOB NAME**	
CITY, STATE & ZIP CODE	**JOB LOCATION**	
CONTACT	**CITY, STATE & ZIP CODE**	**JOB PHONE**

ROOF TYPE: Versico Mechanically Attached Rubber System

On All Roofs:

1. Install 060 mill Versico rubber mechanically attached membrane on top of all 200 squares of existing roof deck.
2. Rubber is to be mechanically fastened at all seams with batten bar and 6″ seam tape. All parapet walls are to be fully adhered.
3. All existing heating ventilation curves are to be flashed with membrane and fasteners.
4. All drains to be replaced with manufacturer rack drains.
5. All parameter edges to be secured with 6″ parameter edge metal and flashed with 6″ uncured flashing.
6. Entire roof surface to be insulated with ½″ insulation and secured with 12 fasteners per 4/8 sheet.
7. Any parapet wall that is not secured with parameter metal is to be terminated with termination bar – brick walls.
8. Any parameter sheet of rubber membrane is to have batten bar T's at each corner and flashed with 6″ cured flashing.
9. All AC or heating roof top units are to be flashed with 9″ uncured flashing and lap sealed.
10. All cross laps of EPDM rubber are to have 5″ uncured flashing at joints and cross laps and lap sealed.

We Propose hereby to furnish material and labor – complete in accordance with above specifications for the sum of:	
Sixty Seven Thousand and no/100-----------Dollars	($67,000.00)

Payment to be made as follows:

One half (1/3) to be paid before start of project

One Fourth (1/3) to be paid after half of project is completed

One Fourth (1/3) to be paid after project is fully completed

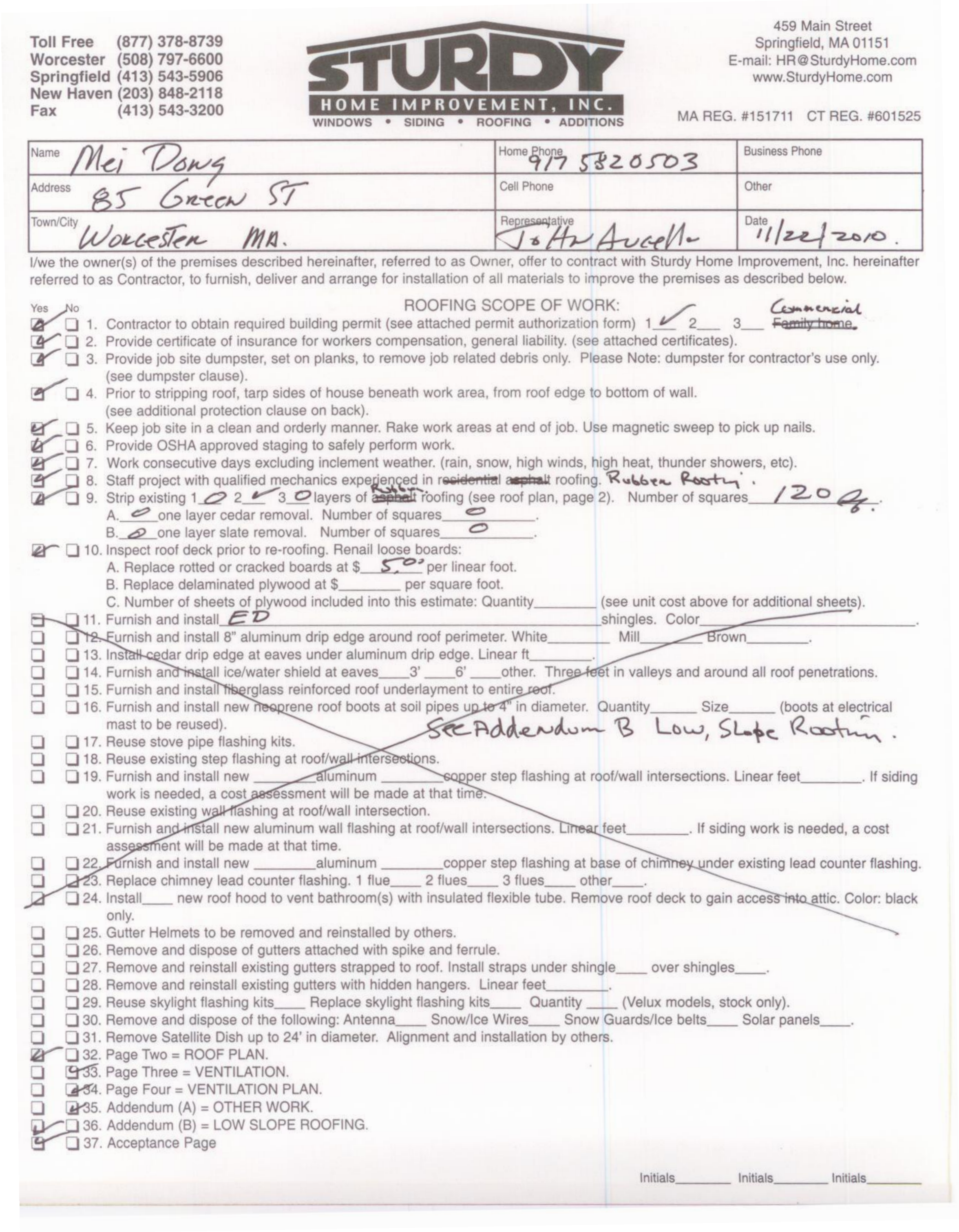
Line Item Costs:
-Any deck replacement necessary will be invoiced at the cost of $40 per 4 ft. by 8 ft. sheet of decking.
-Any fascia wood replacement necessary will be invoiced at the cost of $50 for the first 10 linear feet and an additional cost of $3.50 per lineal foot thereafter.

.

Initial here if accepted ___________

All material is guaranteed to be as specified. All work is to be completed in a workmanlike manner according to standard practices. Any alteration or deviation from the above specifications involving extra costs will be charged accordingly. Under no circumstances is M.J. & Sons Contracting responsible for existing damages to building, its contents or roof deck. Owner to carry Fire, Tornado and other necessary insurance. Our workers are fully covered by Workmen's Compensation Insurance.	Contractor's Signature ____ Note: This proposal may be withdrawn by us if not accepted within _**30**__days.
Acceptance of Proposal – **The above prices, specifications and conditions are satisfactory and are hereby accepted. You are authorized to do the work as specified. Payment will be made as outlined above.**	**Signature**____
Date of Acceptance: ____/____/____	**Signature**____

GUARANTEE: FIVE (5) year(s) roof leak repair under normal weather conditions from completion date.
The warranty shall protect the owner from damage to the building and contents resulting from roof leakage for a period of five (5) years, beginning from the date of completion of the project. The warranty shall cover and include repair or replacement of any damaged exterior structure, interior structure, interior components and contents of the building, resulting from roof leakage directly attributed to the contractor's workmanship.



Toll Free (877) 378-8739
Worcester (508) 797-6600
Springfield (413) 543-5906
New Haven (203) 848-2118
Fax (413) 543-3200

STURDY
HOME IMPROVEMENT, INC.
WINDOWS • SIDING • ROOFING • ADDITIONS

459 Main Street
Springfield, MA 01151
E-mail: HR@SturdyHome.com
www.SturdyHome.com

MA REG. #151711 CT REG. #601525

Name Mei Dong	Home Phone 917 5820503	Business Phone
Address 85 Green ST	Cell Phone	Other
Town/City Worcester MA.	Representative John Avcello	Date 11/22/2010.

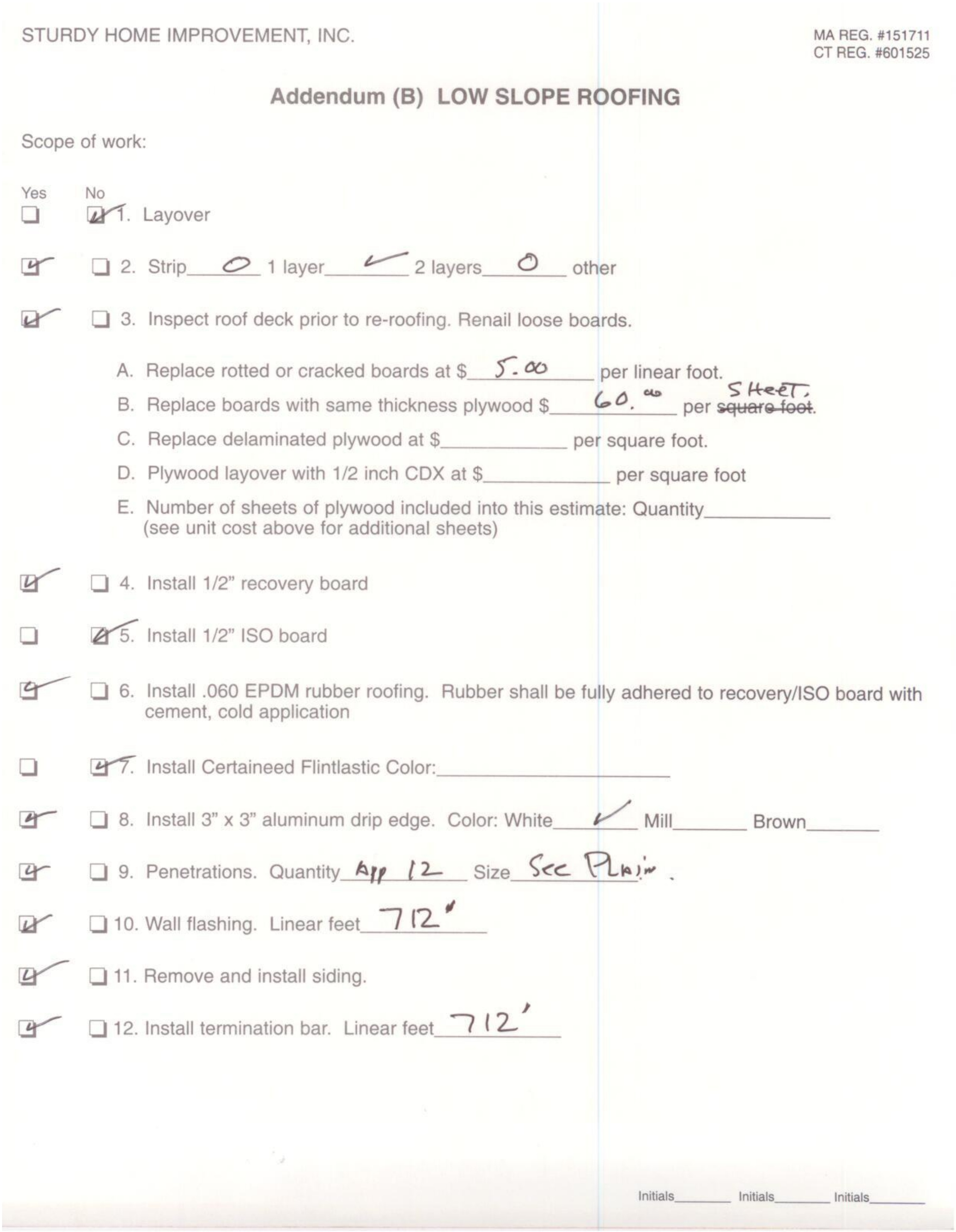
I/we the owner(s) of the premises described hereinafter, referred to as Owner, offer to contract with Sturdy Home Improvement, Inc. hereinafter referred to as Contractor, to furnish, deliver and arrange for installation of all materials to improve the premises as described below.

ROOFING SCOPE OF WORK:

Yes No

☑ ☐ 1. Contractor to obtain required building permit (see attached permit authorization form) 1 ✓ 2___ 3___ ~~Family home.~~ Commercial
☑ ☐ 2. Provide certificate of insurance for workers compensation, general liability. (see attached certificates).
☑ ☐ 3. Provide job site dumpster, set on planks, to remove job related debris only. Please Note: dumpster for contractor's use only. (see dumpster clause).
☑ ☐ 4. Prior to stripping roof, tarp sides of house beneath work area, from roof edge to bottom of wall. (see additional protection clause on back).
☑ ☐ 5. Keep job site in a clean and orderly manner. Rake work areas at end of job. Use magnetic sweep to pick up nails.
☑ ☐ 6. Provide OSHA approved staging to safely perform work.
☑ ☐ 7. Work consecutive days excluding inclement weather. (rain, snow, high winds, high heat, thunder showers, etc).
☑ ☐ 8. Staff project with qualified mechanics experienced in ~~residential~~ ~~asphalt~~ roofing. Rubber Roofing.
☑ ☐ 9. Strip existing 1 0 2 ✓ 3 0 layers of ~~asphalt~~ Rubber roofing (see roof plan, page 2). Number of squares 120 sq.
A. 0 one layer cedar removal. Number of squares 0.
B. 0 one layer slate removal. Number of squares 0.
☑ ☐ 10. Inspect roof deck prior to re-roofing. Renail loose boards:
A. Replace rotted or cracked boards at $ 5.00 per linear foot.
B. Replace delaminated plywood at $________ per square foot.
C. Number of sheets of plywood included into this estimate: Quantity________ (see unit cost above for additional sheets).
~~☐ ☐ 11. Furnish and install ED shingles. Color________.~~
~~☐ ☐ 12. Furnish and install 8" aluminum drip edge around roof perimeter. White________ Mill________ Brown________.~~
~~☐ ☐ 13. Install cedar drip edge at eaves under aluminum drip edge. Linear ft________.~~
~~☐ ☐ 14. Furnish and install ice/water shield at eaves____3' ____6' ____other. Three feet in valleys and around all roof penetrations.~~
~~☐ ☐ 15. Furnish and install fiberglass reinforced roof underlayment to entire roof.~~
~~☐ ☐ 16. Furnish and install new neoprene roof boots at soil pipes up to 4" in diameter. Quantity______ Size______ (boots at electrical mast to be reused).~~
See Addendum B Low, Slope Roofing.
~~☐ ☐ 17. Reuse stove pipe flashing kits.~~
~~☐ ☐ 18. Reuse existing step flashing at roof/wall intersections.~~
~~☐ ☐ 19. Furnish and install new ________aluminum ________copper step flashing at roof/wall intersections. Linear feet________. If siding work is needed, a cost assessment will be made at that time.~~
~~☐ ☐ 20. Reuse existing wall flashing at roof/wall intersection.~~
~~☐ ☐ 21. Furnish and install new aluminum wall flashing at roof/wall intersections. Linear feet________. If siding work is needed, a cost assessment will be made at that time.~~
~~☐ ☐ 22. Furnish and install new ________aluminum ________copper step flashing at base of chimney under existing lead counter flashing.~~
~~☐ ☐ 23. Replace chimney lead counter flashing. 1 flue____ 2 flues____ 3 flues____ other____.~~
~~☐ ☐ 24. Install____ new roof hood to vent bathroom(s) with insulated flexible tube. Remove roof deck to gain access into attic. Color: black only.~~
☐ ☐ 25. Gutter Helmets to be removed and reinstalled by others.
☐ ☐ 26. Remove and dispose of gutters attached with spike and ferrule.
☐ ☐ 27. Remove and reinstall existing gutters strapped to roof. Install straps under shingle____ over shingles____.
☐ ☐ 28. Remove and reinstall existing gutters with hidden hangers. Linear feet________.
☐ ☐ 29. Reuse skylight flashing kits____ Replace skylight flashing kits____ Quantity ____ (Velux models, stock only).
☐ ☐ 30. Remove and dispose of the following: Antenna____ Snow/Ice Wires____ Snow Guards/Ice belts____ Solar panels____.
☐ ☐ 31. Remove Satellite Dish up to 24' in diameter. Alignment and installation by others.
☑ ☐ 32. Page Two = ROOF PLAN.
☐ ☑ 33. Page Three = VENTILATION.
☐ ☑ 34. Page Four = VENTILATION PLAN.
☐ ☑ 35. Addendum (A) = OTHER WORK.
☑ ☐ 36. Addendum (B) = LOW SLOPE ROOFING.
☑ ☐ 37. Acceptance Page

Initials________ Initials________ Initials________



STURDY HOME IMPROVEMENT, INC.

MA REG. #151711
CT REG. #601525

Addendum (B) LOW SLOPE ROOFING

Scope of work:

Yes No
☐ ☑ 1. Layover

☑ ☐ 2. Strip 0 1 layer ✓ 2 layers 0 other

☑ ☐ 3. Inspect roof deck prior to re-roofing. Renail loose boards.

A. Replace rotted or cracked boards at $ 5.00 per linear foot.
B. Replace boards with same thickness plywood $ 60.00 per ~~square foot~~ SHEET.
C. Replace delaminated plywood at $__________ per square foot.
D. Plywood layover with 1/2 inch CDX at $__________ per square foot
E. Number of sheets of plywood included into this estimate: Quantity__________
(see unit cost above for additional sheets)

☑ ☐ 4. Install 1/2" recovery board

☐ ☑ 5. Install 1/2" ISO board

☑ ☐ 6. Install .060 EPDM rubber roofing. Rubber shall be fully adhered to recovery/ISO board with cement, cold application

☐ ☑ 7. Install Certaineed Flintlastic Color:__________

☑ ☐ 8. Install 3" x 3" aluminum drip edge. Color: White ✓ Mill_____ Brown_____

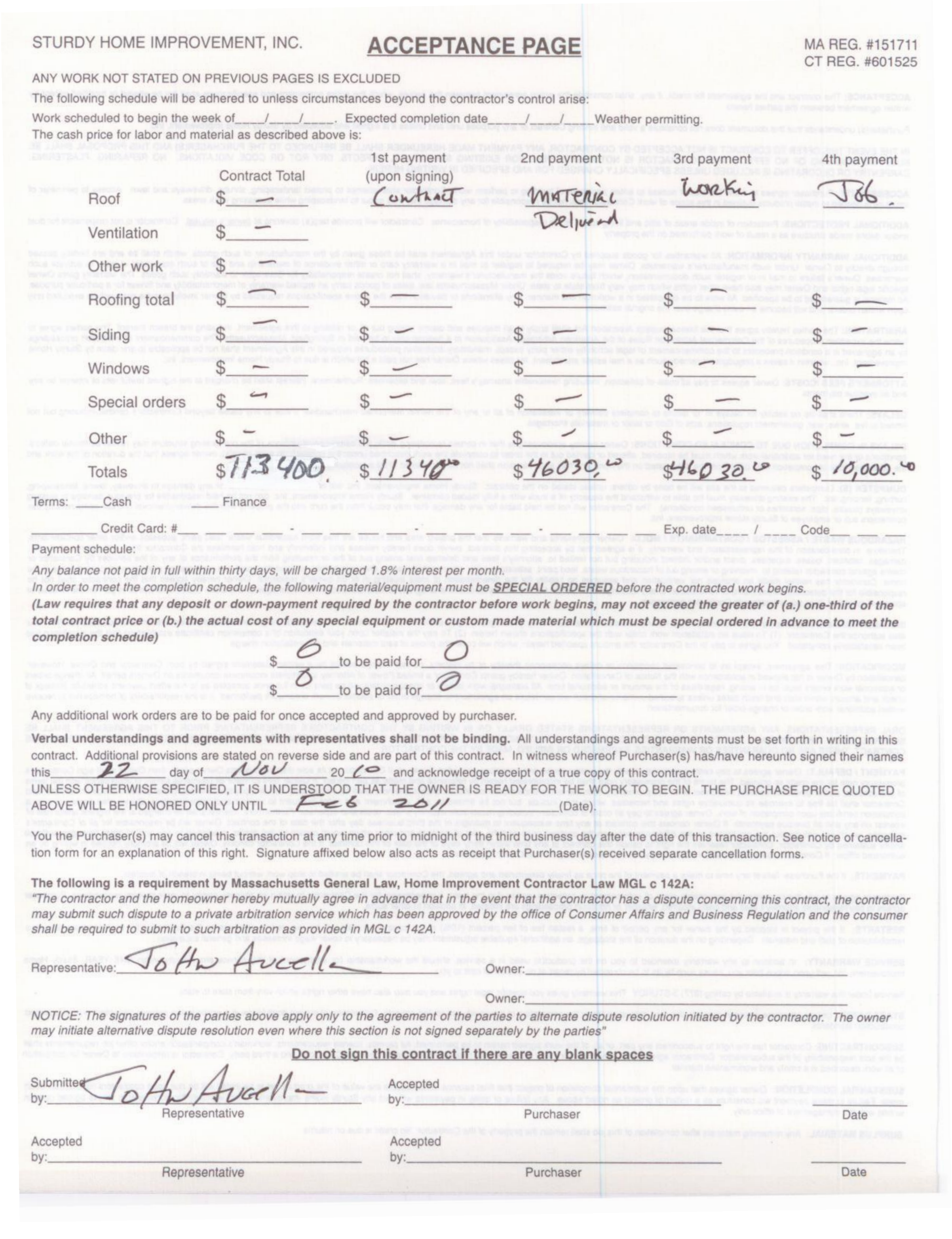
☑ ☐ 9. Penetrations. Quantity App 12 Size See Plain.

☑ ☐ 10. Wall flashing. Linear feet 712'

☑ ☐ 11. Remove and install siding.

☑ ☐ 12. Install termination bar. Linear feet 712'

Initials_____ Initials_____ Initials_____



STURDY HOME IMPROVEMENT, INC.

ACCEPTANCE PAGE

MA REG. #151711
CT REG. #601525

ANY WORK NOT STATED ON PREVIOUS PAGES IS EXCLUDED

The following schedule will be adhered to unless circumstances beyond the contractor's control arise:

Work scheduled to begin the week of____/____/____. Expected completion date____/____/____Weather permitting.

The cash price for labor and material as described above is:

	Contract Total	1st payment (upon signing)	2nd payment	3rd payment	4th payment
Roof	$ —	Contract	Material Delivered	Working	Job.
Ventilation	$ —				
Other work	$ —				
Roofing total	$ —	$ —	$ —	$ —	$ —
Siding	$ —	$ —	$ —	$ —	$ —
Windows	$ —	$ —	$ —	$ —	$ —
Special orders	$ —	$ —	$ —	$ —	$ —
Other	$ —	$ —	$ —	$ —	$ —
Totals	$113400.	$11340.00	$46030.00	$46030.00	$10,000.00

Terms: ____Cash ____Finance

________ Credit Card: #___ ___ ___ ___ - ___ ___ ___ ___ - ___ ___ ___ ___ - ___ ___ ___ ___ Exp. date____ / ____ Code___ ___ ___

Payment schedule:

Any balance not paid in full within thirty days, will be charged 1.8% interest per month.

In order to meet the completion schedule, the following material/equipment must be ***SPECIAL ORDERED*** *before the contracted work begins.*

(Law requires that any deposit or down-payment required by the contractor before work begins, may not exceed the greater of (a.) one-third of the total contract price or (b.) the actual cost of any special equipment or custom made material which must be special ordered in advance to meet the completion schedule)

$ 0 to be paid for 0

$ 0 to be paid for 0

Any additional work orders are to be paid for once accepted and approved by purchaser.

Verbal understandings and agreements with representatives shall not be binding. All understandings and agreements must be set forth in writing in this contract. Additional provisions are stated on reverse side and are part of this contract. In witness whereof Purchaser(s) has/have hereunto signed their names this 22 day of Nov 20 10 and acknowledge receipt of a true copy of this contract.

UNLESS OTHERWISE SPECIFIED, IT IS UNDERSTOOD THAT THE OWNER IS READY FOR THE WORK TO BEGIN. THE PURCHASE PRICE QUOTED ABOVE WILL BE HONORED ONLY UNTIL Feb 2011 (Date).

You the Purchaser(s) may cancel this transaction at any time prior to midnight of the third business day after the date of this transaction. See notice of cancellation form for an explanation of this right. Signature affixed below also acts as receipt that Purchaser(s) received separate cancellation forms.

The following is a requirement by Massachusetts General Law, Home Improvement Contractor Law MGL c 142A:
"The contractor and the homeowner hereby mutually agree in advance that in the event that the contractor has a dispute concerning this contract, the contractor may submit such dispute to a private arbitration service which has been approved by the office of Consumer Affairs and Business Regulation and the consumer shall be required to submit to such arbitration as provided in MGL c 142A.

Representative: John Aucell Owner:________

Owner:________

NOTICE: The signatures of the parties above apply only to the agreement of the parties to alternate dispute resolution initiated by the contractor. The owner may initiate alternative dispute resolution even where this section is not signed separately by the parties"

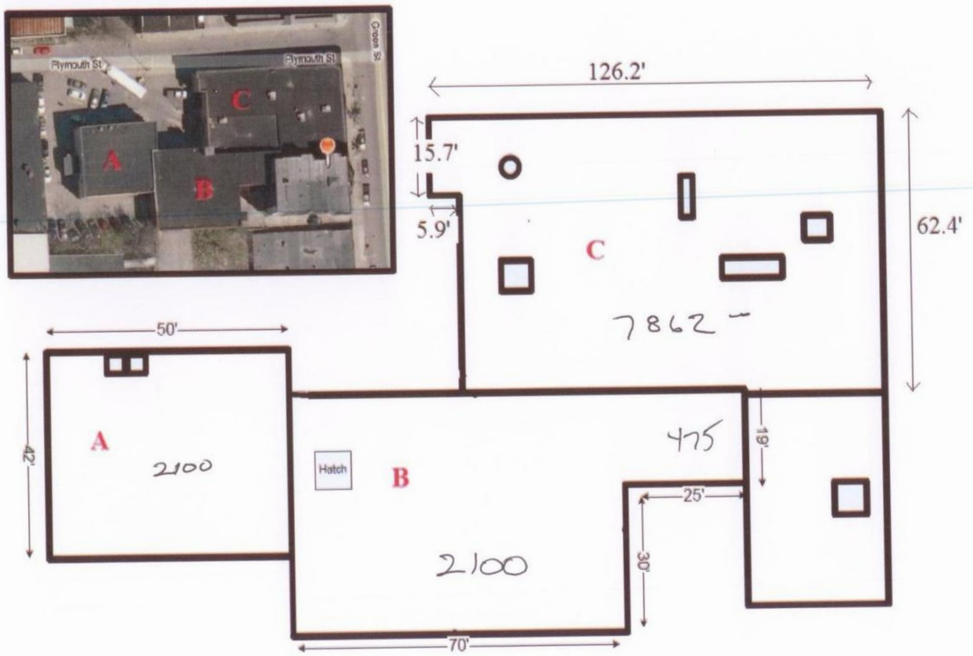
Do not sign this contract if there are any blank spaces

Submitted by: John Aucell
Representative

Accepted by:________ ________
Purchaser Date

Accepted by:________
Representative

Accepted by:________ ________
Purchaser Date


Plymouth St
Plymouth St
Green St
C
A
B
126.2'
15.7'
5.9'
62.4'
C
7862 —
50'
42'
A
2100
Hatch
B
475
19'
25'
30'
2100
70'

Section Two: Solar Panels Companies Reports

Advanced Energy Systems Development, LLC

24 Hampden Street

Wellesley, MA

02482

APW November 11, 2010

85 Green Street

Worcester, MA, 01608

c/o Richard Nazzaro

WPI

Rich,

Thank you for contacting Advanced Energy Systems Development regarding your interest in renewable energy technologies for the APW facility and thank you for showing me around the site last week. As promised I have prepared an estimate for the installation of a solar domestic hot water system and a photovoltaic system on the property.

Figure 1. Satellite Image

As we discussed, I have prepared an estimate for installing a photovoltaic system on the roof at 85 Green Street. The photovoltaic system would be installed on the roof using self ballasted mounting racks. System cost is provided in Cost Estimate 1. The 31 kW system estimated will generate in the neighborhood of 4,000 kWhrs per month (average). The installed system would be eligible for a 30% federal tax credit, accelerated 5 year depreciation, a Massachusetts business tax deduction and Mass CEC rebate which would lower the cost to $49,000. In addition, the system would be eligible for Solar Renewable Energy Credits (SRECs) which could be worth as much as $0.50/kWhr generated. The system would pay for itself in roughly 1 year.

A second renewable energy system to generate hot water can be installed on the roof of the building. A two panel solar hot water system would generate close to 100 gallons of 120 F hot water per day, lowering the consumption of electricity at the facility and reducing the generation of carbon gases. The existing electric hot water tank would become the backup system. Alternatively, a heat pump can be used to provide backup hot water capability (not estimated, approximately $1,000).

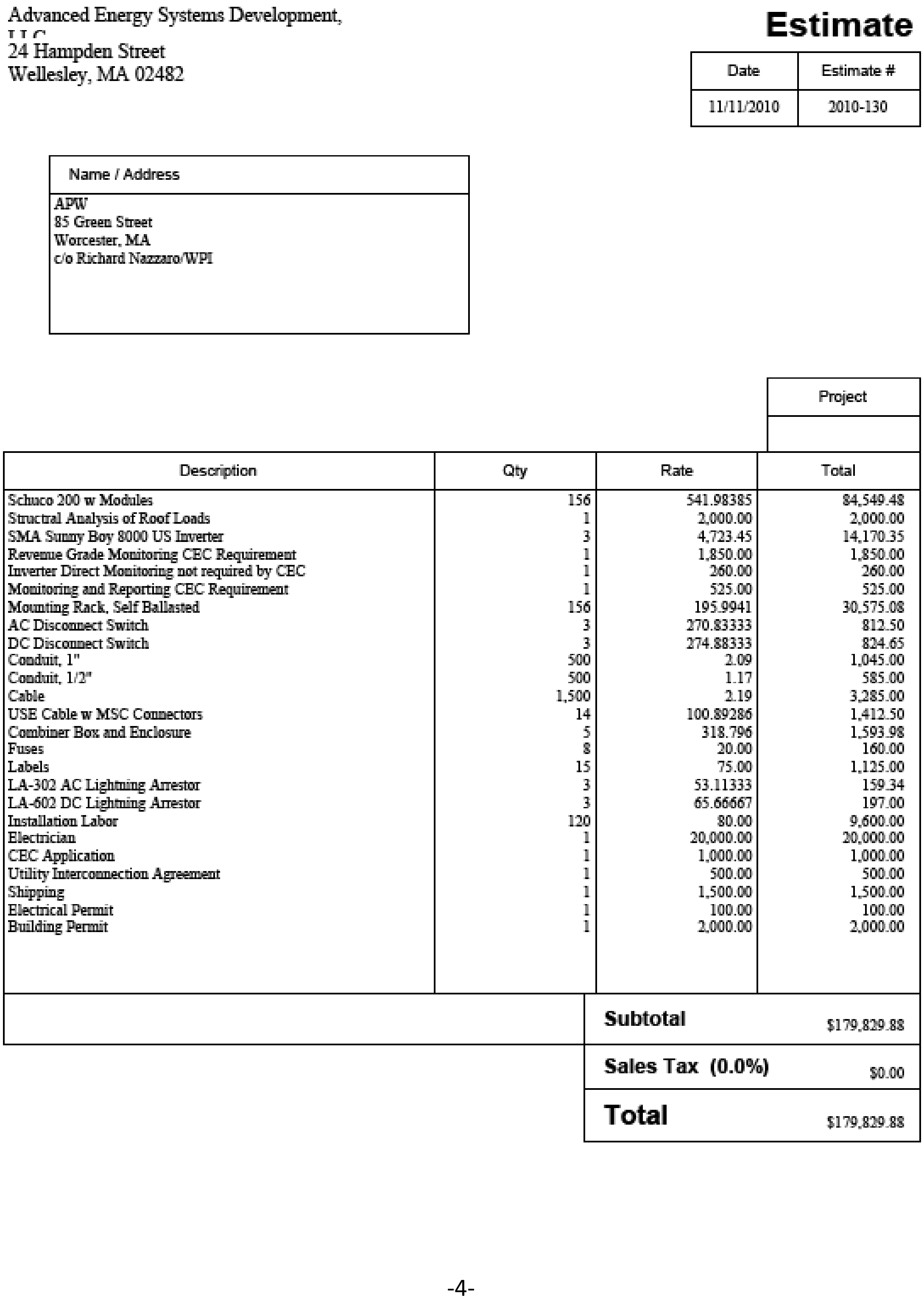
Figure 5. Three Schuco Slim V Collectors on a Tilt Rack, Cambridge, MA

We recommend and typically install Apricus, Schuco and Heliodyne solar hot water panels. Schuco and HelioPak pump stations/heat exchangers and Super Stor, Rheem Solar Aid and Marathon solar storage tanks. The Super Stor and the Rheem Marathon tanks come with a lifetime warranty. Pictures of any of these items can be supplied. In addition to the recommended Apricus, Schuco and Heliodyne flat plate collectors we can supply Vellux, Wagner, Buderus, Viessmann and AET flat plate collectors. We can also supply Viessmann and SunMaxx evacuated tube collectors.

-3-

Cost Estimate 1

Photovoltaic System



Advanced Energy Systems Development,
24 Hampden Street
Wellesley, MA 02482

Estimate

Date	Estimate #
11/11/2010	2010-130

Name / Address

APW
85 Green Street
Worcester, MA
c/o Richard Nazzaro/WPI

Project

Description	Qty	Rate	Total
Schuco 200 w Modules	156	541.98385	84,549.48
Structral Analysis of Roof Loads	1	2,000.00	2,000.00
SMA Sunny Boy 8000 US Inverter	3	4,723.45	14,170.35
Revenue Grade Monitoring CEC Requirement	1	1,850.00	1,850.00
Inverter Direct Monitoring not required by CEC	1	260.00	260.00
Monitoring and Reporting CEC Requirement	1	525.00	525.00
Mounting Rack, Self Ballasted	156	195.9941	30,575.08
AC Disconnect Switch	3	270.83333	812.50
DC Disconnect Switch	3	274.88333	824.65
Conduit, 1"	500	2.09	1,045.00
Conduit, 1/2"	500	1.17	585.00
Cable	1,500	2.19	3,285.00
USE Cable w MSC Connectors	14	100.89286	1,412.50
Combiner Box and Enclosure	5	318.796	1,593.98
Fuses	8	20.00	160.00
Labels	15	75.00	1,125.00
LA-302 AC Lightning Arrestor	3	53.11333	159.34
LA-602 DC Lightning Arrestor	3	65.66667	197.00
Installation Labor	120	80.00	9,600.00
Electrician	1	20,000.00	20,000.00
CEC Application	1	1,000.00	1,000.00
Utility Interconnection Agreement	1	500.00	500.00
Shipping	1	1,500.00	1,500.00
Electrical Permit	1	100.00	100.00
Building Permit	1	2,000.00	2,000.00

Subtotal	$179,829.88
Sales Tax (0.0%)	$0.00
Total	$179,829.88

-4-

The solar hot water system has an estimated cost of $9,600. This system is eligible for a 30% federal tax credit, accelerated 5 year depreciation, and a Massachusetts business tax deduction which would lower the cost to $3,720. In addition, the system would become eligible for Solar Renewable Energy Credits (SRECs) which could be worth as much as $0.50/kWhr generated when this system is implemented in the near future. Ignoring the impact of the SRECs yields a payback of 18 months assuming a monthly charge of $80 for electricity utilized for hot water at the facility.

Please call me at the Advanced Energy Systems Development, LLC office (617 775-1720) to discuss any questions you may have concerning our estimate or if there are any additional estimates that you would like prepared.

Regards,

Charlie

Charles Nadel

Advanced Energy Systems Development, LLC

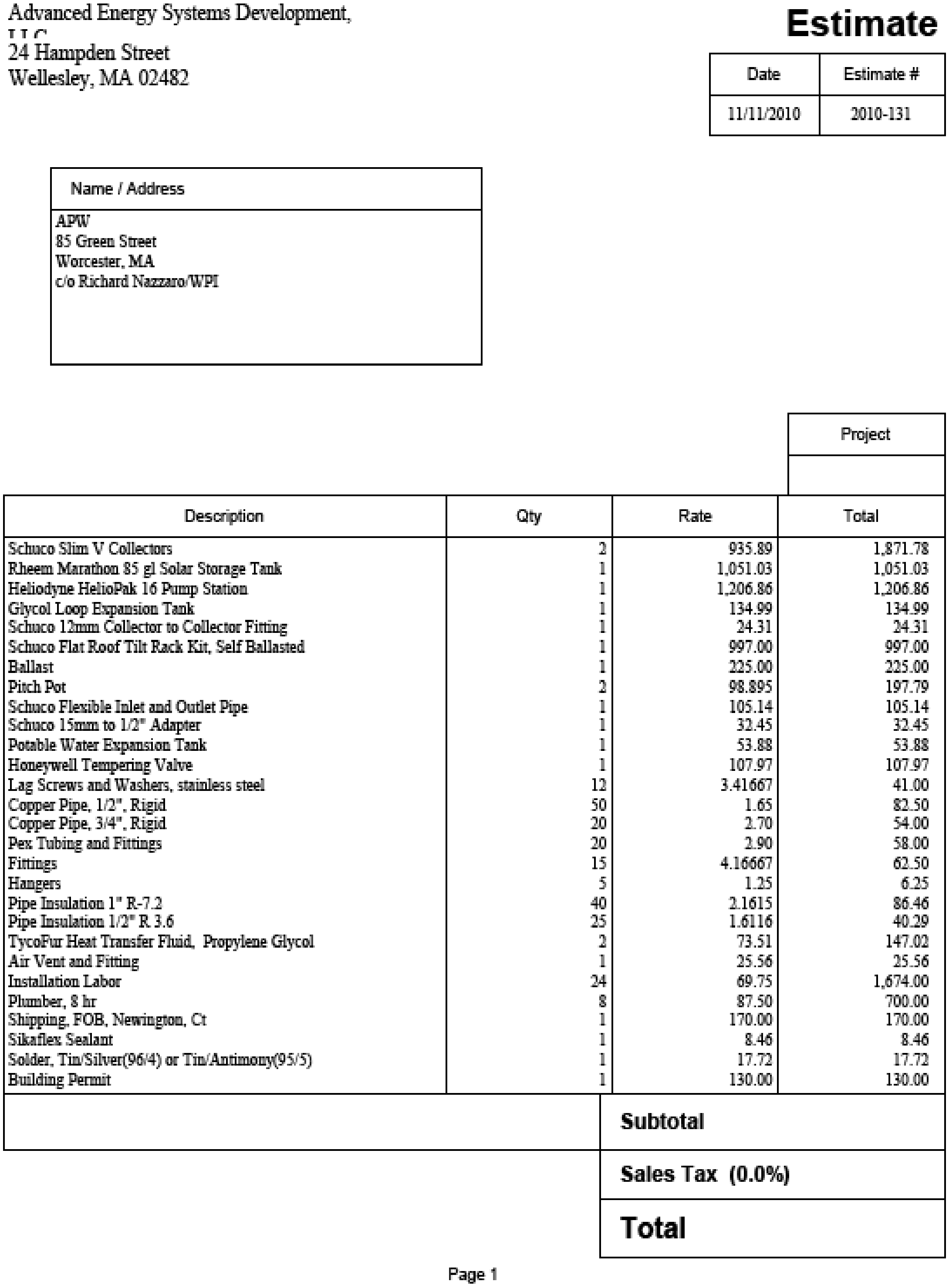
617 775-1720

www.advancedenergysystemsusa.com

File: Estimate

Cost Estimate 2

Solar Hot Water System



Advanced Energy Systems Development,
LLC
24 Hampden Street
Wellesley, MA 02482

Estimate

Date	Estimate #
11/11/2010	2010-131

Name / Address
APW 85 Green Street Worcester, MA c/o Richard Nazzaro/WPI

Project

Description	Qty	Rate	Total
Schuco Slim V Collectors	2	935.89	1,871.78
Rheem Marathon 85 gl Solar Storage Tank	1	1,051.03	1,051.03
Heliodyne HelioPak 16 Pump Station	1	1,206.86	1,206.86
Glycol Loop Expansion Tank	1	134.99	134.99
Schuco 12mm Collector to Collector Fitting	1	24.31	24.31
Schuco Flat Roof Tilt Rack Kit, Self Ballasted	1	997.00	997.00
Ballast	1	225.00	225.00
Pitch Pot	2	98.895	197.79
Schuco Flexible Inlet and Outlet Pipe	1	105.14	105.14
Schuco 15mm to 1/2" Adapter	1	32.45	32.45
Potable Water Expansion Tank	1	53.88	53.88
Honeywell Tempering Valve	1	107.97	107.97
Lag Screws and Washers, stainless steel	12	3.41667	41.00
Copper Pipe, 1/2", Rigid	50	1.65	82.50
Copper Pipe, 3/4", Rigid	20	2.70	54.00
Pex Tubing and Fittings	20	2.90	58.00
Fittings	15	4.16667	62.50
Hangers	5	1.25	6.25
Pipe Insulation 1" R-7.2	40	2.1615	86.46
Pipe Insulation 1/2" R 3.6	25	1.6116	40.29
TycoFur Heat Transfer Fluid, Propylene Glycol	2	73.51	147.02
Air Vent and Fitting	1	25.56	25.56
Installation Labor	24	69.75	1,674.00
Plumber, 8 hr	8	87.50	700.00
Shipping, FOB, Newington, Ct	1	170.00	170.00
Sikaflex Sealant	1	8.46	8.46
Solder, Tin/Silver(96/4) or Tin/Antimony(95/5)	1	17.72	17.72
Building Permit	1	130.00	130.00

Subtotal

Sales Tax (0.0%)

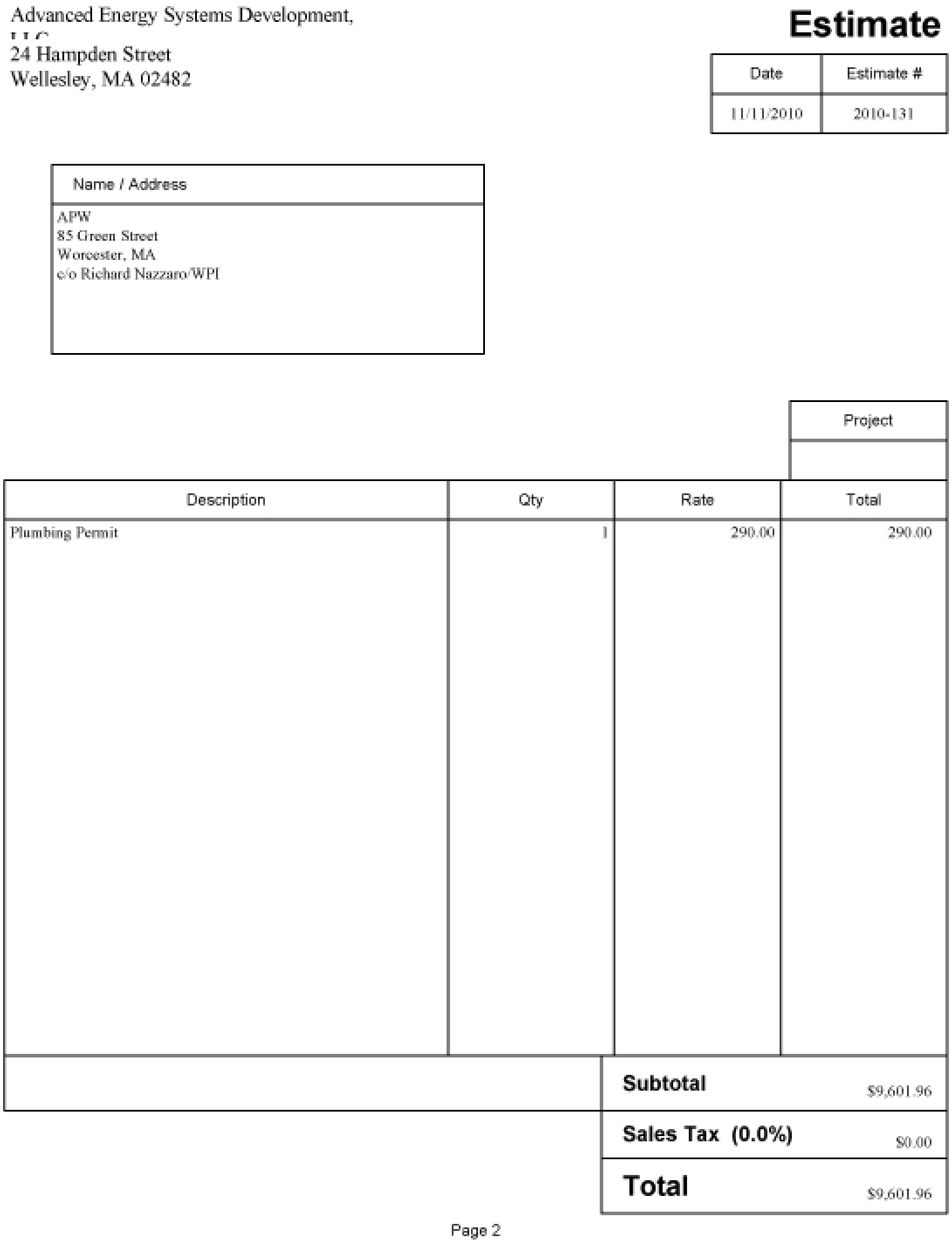
Total

Page 1

-6-

Cost Estimate 2

Solar Hot Water System, pg 2



Advanced Energy Systems Development,
LLC
24 Hampden Street
Wellesley, MA 02482

Estimate

Date	Estimate #
11/11/2010	2010-131

Name / Address

APW
85 Green Street
Worcester, MA
c/o Richard Nazzaro/WPI

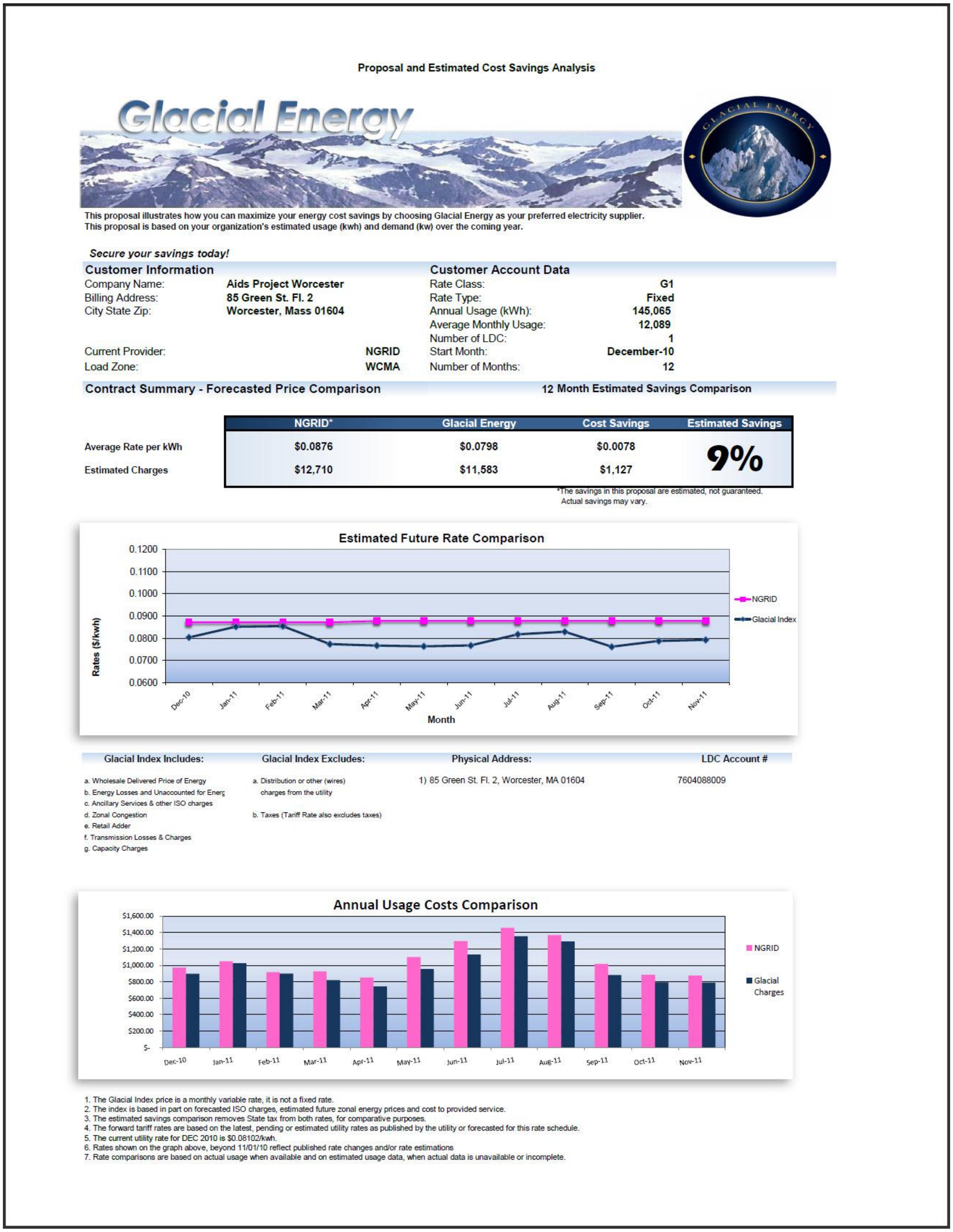
Project

Description	Qty	Rate	Total
Plumbing Permit	1	290.00	290.00

Subtotal	$9,601.96
Sales Tax (0.0%)	$0.00
Total	$9,601.96

Page 2

Section Three: Glacial Energy Report (Fix-Rate Program)



Proposal and Estimated Cost Savings Analysis

This proposal illustrates how you can maximize your energy cost savings by choosing Glacial Energy as your preferred electricity supplier.
This proposal is based on your organization's estimated usage (kwh) and demand (kw) over the coming year.

Secure your savings today!

Customer Information			**Customer Account Data**	
Company Name:	**Aids Project Worcester**		Rate Class:	**G1**
Billing Address:	**85 Green St. Fl. 2**		Rate Type:	**Fixed**
City State Zip:	**Worcester, Mass 01604**		Annual Usage (kWh):	**145,065**
			Average Monthly Usage:	**12,089**
			Number of LDC:	**1**
Current Provider:		**NGRID**	Start Month:	**December-10**
Load Zone:		**WCMA**	Number of Months:	**12**

Contract Summary - Forecasted Price Comparison **12 Month Estimated Savings Comparison**

	NGRID*	Glacial Energy	Cost Savings	Estimated Savings
Average Rate per kWh	**$0.0876**	**$0.0798**	**$0.0078**	**9%**
Estimated Charges	**$12,710**	**$11,583**	**$1,127**	

*The savings in this proposal are estimated, not guaranteed.
Actual savings may vary.

Estimated Future Rate Comparison

Glacial Index Includes:	Glacial Index Excludes:	Physical Address:	LDC Account #
a. Wholesale Delivered Price of Energy b. Energy Losses and Unaccounted for Energ c. Ancillary Services & other ISO charges d. Zonal Congestion e. Retail Adder f. Transmission Losses & Charges g. Capacity Charges	a. Distribution or other (wires) charges from the utility b. Taxes (Tariff Rate also excludes taxes)	1) 85 Green St. Fl. 2, Worcester, MA 01604	7604088009

Annual Usage Costs Comparison

1. The Glacial Index price is a monthly variable rate, it is not a fixed rate.
2. The index is based in part on forecasted ISO charges, estimated future zonal energy prices and cost to provided service.
3. The estimated savings comparison removes State tax from both rates, for comparative purposes.
4. The forward tariff rates are based on the latest, pending or estimated utility rates as published by the utility or forecasted for this rate schedule.
5. The current utility rate for DEC 2010 is $0.08102/kwh.
6. Rates shown on the graph above, beyond 11/01/10 reflect published rate changes and/or rate estimations
7. Rate comparisons are based on actual usage when available and on estimated usage data, when actual data is unavailable or incomplete.

Section Four: Funding Options for Solar Panels Installations

MassCEC - Commonwealth Solar II Rebates

Last DSIRE Review: 10/18/2010

State:	Massachusetts
Incentive Type:	State Rebate Program
Eligible Renewable/Other Technologies:	Photovoltaics
Applicable Sectors:	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Fed. Government, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional
Amount:	$1.00 - $2.10/W DC (varies by rebate "adders")
Maximum Incentive:	Residential: $10,500; Commercial: $5,500 (per host customer), up to $250,000 per parent company.
Eligible System Size:	1 kW (minimum) up to 10 kW (DC)
Equipment Requirements:	All equipment must be new, UL-listed and compliant with IEEE standards. Modules must be certified to UL 1703 standards. Inverters must be certified to IEEE 929 and UL 1741 standards. All modules, inverters, and production meters must be on the California Energy Commission's list of eligible equipment. Automated reporting encouraged for systems over 10 kW. Minimum manufacturer warranties required: 5 years product and 20 years performance for modules; 10 years for inverters; 2 years for revenue grade production meters; and 5 years for mounting equipment.
Installation Requirements:	Projects must be installed in compliance with all local, state, and/or federal building and electrical laws, codes and practices. Electrical work must be performed by a Massachusetts licensed electrician. NABCEP certification recommended. Projects must have a minimum 5-year warranty provided by the installer against defective workmanship, project or component breakdown, or degradation in electrical output of more than 15% from original rated electrical output during the warranty period. Projects must be grid-tied and "behind the meter."*
Ownership of Renewable Energy Credits:	Remains with project owner
Funding Source:	Massachusetts Renewable Energy Trust
Program Budget:	$4 million/year ($1 million/quarter)
Expiration Date:	12/31/2010
Web Site:	http://www.masscec.com/solar

Block 4 launched October 15, 2010 and is accepting applications.

Commonwealth Solar II, offered by the Massachusetts Clean Energy Center (MassCEC) provides rebates for the installation of grid-tied photovoltaic (PV) systems at residential, commercial, industrial, institutional and public facilities.* Commonwealth Solar II rebates are available to electricity customers served by the following Massachusetts investor-owned electric utilities: Fitchburg Gas and Electric Light (Unitil), National Grid, NSTAR Electric and Western Massachusetts Electric. In addition, customers of certain municipal lighting plant (MLP) utilities are now eligible. Commercial projects are eligible for rebates for PV projects less than or equal to 10 kilowatts (kW) in capacity and the rebate will be based on the first 5 kW only. Residential rebates do not have a cap, but the rebate will be based on the first 5 kW only. All rebate applications must be approved BEFORE the project installation begins.

Rebate amounts are based on the total PV system size per building, regardless of the number of electric meters in use and certain other characteristics of the project. The proposed Commonwealth Solar II rebate levels for residential and commercial PV systems are:

- Base incentive: $1.00/watt
- Adder for Massachusetts company components: $0.10/watt
- Adder for moderate home value: $1.00/watt (applicable to residential projects only), or
- Adder for moderate income: $1.00/watt (applicable to residential projects only)

The rebate is available to the system owner, which may or may not be the host customer. In the case where the system owner is a third-party owner serving a residential host customer, the project is treated as a commercial project (and eligible for the commercial rebate amounts only). Solar renewable-energy credits (SRECs) associated with system generation belong to the system owner and may be sold via the Department of Energy Resources (DOER) SREC program. Note: appropriate, approved tracking must be utilized in order to qualify to sell SRECs. MassCEC reserves the right to conduct post-installation inspections of PV projects prior to approval for payments.

System installers are responsible for the application process and securing necessary permits. MassCEC has developed an online application system (called PowerClerk) for pre-approved installers. Only online applications will be accepted. An energy-efficiency audit is generally required. Required documentation generally includes electric utility interconnection approval, an energy-efficiency audit, paid invoices or equivalent, and, if applicable, evidence that automated reporting is functional. All installers must comply with the minimum insurance requirements established by the MassCEC. It is recommended, but not required, that installers or their subcontractors obtain or seek to obtain North American Board of Certified Energy Practitioners (NABCEP) PV installer certification.

This summary does not capture all of the requirements of the Commonwealth Solar II program. The MassCEC provides program manuals as well as appendices with full program requirements.

History

Commonwealth Solar, a program launched in January 2008 by the Massachusetts Technology Collaborative (MTC), provided rebates for the installation of grid-tied photovoltaic (PV) systems at residential, commercial, industrial, institutional and public facilities through 2009. The initial $68 million Commonwealth Solar program was designed to promote the deployment of PV installations in Massachusetts through 2012. The effort combined $40 million from the Massachusetts Renewable Energy Trust (Trust) and $28 million from the Alternative Compliance Payment funds that the Massachusetts Department of Energy Resources has collected under the state's Renewable Portfolio Standard (RPS) program. Of the total $68 million, at least $16 million was reserved for PV projects on Massachusetts public buildings, and at least $8 million was reserved for PV projects on homes. As of mid October 2009, the state had received enough applications via Commonwealth Solar for 27 megawatts (MW) of PV projects, two years ahead of projections. Over 1,200 applicants benefited from the program.

**According to the program manual, stationary off-grid PV systems that are permanently located on the same contiguous property of an eligible non-residential grid-connected applicant and facility may be eligible for a rebate of up to 5 kW (DC) per project.*

Contact:

Commonwealth Solar II
Massachusetts Clean Energy Center
55 Summer Street, 9th Floor
Boston, MA 02110
E-Mail: cs@masscec.com
Web Site: http://www.commonwealthsolar.org/

Alternative Energy and Energy Conservation Patent Exemption (Corporate)

Last DSIRE Review: 06/04/2010

State:	Massachusetts
Incentive Type:	Industry Recruitment/Support
Eligible Efficiency Technologies:	Yes; specific technologies not identified
Eligible Renewable/Other Technologies:	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste
Applicable Sectors:	Commercial
Amount:	100% deduction
Start Date:	1979
Web Site:	http://www.state.ma.us/doer/programs/renew/renew.htm#taxcred

Authority 1:

MGL ch. 62, § 2(a)(2)(G)

Date Effective:

1979

Massachusetts offers a corporate excise tax deduction for (1) any income -- including royalty income -- received from the sale or lease of a U.S. patent deemed beneficial for energy conservation or alternative energy development by the Massachusetts Department of Energy Resources, and (2) any income received from the sale or lease of personal or real property or materials manufactured in Massachusetts and subject to the approved patent. The deduction is effective for up to five years from the date of issuance of the U.S. patent or the date of approval by the Massachusetts Department of Energy Resources, whichever expires first.

Contact:

Tax Information
Massachusetts Department of Revenue
P.O. Box 701
Boston, MA 02204
Phone: (800) 392-6089
Web Site: http://www.dor.state.ma.us

New Generation Energy - Community Solar Lending Program

Last DSIRE Review: 09/09/2010

State:	Massachusetts
Incentive Type:	Local Loan Program
Eligible Renewable/Other Technologies:	Solar Water Heat, Photovoltaics
Applicable Sectors:	Commercial, Industrial, Nonprofit, Schools, Agricultural, (any for-profit or non-profit enterprise)
Amount:	$5,000 to $100,000
Maximum Incentive:	$100,000
Terms:	Loans up to 1-10 years, rates vary from 0 to 5% (subject to change)
Funding Source:	NGE's Renewable Energy Investment Note and Private Donations to NGE
Start Date:	05/2009
Web Site:	http://www.newgenerationenergy.org/?q=community-lending/community...

The Boston-based non-profit organization New Generation Energy offers low interest loans for the installation of solar electric and solar water heating systems via its Community Lending Program. The solar loans are available to companies (including sole-proprietorship) and non-profits in New England (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont), with an emphasis on those located in low and middle-income communities. The interest rate is currently 5.0%, although certain projects may be awarded grants and receive a lower interest rate. Only projects applying for loans are eligible for grants. The interest rate and terms are subject to change.

Interested businesses and non-profits should work with solar distributors and/or installers to receive a price quote. After quotes have been received, they must submit a pre-application to the Community Lending Program. New Generation Energy staff will review the pre-application and will invite only qualified projects to complete a full application. A personal guarantee is normally required for loans. After a site visit, the final determination is made and loan terms are offered to the successful applicants.

There are also loans available for the purchase of Energy Star kitchen appliances for organizations and business involved in food sales and service. Pre-applications are available on New Generation Energy's web site.

Contact:

Community Lending Officer
New Generation Energy
Community Lending Program
98 N. Washington St., Suite 305
Boston, MA 02114
Phone: (617) 624-3688
Fax: (617) 624-3699
E-Mail: clp@newgenerationenergy.org
Web Site: http://www.newgenerationenergy.org/

Local Option - Energy Revolving Loan Fund

Last DSIRE Review: 09/01/2010

State:	Massachusetts
Incentive Type:	PACE Financing
Eligible Efficiency Technologies:	Locally determined
Eligible Renewable/Other Technologies:	Solar Water Heat, Photovoltaics, Locally determined
Applicable Sectors:	Commercial, Industrial, Residential
Terms:	Financing amount locally determined; 20-year financing term

Authority 1:

H.B. 4877 (Chapter Law 188)

Date Enacted:

07/27/2010

Date Effective:

07/27/2010

Note: The Federal Housing Financing Agency (FHFA) issued a statement in July 2010 concerning the senior lien status associated with most PACE programs. In response to the FHFA statement, most local PACE programs have been suspended until further clarification is provided.

Property-Assessed Clean Energy (PACE) financing effectively allows property owners to borrow money to pay for energy improvements. The amount borrowed is typically repaid via a special assessment on the property over a period of years. Massachusetts has authorized local governments to establish such programs, as described below. (Not all local governments in Massachusetts offer PACE financing; contact your local government to find out if it has established a PACE financing program.)

In July 2010, Massachusetts established PACE financing as part of a larger "Municipal Relief Bill" (H.B. 4877). This law authorizes local governments to establish an "Energy Revolving Loan Fund" to provide financing to private property owners (including condominium owners, as long as the improvements include part of the common areas/facilities) for energy efficiency and renewable energy improvements. While the law permits local governments to consult with the Division of Green Communities (part of the Massachusetts Department of Energy Resources), to determine which improvements should be eligible, the Division of Green Communities announced in November 2010 that it is not providing PACE guidance until the FHFA situation has been resolved.

Local governments interested in establishing an Energy Revolving Loan Fund must first hold a public meeting. Then, the local government must pass an ordinance or by-law to create the program and identify the fund's administrator. Local governments are allowed to enter into agreements with other local governments to create and administer a program. After establishing an *Energy Revolving Loan Fund*, the administrator is authorized to provide financing to property owners for energy efficiency and renewable energy improvements, provided those property owners have had an energy audit* and meet any additional energy conservation requirements. Property owners that opt in to a local program will enter into a "betterment" agreement and are responsible for repaying the assessment according to the agreement's terms.

* *An energy audit must be performed for facilities that have not undertaken such an audit after July 1, 2008.*