

Providing Organizational Guidance to the Worcester Energy Barnraisers



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Providing Organizational Guidance to the Worcester Energy Barnraisers

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ABSTRACT

The Worcester Energy Barnraisers promotes energy efficiency and lowers the carbon footprint from buildings through weatherization projects. This report analyzes the non-profit's present challenges and explores possible solutions to improve organizational management. Our approach involved interviews with members and understanding the Barnraisers' process through a participatory weatherization event planning. We determined the organization's challenges to be small number of volunteers in the organization's leadership, inconsistent supply of projects, and organizational structure difficulties. Recommendations developed were key leadership role assignments, consistent member communication, student group connections, community outreach in absence of barnraisings and continuous project search.

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EXECUTIVE SUMMARY

Project Summary

This project aimed to support a local non-profit organization, the Worcester Energy Barnraisers, also referred to as the WEBr, in achieving their goal of supporting and promoting energy sustainability, and reducing the overall carbon footprint in the community of Worcester, Massachusetts. The Worcester Energy Barnraisers organize energy sustainability events involving outreach and weatherization projects to fix energy inefficient buildings within the Worcester community while expanding awareness about energy conservation and teaching the volunteers vital skills to apply to their dwellings. From research about the Barnraisers, face-to-face meetings with the core leadership of the organization and hands-on training with trained members of the organization, we found out that this organization engages in grassroots energy efficiency projects, creates inclusive community solutions for climate change, and strives to promote environmental sustainability, social and economic justice through collaborative home energy efficiency projects.

The Worcester Energy Barnraisers aims to bring the diverse community of people in Worcester together and address the community's energy saving needs through weatherization projects. A barnraising, according to the Amish tradition, is the coming together of people in a community to help build a barn and later celebrating the accomplishments. The idea of "energy" or "weatherization barnraisings" came from the Cambridge-based Home Energy Efficiency Team (HEET) that began doing barnraisings in the summer of 2008 (Worcester Energy Barnraisers, 2012). A typical barnraising consists of community members, students and professionals coming together to all lend a hand with weatherization. The WEBr engages in grassroots energy efficiency projects to create inclusive community solutions for climate change to inspire diverse groups of people to be able to take control of

energy conservation into their own hands, promote environmental justice by creating opportunities accessible for everyone, and to support environmental sustainability throughout central Massachusetts (Worcester Energy Barnraisers, 2012).

The motivation for the project was each team member's drive to help and support any organization that works hard to reduce carbon footprint in the environment, as well as provide assistance to low-income families. We furthermore cared about what the Barnraisers stand for and as such, after considering Worcester and the demographic of its citizens, we decided to support the Worcester Energy Barnraisers in providing assistance to the community. The main challenge of the WEBR is lack of volunteers for weatherization and running of the organization. The organization was initiated by college students from Clark University and Worcester State University and this initial core group moved on out of Worcester, leaving the organization with only adult volunteers and a lack of a core group of energetic and dedicated leaders to drive the organization forward. This left the organization in a desperate need of volunteers. Even though the Worcester Energy Barnraisers constantly faced this dilemma, the organization still managed to organize some barnraising events in the Worcester community, with their most recent in the spring of 2014.

The main objective of this project is to provide organizational guidance to the Worcester Energy Barnraisers and provide recommendations that will aid in making sure the organization thrives after our direct input. In order to support the organization with suggestions for better management and a better organizational structure, the organization and other similar organizations were researched to give the project team the required background knowledge pertaining to nonprofit organizations dealing with energy sustainability, climate change and home-heating. This helped us to understand the current status of the Barnraisers organization. We then pursued obtaining a first-hand understanding the "barnraising"

process through a participatory planning of an energy barnraising event, as well as raising awareness of the Worcester community through outreach events.

In all, the team learned that the WEBr was operating with a small core leadership team, there was an inconsistent supply of projects, and the Barnraisers difficulties with the organizational structure. We also found that old members of the Barnraisers, as well as others who first heard of the organization from us, all had positive interests in working with the Barnraisers. Nevertheless, the effect of the organizational structure was that there were no upcoming projects in the near future hence no volunteer pool or volunteer recruitment for weatherization events. After obtaining a first-hand understanding of the status of the organization, we developed recommendations and documents based on our results to better assist the WEBr organization.

The main deliverable the team produced at the end of the project was a document covering a set of recommendations framed around the challenges and problems we came across in the project especially while organizing a participatory weatherization event. Supplemental materials to the main deliverable presented include a list of volunteers and other personnel with positive interests regarding the organization, major points to consider when pitching for a barnraising, and a brochure that focuses on securing barnraising locations or projects and volunteers, all in the form of a paper document.

Final Recommendations

1. Include student volunteers like WPI's Green Team in the leadership of this non-profit organization to enhance organizational management.

2. Engage Worcester Energy Barnraisers' members with outreach events, in between weatherization events like tabling and creating a database of potential sites to maintain member interest and enthusiasm.
3. Interact with local community more often, through outreach and on campus events.
4. Continuously search for barnraising sites through site visits, and presentations to building owners.
5. Ensure training of more WEBr members to increase number of BPI certified personnel in the organization, and reduce the burden of leading an official energy audit on the few currently certified.
6. After good organizational structure is in place, assign a WEBr member to handle volunteer correspondence, another to handle barnraising location identification, another to serve as a consistent point of contact and another to plan both outreach and weatherization events.
7. Set up electronic quarterly newsletters to coordinate with the members update them with organizational affairs.

CHAPTER 1: Introduction

Energy sustainability involves the provision of energy services in a sustainable manner, which in turn necessitates that energy services be provided for all people in ways that, now and in the future, are sufficient to provide basic necessities, affordable, not detrimental to the environment, and acceptable to communities and people (Rosen, 2009). Universal agreement on a definition of energy sustainability has not yet been achieved, but various definitions and descriptions have been presented (Rosen, 2009). Energy sustainability can be described as the use of energy resources like electricity and heat obtained from our biophysical surroundings in such a way that makes them remain indefinitely available (Huetting, Reijnders, 1998). However, to the average person in society, energy sustainability relates to utility bills and home heating costs as well as fuel used or natural gas prices for combustion engines. Many socio-economic sustainability factors relate to energy and consequently need to be considered in approaches to energy sustainability. These factors often are linked to the sustainability approaches such as harnessing sustainable energy sources must account for economics, global stability and geographic and intergenerational equity to maintain a sustainability focus. Some energy-related socioeconomic sustainability factors are community involvement and social acceptability, especially during energy-related decisions; economic affordability and equity of energy services to people in society; lifestyle changes; land use and aesthetics balancing (Rosen, 2009).

High usage of electricity and natural gas results in an increase in the cost of production to meet the demands of society. When the cost of production increases, low-income families find it difficult to benefit from the availability of such energy resources to the fullest. For example, according to a statistical data from the Florida Power & Light Corporation, there was an electricity consumption increase of about 6 billion kWh from 1995 to 2008, making 460 million kWh or approximately 8%

increase in electrical energy consumption per year for Miami-Dade County alone in Florida (Florida Power & Light, 2009). In Massachusetts, households alone spend 22 percent more on energy than the U.S. average, paying about \$2500/yr, which is slightly less than the six-state New England region average of about \$2750/yr (EIA, 2009)!

Many nonprofit organizations have dedicated their time and energy to raising awareness about the benefits of energy efficiency and energy conservation, in order to address challenges responsible for carbon emissions, energy savings, climate change, home heating, and community environmental sustainability (Madlener, 2009). High energy efficiency allows the greatest benefits to be obtained from energy options and reduces environmental intrusions, and thus aids sustainability efforts (Madlener, 2009). Efficiency improvements also include energy conservation, fuel substitution, and improved energy management, better matching of energy carriers and demands and more efficient utilization of energy quality (Dimitropoulos, 2007).

One of such organizations is the Worcester Energy Barnraisers. The organization strives to promote environmental sustainability, social and economic justice through collaborative home energy efficiency projects. This project aims to support the Worcester Energy Barnraisers and how it seeks to support and promote efficiency and sustainability, to reduce carbon emissions in the community.

The organization organizes energy sustainability events like outreach and weatherization projects to fix old, leaky, energy inefficient buildings within Worcester with an intent of educating and expanding awareness about energy conservation and sustainability, and teaching the volunteers skills to apply to their dwellings and pass on to others. Specifically, the Barnraisers focus on residential and non-residential buildings that do not benefit from weatherization support available through federal

programs. The public buildings include residential houses that are occupied by low-income earners, disabled, and the elderly. Such public buildings are focused on more because unlike homes, that are able to get help from MassSAVE, buildings like churches and community centers are especially in need of help. As such, the Barnraisers promote environmental justice by helping those in the community that have minimal or no help from elsewhere.

The main challenges the WEBr have are a lack of active volunteers for weatherization or barnraising events and a lack of projects available for willing volunteers. A better understanding of the organization exposed another problem - insufficient number of volunteers within the organizations with separate responsibilities for smooth running of the organization.

The main goal of this project is to provide organizational guidance and recommendations to the Worcester Energy Barnraisers that will aid in making sure the organization thrives after our direct input. We pursued obtaining an understanding of the “barnraising” process primarily through a participatory planning of a weatherization event in order to spot out challenges the Barnraisers were facing that were not evident after interviews with the organization’s core leadership. Also, we raised more awareness of the Barnraisers in the Worcester community through outreach events.

A document with recommendations was provided to the Barnraisers with advice on how to solve problems we came across throughout the whole project especially when organizing a participatory weatherization event. Included as supplementary information in this document were a list of volunteers and other personnel with positive interests regarding the organization, focus points for giving pitches to secure barnraising locations and a brochure that provides focus ideas for securing volunteers.

Before going ahead to analyze the challenges of the Barnraisers, we acquired knowledge about climate change, home heating and the weatherization process which can be found in Chapter 2. The methods section which includes the steps we followed and the actual implementation of our plans for the project can be found in Chapter 3 of this report. Chapter 4 presents the findings and accomplishments. It addresses how much our plans fell into place and what we learned after our hands-on approach of the project. All conclusions were summed up and presented in a chronological manner in conclusion and recommendations of the report (Chapter 5) to evaluate the effectiveness of our efforts in completing the project.

CHAPTER 2: Background

2.1. Overview of Climate Change and Home Heating Concerns

2.1.1. Climate Change

Our climate is changing now. Changes in the atmospheric abundance of greenhouse gases and aerosols in solar radiation and in land surface properties alter the energy balance of the climate system. Global atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased markedly as a result of human activities since 1750. The concentrations now exceed pre-industrial values determined from ice cores spanning many thousands of years (I.P.O.C Change, 2007).

Scientists have found that the four most important variable greenhouse gases whose atmospheric concentrations can be influenced by human activities are; carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and chlorofluorocarbons (CFCs). Historically, CO₂ has been the most important, but those other atmospheric trace gases are also radioactively active in that they can affect Earth's heat budget leading to a greenhouse warming of the lower atmosphere (Justus, 2001). The climate is changing at an alarming rate due to increase in carbon emissions (I.P.O.C Change, 2007).

The global atmospheric concentration of carbon dioxide increased from a pre-industrial value of about 280 parts per million (ppm) to about 379 ppm in 2005 (Justus, 2001). A large number of scientists believe that human activities are to blame for this increase atmospheric concentrations of carbon dioxide (CO₂) by 35% from pre-industrial values of 280 ppm to 378 ppm over the past 150 years (Justus, 2001). The annual carbon dioxide concentration growth-rate was higher in last 10 years (1995 – 2005 average: 1.9 ppm per year) as compared to the beginning of continuous direct atmospheric measurements (1960 – 2005 average: 1.4 ppm per year) although there is year-to-year variability in

growth rates. The global increases in carbon dioxide concentration are primarily due to fossil fuel use and land-use changes (I.P.O.C Change, 2007).

The increasing carbon dioxide concentration is leading to an increase in global average temperatures. National Oceanic and Atmospheric Administration's (NOAA) researchers reported that the 12 warmest years (globally averaged since historical records have been kept) occurred in the past two decades with 1990 and 1998 among the warmest (Justus, 2001). Global temperatures have already risen 0.6 degrees C (0.9 degrees F) in the last 100 years, and, according to model projections, might rise anywhere from as little as 1.8 degrees C to as much as 7.1 degrees C (2.7 degrees F to 10.7 degrees F) over the next 100 years (Justus, 2001).

Not only does climate change imply hotter weather but also extreme weather events including prolonged periods of heat, heavy downpours, floods and droughts. These events have all become more intense as well. In addition, global warming is causing sea levels to rise and glaciers and Arctic sea ice to melt. Oceans are becoming more acidic as they absorb carbon dioxide from the atmosphere, and climate change is impacting biodiversity coupled with disruptions in the ecosystems (GlobalChange.gov, 2015). Mountain glaciers and snow cover have declined on average in both hemispheres. Widespread decreases in glaciers and ice caps have contributed to sea level rise (ice caps do not include contributions from the Greenland and Antarctic ice sheets (Change, 2007).

Weather and climate play a significant role in people's health. Changes in climate affect average weather conditions that we are accustomed to. Warmer average temperatures will likely lead to hotter days and more frequent and longer heat waves. This could increase the number of heat-related illnesses

and deaths. Increases in the severity of extreme weather events such as storms could increase the risk of dangerous flooding, high winds, and other direct threats to people and property (EPA, 2013).

Agricultural productivity is expected to be sensitive to global climate change. Models from atmospheric science, plant science, and agricultural economics are linked to explore this sensitivity. Although the results depend on the severity of climate change and the compensating effects of carbon dioxide on crop yields, the simulation suggests that irrigated acreage will expand and regional patterns of U.S. agriculture will shift. The impact on the U.S. economy strongly depends on which climate model is used (Adams, 1990).

Scientists have established that in order to preserve a livable planet, the amount of carbon dioxide (CO₂) in the atmosphere must be reduced from its current level of 400 ppm (parts per million) to below 350 ppm (350.org, 2008). Such changes in atmospheric carbon dioxide concentration manifest as fluctuations in weather patterns - colder winters and warmer summers that make home-heating and cooling more difficult thus leading to increased energy demand and ultimately to climate change. They are primarily due to the increase in carbon footprint, which began its race to the sky after the start of industrial revolution. Carbon dioxide emission has been increasing over the years since 1958 with a break of the optimum upper concentration level of 350 ppm in 1985.

In climate science, radiative forcing or climate forcing, is defined as the difference of sunlight absorbed by the Earth and energy radiated back to space. Usually, radiative forcing is quantified at the tropopause in units of watts per square meter of the Earth's surface. A positive forcing (more incoming energy) warms the system, while negative forcing (more outgoing energy) cools it. Some causes of radiative forcing include changes in insolation and the concentrations of radioactively active gases,

commonly known as greenhouse gases and aerosols (Forster, Piers, et al, 2007). In essence, increasing carbon dioxide emissions give the Earth's surface a positive forcing, and result in global warming. In Figure 1, data collected via ice cores and modern data are used to show the sharp exponential increase in Greenhouse gases including CO₂ for the last 10,000 years.

Changes in Greenhouse Gases from ice-Core and Modern Data

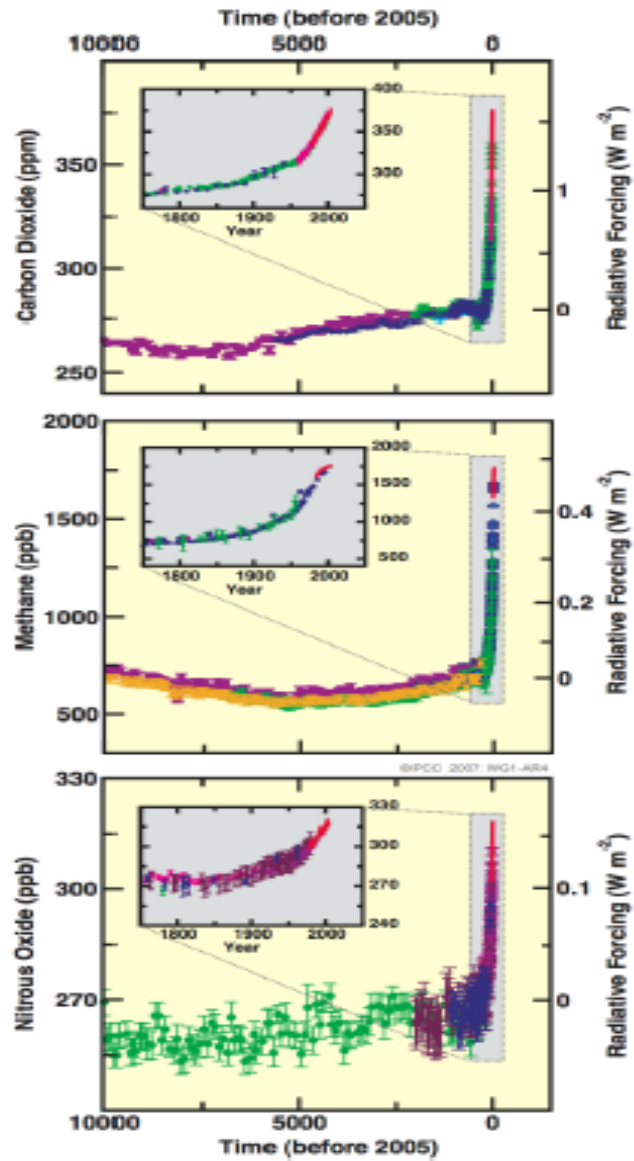


Figure 1: Atmospheric concentrations of carbon dioxide, methane and nitrous oxide over the last 10,000 years (large panels) and since 1750 (inset panels). Measurements are shown from ice cores (symbols with different colours for different studies) and atmospheric samples (red lines). The corresponding radiative forcings are shown on the right hand axes of the large panels. (I.P.O.C Change, 2007).

2.1.2. The Importance of Energy Conservation in Home Heating

Energy conservation can be described as methods for saving energy or preventing waste of energy that can be used to do some work. These methods include lowering thermostat settings to avoid overheating or overcooling, using less hot water by installing low flow-heads on showers, buying cars that have higher mileage per gallon, and choosing reusable products over disposable ones and recycling to mention a few.

Energy conservation and energy efficiency are often used interchangeably. The main difference is that energy efficiency measures the difference between how much energy is used to provide the same level of comfort and performance by the same type of product, building or vehicle, whereas energy conservation refers to saving energy or using less energy, like turning off lights not in use or adjusting thermostat settings as needed. Energy conservation usually involves a behavioral change while energy efficiency involves primarily technological changes (National Resources of Canada, 2010).

Countries in the temperate regions of the Earth experience seasons - spring, summer, fall and winter. During the fall and winter seasons, home heating is a practice that everyone indulges in to be protected from the dangerously cold temperatures. Everyone who lives in regions that experience snowy cold winters, such as Worcester, Massachusetts, knows the challenges of home heating costs. This is a big challenge for communities with a large number of low-income families because it is quite a costly practice with total energy use in residential houses of 29% attributed only to heating. This is depicted in the bar graph below in Figure 2.

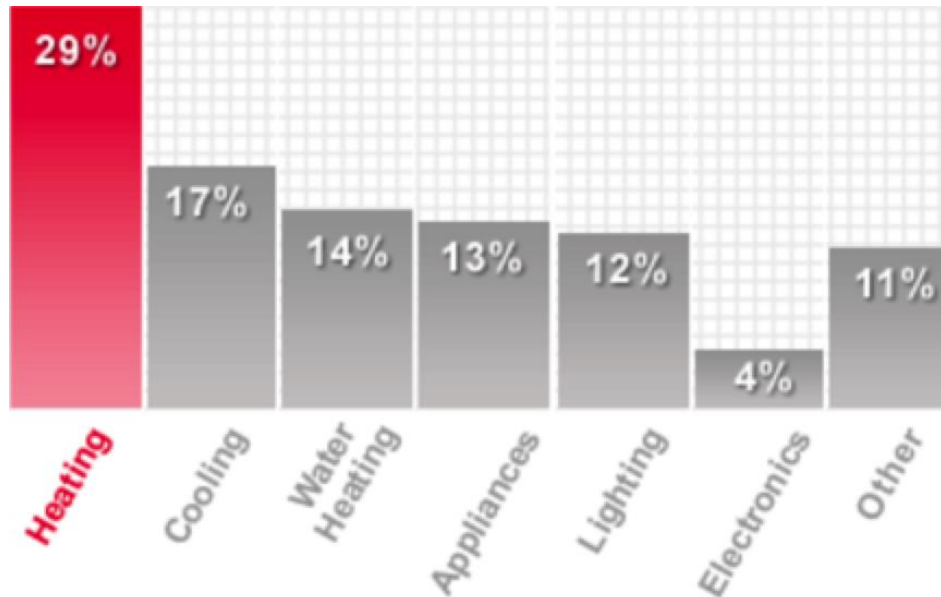


Figure 2: Estimated percentage of energy use in residential houses. https://www.energystar.gov/index.cfm?c=products.pr_where_money. (ENERGY STAR, 2013).

As such, for families that find it difficult to afford more advanced methods of home-heating, energy efficiency practices, like repairing old heating systems or energy conservation methods such as sealing gaps or spaces that allow heat to seep out to the environment from a building must all be well followed to ensure the safety and comfort of all residents in the community.

2.2. Home Heating and Energy Sustainability in Worcester

Worcester is the second largest city in Massachusetts. Located at the center of the state, it has the connotation of being the Heart of the Commonwealth (Secretariat, C., 2002). Massachusetts is located in New England and has a humid continental climate. Specifically in Worcester we have hot summers and bitterly cold snowy winters. This past winter (2014-15) up until late February, Worcester, Massachusetts was the snowiest city in America (Fritz, A., 2015). Bitter winters combined with dated buildings and homes built in the height of the industrial revolution are not a good combination for home

energy efficiency. As industry expanded and the ranks of workers swelled, builders constructed wooden triple-decker housing units near the factories (Worcester Historical Museum, 2013). The construction of many of these triple-deckers happened during the turn of the century when energy efficiency was not valued.

The local government is very active in its desire to make Worcester as green as possible. They have established Energy Task Force which created a Climate Action plan and published it back in December of 2006. Contained in the plan are a variety of objectives to further Worcester's energy sustainability, like developing a 250 KW windmill at new North High School and potential methane generation from Greenwood Street landfill. This new initiatives among many others are the basis for which the city manager has coined Worcester "the Green Heart of the Commonwealth" (Climate Action Plan Report).

Even with the great sense of a green community action and energy conservation Worcester still has the need for volunteers and organizations. This is the gap the Worcester Energy Barnraisers fill. They are a non-profit organization that provides weatherization to residents and other non-profit organization events, outreach events in the Worcester communities. Federal and state government subsidies, like MassSAVE, exist, but many non-profit organizations or apartment owners do not qualify for the rebates or could not do the major work that would warrant them. As such, the Worcester Energy Barnraisers come in to help these churches, community groups and apartment owners with absentee landlords that are all in need of help. These events are organized in hopes to educate the public and reduce the energy inefficiency of buildings with the use of simple tools and materials. Since the founding of this organization in 2009, the Worcester Energy Barnraisers have always hoped to achieve

environmental justice by making weatherization opportunities accessible to everyone and supporting environmental sustainability throughout central Massachusetts (Sutton, 2012).

2.3. Weatherization

2.3.1. What is weatherization? What are the impacts?

Weatherization is the practice of insulating and reducing energy transfer and consumption across a boundary layer (walls/windows) to optimize energy efficiency. This is done to protect the building from adverse weather conditions like precipitation, wind, cold, and scorching sunlight (Energy.gov, 2015).

Weatherization is a tough business because insulating a building is physical dirty work that can take you into tight uncomfortable spaces. It requires someone to work in confined spaces and at temperatures such as 140°F wearing a respirator (Van Hoesen et al., 2013).

The weatherization of homes for low-income households can have broad, positive effects on human health and safety. It can eliminate many environmental risks that threaten the health of low-income households like chemical outgassing, fungi, lead, radon, and even asbestos. This is why many non-profit organizations concentrate on low-income households because they are aware of the impact weatherization has on the communities and would like to increase its impact on them (Medicinenet, 2015).

The weatherization of homes and buildings has some economic benefits as well as human health benefits and advantages. Even in times of relatively stable low fuel prices, a 20% to 30% return on investment in fuel savings is the norm. Even better are the long-term maintenance issues, such as

peeling paint and ice damming that effective weatherization helps to solve. Best of all is the increased level of comfort for the home's residents (Van Hoesen et al., 2013).

2.3.2. Evaluation and Audits

2.3.2.1. What is an energy audit? Who does energy audits and how are they done? What do you get from an audit?

A professional energy audit gives people a thorough picture of where and how a building structure is losing energy and what can be done to reduce the loss and save money. A nationally recognized Building Performance Institute (BPI) certified energy auditor assesses the energy efficiency of buildings and conducts an energy consumption test based on the appliances and systems installed in the home (BPI.org). The professional then provides the homeowner with a list of energy-saving recommendations for the home. This helps the homeowner to develop a plan to make the home more efficient (MassSAVE, 2014).

Homeowners should expect the following from an energy audit:

- A home energy assessment which usually takes 1.5 to 2.5 hours.
- All key decision-makers, that is homeowner(s), should be present at the assessment.
- The specialist will help the homeowner develop an energy plan and explain applicable incentives that are available.

Most people have reported saving 5%-30% on energy bills after making upgrades that the home energy assessment identified. These upgrades are eligible for state, local, or utility incentives (MassSAVE, 2014). Energy audits are extremely helpful indicators that guide and educate the homeowner, and especially the low-income households because they reduce utility bills by making long-

term energy-efficiency improvements to their homes. These improvements can make a significant financial difference for the homeowners.

2.3.2.2. Some Advanced Auditing Tools

Some advanced tools that are used for auditing exist, however, they are not too common to the basic energy auditor due to the special skills and training required for their use. The two described below are the blower door and the thermal imaging camera.

Blower Door Test

A blower door is a device that tests air tightness of a building (WAPTAC, 2007). It has a powerful fan that mounts into the frame of an exterior door of a building. The fan then pulls air out of the house and lowers the air pressure inside. The higher outside air pressure then flows in through all unsealed cracks and openings. The auditors may then use a smoke pencil to detect air leaks. These tests determine the air infiltration rate of a building (Energy.gov, 2015). Blower doors are fit in the space where a door leading to the exterior of a building would fit. A typical set-up of an actual blower door test is shown below in Figure 3.



Figure 3: Blower door test during a home energy audit. <https://www.holtkamphvac.com/>. (Holtkamp Heating & A/C, Inc., 2012).

Thermal Imaging Camera

Thermal imaging cameras don't actually see temperature; they capture the infrared (IR) energy transfer from an object to its environment and produce a real-time image in a color palette where hotter objects appear brighter (reddish) and cooler objects appear darker (bluish).

Thermal imaging cameras are becoming popular in the home inspection industry where they are being used to verify building performance to specifications to determine insulation condition, locate leaks, verify structural design, and to locate moisture intrusion. These are not the only thermal imaging camera applications for their use is limited only by the imagination of the user. Primarily, thermal

imaging cameras are used where the identification of thermal patterns can be used to diagnose a condition, such as poor insulation in a home or an overloaded electrical circuit (GRAINGER, 2015).

Examples of thermal imaging camera photos are shown in the figure below. The blue/black areas are the air drafts where cold air is leaking in. Below Figure 4, and in Figure 5, the reverse colors are seen when heat from outside is penetrating into the temperature control indicated by the camera. In general, thermal imaging camera applications include:

- Substation electrical inspections
- Thermal heat loss inspections of buildings
- Locate radiant heating wires or pipes
- Locate potential areas for mold growth
- Flat-roof leak detection for buildings
- Detect thermal patterns on boiler tubes
- Mechanical bearing inspections
- Detect insulation leaks in refrigeration equipment

Thermal Imaging – Under Pressure

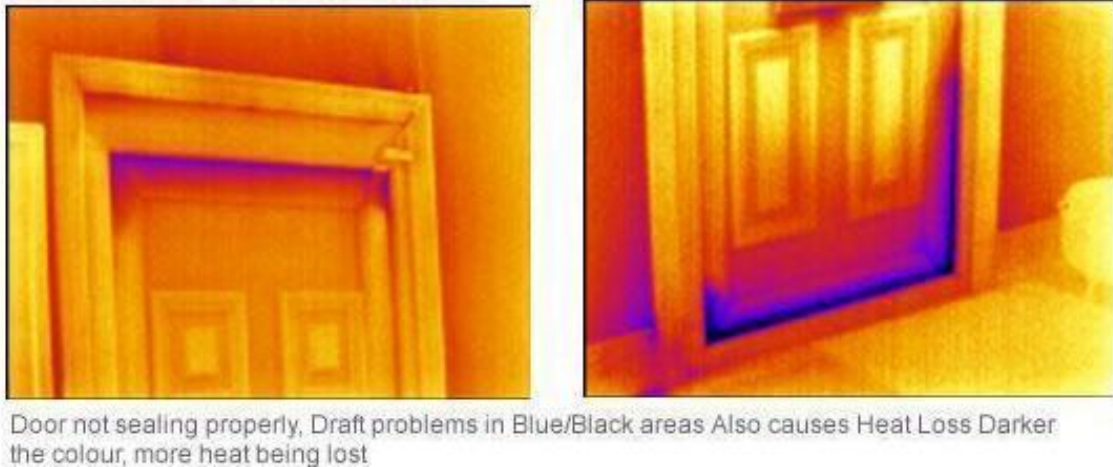


Figure 4: Typical thermograph taken during a home energy audit. <http://www.iber.ie/imaging>. (IBER Consultancy Services, 2009).



Figure 5: Thermograph taken from a different home energy audit. <http://www.iber.ie/imaging>. (IBER Consultancy Services, 2009).

2.3.3. Weatherization techniques

As new or strange as the term weatherization may be to some, it actually involves a couple of simple, easy-to-learn tasks with common everyday tools. With some research and trial and error anyone can perform the basic types of weatherization.

2.3.3.1. Insulation

For optimal energy efficiency, the homes should be properly insulated from the roof down to its foundation. In addition to insulation, you have to consider moisture and air leakage control in each area of the house. Properly installed insulation reduces heating and cooling costs by reducing heat losses and gains through a home's building envelope (Energy.gov, 2015).

Insulation materials run from bulky fiber materials such as fiberglass, rock and slag wool, cellulose, and natural fibers to rigid foam boards to sleek foils. Bulky materials resist conductive and to a lesser degree convective heat flow in a building cavity. Rigid foam boards trap air or another gas to resist conductive heat flow. Highly reflective foils in radiant barriers and reflective insulation systems reflect radiant heat away from living spaces, making them particularly useful in cooling climates (Energy.gov, 2015). An example of a blown-in-insulation of a home's attic is shown in the figure below. An insulation professional is filling the attic of a home by using blown-in-insulation.



Figure 6: An insulation professional filling the attic of a home with blown-in insulation. A respirator is used because certain types of insulation can be hazardous to the lungs and so one must adhere to all manufacture safety warnings. <http://www.greenbuildingadvisor.com> (Green Building Advisor, 2015).

2.3.3.2. Air Sealing

Air-sealing is typically one of the first steps taken on any weatherization project. While individuals tend to think that insulation is all they need for their attic, they don't realize that insulation alone doesn't actually stop air movement, it just slows it down. Combinations of foam board and spray foam to air seal are usually used by contractors in order to fix this problem. The home energy audit will outline areas in the home in need of air sealing work so that the owners can undertake these retrofits themselves or to guide other contractors through proper installation (EDGE Energy, 2015).

Air leakage is a major source of energy loss as well as discomfort in many homes. Common areas of air leakage as shown in the figure below, including knee walls, recessed lights, attic hatches, windows and doors, flue and duct chase ways, vents, wiring holes, cantilevers, band and rim joists, etc. Besides the cost and comfort issues, air leakage also contributes to issues with indoor air quality by allowing moisture, mold and dust to enter inside conditioned space from the attic, crawlspace and outside (EDGE Energy, 2015).

Common Household Air Leaks

- A** Behind Kneewalls
- B** Attic Hatch
- C** Wiring Holes
- D** Plumbing Vent
- E** Open Soffit (the box that hides recessed lights)
- F** Recessed Light
- G** Furnace Flue or Duct Chaseways (the hollow box or wall feature that hides ducts)
- H** Basement Rim Joists (where the foundation meets the wood framing)
- I** Windows and Doors

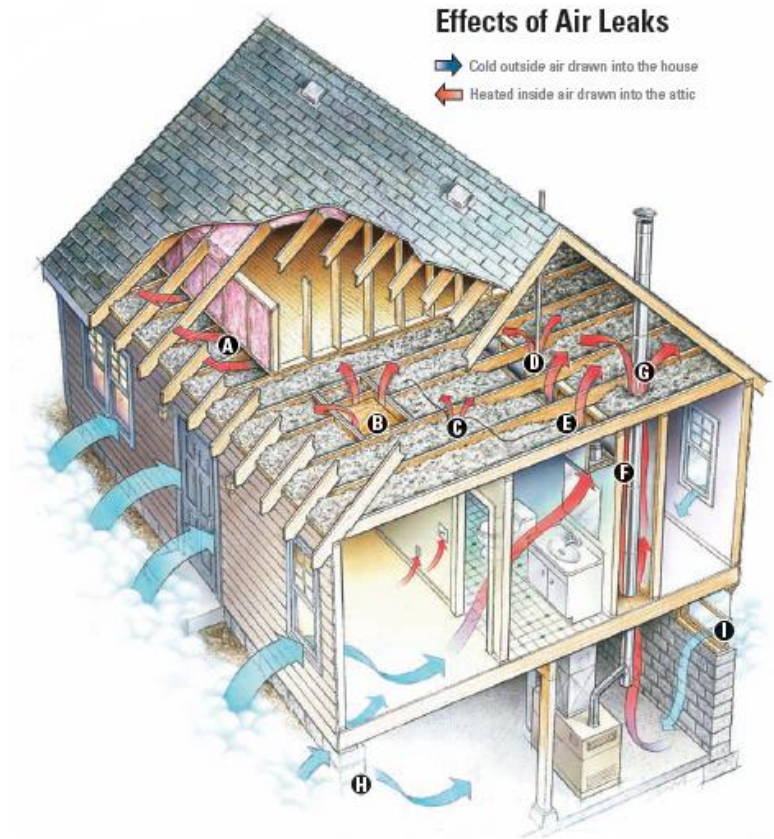


Figure 7: Locations where household air leaks are common. <http://www.familyhandyman.com/attic/how-to-seal-attic-air-leaks/view-all>. (The Family Handyman, 2015).

2.3.3.3. Moisture Control and Ventilation

When creating an energy-efficient, airtight home through air sealing, it's very important to consider ventilation. Unless properly ventilated, an airtight home can seal in indoor air pollutants. Ventilation also helps control moisture—another important consideration for a healthy, energy-efficient home (Energy.gov, 2015).

[2.3.3.4. Weather-stripping](#)

Weatherstripping is an easy and cost-effective way to save money on energy costs and improve comfort by reducing drafts in the homes. People use weatherstripping in their homes to seal air leaks around movable building components, such as doors or operable windows. For stationary components, caulk is the appropriate material for filling cracks and gaps.

[2.3.3.5. Air Duct Sealing](#)

Sealing a leaky duct system can be single handedly the most cost-effective way to reducing your home's heating or cooling bills. Through research we found that in some older homes, those that have ducting built into stud bays, energy retrofits can improve the air handler's performance by over 50% and drastically reduce indoor air quality problems, and sources of pollution according to EDGE Energy. Our own health and safety can be influenced by the HVAC duct performance, so it's crucial to take appropriate measurements (EDGE Energy, 2015). An example of air duct sealing is illustrated in Figure 8 below, where a technician is fixing and correcting problems in the air duct by using special air duct sealing tape alongside chemical solutions.



Figure 8: A typical air duct sealing procedure. <http://www.goodmanphc.com/>. (Goodman Plumbing, Heating & Cooling, 2015).

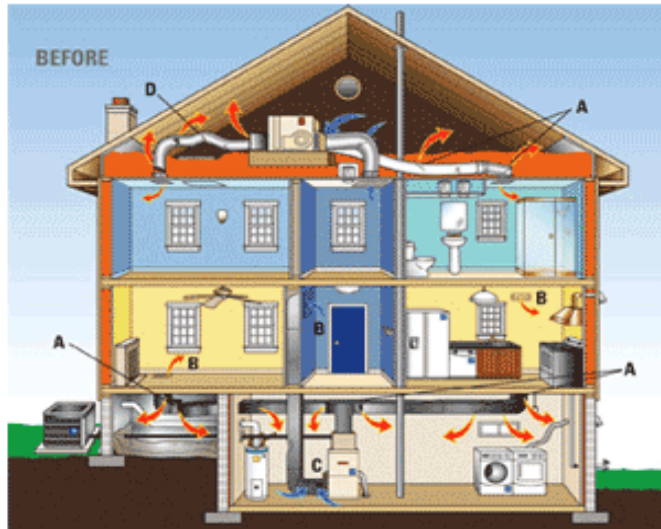
According to the U.S. Department of Energy, in a typical house as much as 20% and in some cases 50% of the air moving through the ductwork system is lost because of duct leaks (Energy.gov, 2014). Duct leakage forces your HVAC system to work harder and longer in order to meet the temperature setting on your thermostat. Leaky ducts also cause "bad" air from your basement, crawlspace or attic to be drawn into your system and distributed throughout the house. Duct sealing is an energy-saving upgrade that will pay off by improving interior comfort and air quality while reducing your utility bills. It's smart to have this work done by an experienced professional because a typical ductwork system contains different duct materials and many different fittings and connections. A technician familiar with air duct sealing will know what materials and duct sealing techniques work best on different parts of your ductwork system (Goodman Plumbing, Heating & Cooling, 2012).

An air duct system that is well-designed and properly sealed can make any home more comfortable, energy efficient, and safer for everyone. Sealing and insulating ducts can make homes and

buildings more comfortable during the summer and winter. A consequence of poor air duct systems is rooms that are too hot in the summer or too cold in the winter (Acosta Heating and Cooling, 2015).

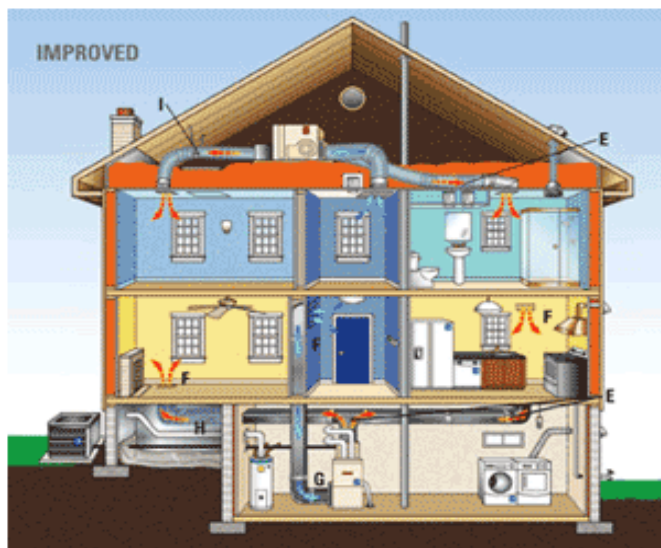
Fumes from household and garden chemicals, insulation particles, and dust can enter the duct system, aggravating asthma and allergy problems. Sealing ducts can help improve indoor air quality by reducing the risk of pollutants entering ducts and circulating through the home.

Leaky ducts can reduce heating and cooling system efficiency by as much as 20%. Sealing and insulating ducts increases efficiency, lowers energy bills, and can often pay for itself in energy savings. Also, by installing new heating and cooling equipment, a well-designed and sealed duct system may allow the owner to downsize to a smaller, less costly heating and cooling system that will provide better dehumidification (Goodman Plumbing, Heating & Cooling, 2012). An example of common air duct problems and solutions are indicated in the figure below.



Common Duct Problems and Solutions

- A. Leaky, torn, and disconnected ducts
- B. Poorly sealed registers and grills
- C. Leaks at furnace and filter slot
- D. Kinks in flexible ductwork restricting airflow



Solutions

- E. Properly sealed ducts
- F. Registers and grills tightly sealed to ducts
- G. Sealed furnace and filter slot
- H. Well-insulated ducts in unfinished areas
- I. Straightened flexible

Figure 9: Common duct problems and solutions that can be adopted during a weatherization project. <http://www.goodmanphc.com/>. (Goodman Plumbing, Heating & Cooling, 2014)

Energy used in the homes often comes from the burning of fossil fuels at power plants, which contributes to smog, acid rain, and climate change. So, the less energy we use in our homes, the less air pollution we generate. By sealing the ducts and reducing the amount of energy necessary to comfortably heat or cool the home, people can reduce the amount of air pollution generated (EIA, 2015).

[2.3.3.6. Window Replacements](#)

New windows can increase the home's value and energy savings. In fact, according to ENERGY STAR®, replacing old windows with new ENERGY STAR® qualified models yields between 7 and 15 percent annual savings on household energy bills (Jeld-Wen.com, 2015).

There are many good reasons to replace windows such as durability, safety, or simply to add equity to the home. Energy efficient replacement windows typically have multiple panes and a low-emissivity coating. The low-emissivity coating blocks infrared radiation transmission, keeping warm air in the winter and heat out in the summer. Between the multiple panes, Argon, Krypton, or other non-toxic gases form an insulation barrier. Similar to replacement doors, the most energy efficient windows meet the new 2010 Energy Star performance levels, and can also help people save up to 15% on energy costs (EDGE Energy, 2015).

[2.3.3.7. Plastic Film Insulation for Windows](#)

You don't have to buy all new expensive windows to save on your energy bills during the winter time. In fact, it has been shown new windows don't offer nearly the return on investment that other more affordable energy upgrades like light bulbs and added wall insulation do. Plastic window insulation typically costs about 20 cents per square foot and provides tremendous cost savings for people with drafty windows. Installing it is relatively easy and can be done on your own (erc-co.org, 2015).



Figure 10: Weatherizing windows with Plastic Film insulation. <http://www.homerepairtutor.com/how-to-weatherize-windows-with-plastic-film-insulation/>. (Patterson, 2014).

One way to stop the cold air flow is to use plastic film insulation on windows or bubble wrap, which is a plastic film with air filled pockets. Both of these products are very inexpensive and they will insulate windows very well. Plastic-insulated windows can save significant money and energy and don't look bad when they're done right. An example of plastic film insulation is shown in the figure above, where a homeowner is in the process of insulating the window with the insulating film.

Steps how to install the window insulation:

1. After you have caulked and applied weather-stripping around the windows, place the double-sided tape a couple inches away from the window on the windowsill.
2. Remove anything that protrudes from the window, such as a handle, that will poke into the plastic.

3. Premeasure the plastic so the piece is more manageable and you're not wasting a lot of the plastic. Begin sticking it from the middle out.
4. Work with a partner. It makes the process much easier.
5. Use a blow-dryer to tighten the plastic.
6. Trim the edges.

2.3.3.8. Crawlspace Treatment

For houses without basements, the crawlspace takes its place as a top priority area for weatherization. Crawlspaces often have issues with moisture, which down the road leads to mold and wood rotting problems. Furthermore, this moisture can find its way into the house, causing indoor air quality problems as well as raising cooling and heating bills. HVAC duct work is often located in the crawlspace, and can further add to air quality problems if it's leaky, which will suck the dust and damp air from the crawlspace into the HVAC unit, and into your home (Basement Systems, 2015). A possible problematic duct is shown in the figure below.



Figure 11: A crawlspace that needs some attention or treatment (before weatherization). <http://edge-gogreen.com/home-performance/home-performance-and-weatherization/crawlspace-weatherization/>. (EDGE Energy, 2015).



Figure 12: The aftermath of a crawlspace treatment procedure (after weatherization). <http://edge-gogreen.com/home-performance/home-performance-and-weatherization/crawlspace-weatherization/>. (EDGE Energy, 2015).

Trained weatherization specialists will lay down a vapor barrier on the floor of the crawlspace, which will put an end to the moisture issues. The result of the whole process is shown in the figure

above. Any penetrations up to the living space are air-sealed using spray-foam, and insulation is properly installed (or re-installed) on the above floor. If any HVAC ductwork is present, they will properly seal and insulate it.

Depending on the configuration, the specialists will also decide whether to keep it vented or close off the vents, and install insulation on the walls. The moisture problems will cease quickly after the weatherization, and the heating and cooling bills will begin to shrink (Basement Systems, 2015).

Another place to concentrate on is the common wall between the house and its attached garage, if there is one. Air leaks here always have the potential to vacuum car exhaust, solvent and weed-killer fumes, and fuel gases into the living space, so this is a spot that requires a NASA-grade air-seal. Obvious holes are usually easy to find and fix in the open framing. Caulking framing and sheathing joints down to and along the foundation makes a big difference (Van Hoesen et al., 2013).

Research shows the common places in a building that are susceptible to air leakages are in the places such as floors, walls, ceilings, air ducts, fireplaces, plumbing penetrations and doors as shown in the figure below.

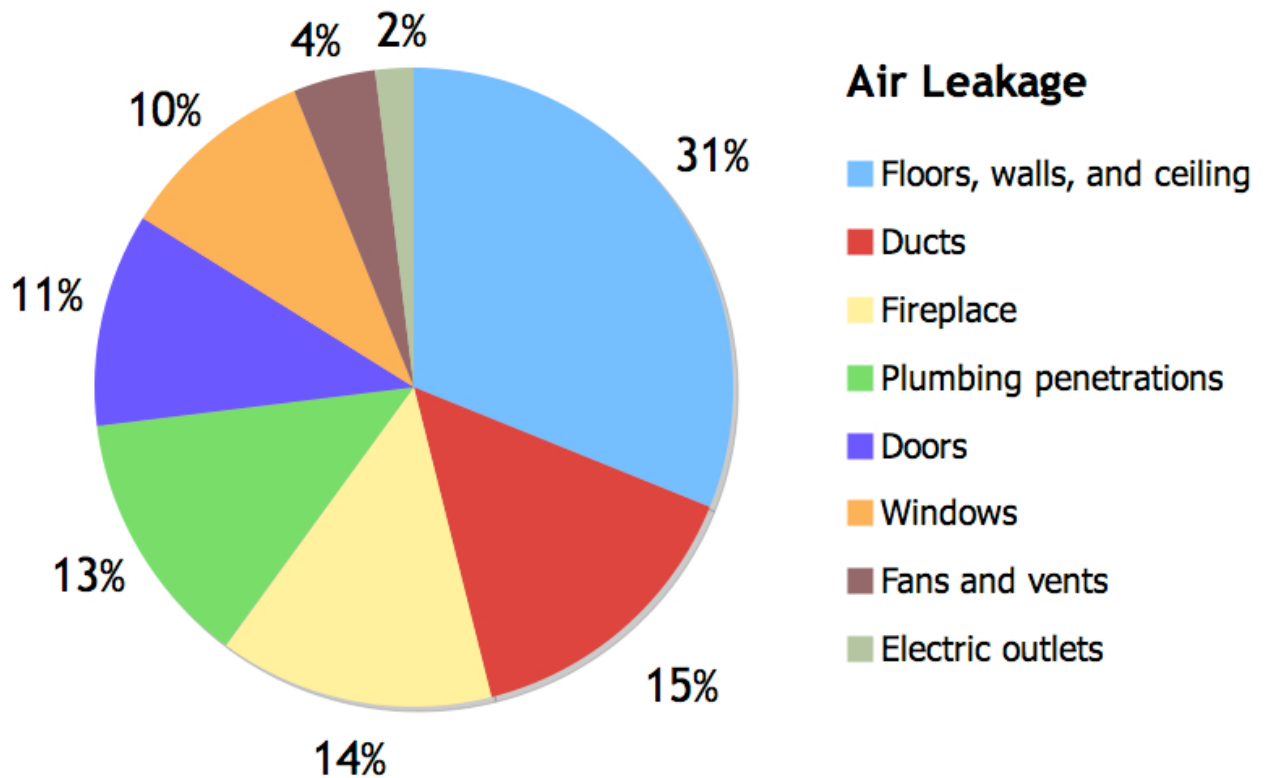


Figure 13: Pie chart of common sites for air leaks out in most of our U.S. homes. <http://cleancrawls.com/services/weatherization-air-sealing/>. (Clean Crawls, 2014).

2.4. Nonprofit Organizations and Management

2.4.1. Nonprofits and their roles in the community

A non-profit organization is defined as an association that conducts business for the benefit of the general public without shareholders and without a profit motive (Chastain, 2013). A non-profit organization raises money or performs deeds for a specific cause or set of causes. For instance, an organization that uses its revenue to feed the homeless or educate children is a typical example of a non-profit. These organizations receive revenue by soliciting donations from the community or selling items to raise funds for their causes that they introduce in their communities. Such organizations fall

into the Internal Revenue Service (IRS) tax code “501” (Anheier, 2009). While each individual nonprofit's goals may be different, they all strive to fill a gap in their particular community or help an underprivileged group.

The nonprofit sector has experienced decades of growth in relatively stable political environments, at least in EU countries and the United State (Anheier, 2000). From 2000 to 2010, the number of non-profit organizations in the United States has grown from 1.26 million to 1.56 million, a massive 23.6% growth (Blackwood, 2012). This growth of non-profit organizations correlates to the growth of wealth in the United States, technological innovations, an increase in philanthropy, and a need for non-government social services (Dang et al., 2014).

Even in industrial countries, the nonprofit sector has become a major economic force. In the 22 countries studied by the Johns Hopkins Comparative Nonprofit Sector Project, which includes the US, the UK, France, Germany and Japan, the nonprofit sector employed on average 5% of total employment (Salamon et al, 1999).

A non-profit does not operate in an effort to build wealth or revenue for the benefit of the owner, directors or shareholders. The main goal of a non-profit is to generate funds and volunteer assistance to help further its chosen cause. A non-profit organization can also act as a publicity vehicle to bring more attention to an issue in the community (Balle, 2010). Non-profit organizations in general can help build a community in a way that government or private businesses cannot. They help connect the community to arts and culture, assist in ensuring public safety, help with economic development, and provide mental health and other social services.

From the research conducted we have found that communication between the non-profit organization core members is vital fact for ensuring a successful outcome of the whole organization. The plea for good communication is very common among those who have experienced collaboration, probably because of the frustration that poor communication induces. From research conducted we have observed a distinction between three different communication channels which are the communication between the people in the core group; the communication between the core group and the organizations concerned; and the communication between the collaboration and the wider community (Bryson, 1988).

Organizational management plays a large and very important role in the success or failure of a nonprofit. Specifically the size and scope of a nonprofit's management can have a large impact on its success. A risk resulting from the nonprofit sectors recent move to the market is that smaller agencies will be at an increasing disadvantage. Successful adaptation to the prevailing market pressures increasingly requires access to advanced technology, professional marketing, corporate partners, sophisticated fundraising, and complex government reimbursement system, all of which are problematic for smaller agencies (Herman, 1994). The Worcester Energy Barnraisers fall into this “small agency” category and suffer many of the same issues.

2.4.2. Other nonprofits and organizations that support home energy efficiency in Massachusetts.

2.4.2.1. Home Energy Efficiency Team (HEET)

Home Energy Efficiency Team is a non-profit organization that operates from Cambridge, MA. It started out its first missions in 2008, right after a New England winter storm which caused massive

power outages throughout the state of Massachusetts and New Hampshire. This led to establishment of the Energy Upgrade Work Party as a monthly program from that day on, which became more popular and attracted more volunteers who were excited and ready to assist the community. So far HEET has organized more than 225 Energy- Upgrade Work- Parties, assisted with more than 50 solar installations, and installed over 5,000 compact fluorescent lamps for various buildings. They have trained more than 3,500 volunteers on how to save energy, reduce carbon dioxide (CO₂) content in the atmosphere which is equivalent to the gaseous emissions produced by 2,169 cars in a year. They have also saved more than 3 million gallons of water, which equates to at least \$2.7 million in energy and water bills over the lifetime of the measures in Greater Boston (HEET, 2013). HEET is one of the few groups that provide free and realistic education to local communities through educating people on how to fully benefit from taking energy efficiency and water conservation measures in their homes (HEET, 2013).

2.4.2.2. MassSAVE

MassSAVE is a government-funded program that works faithfully with the Massachusetts Department of Energy Resources to deliver a wide range of services, incentives, trainings, and information promoting energy efficiency that help residents and businesses manage energy use, and related costs and services. MassSAVE can also help the homeowners to find income-based energy programs near their communities or homes, depending on their eligibility. The goal of this program is not only to provide excellent service to eligible residences, but to encourage homeowners, small businesses, and enormous corporations to manage their energy costs and reduce greenhouse gas emissions. We all have a role to play in creating more energy efficient communities, and by making smarter choices in our daily lives in order to enhance the value and the comfort of our homes and businesses.

MassSAVE has introduced a new service for homeowners called home energy assessment. A home energy assessment is a professional audit of how you use energy in your home and where you can make improvements by implementing the help of new technologies, and by making changes homeowners can save you money on their monthly energy bills.

Also, MassSAVE offers training, incentives, and educational resources to contractors, manufacturers, entrepreneurs, building/facility managers, architects, developers, building managers, and facilities teams so people can recommend, install, and maintain the latest generation of energy-efficient equipment by helping their customers achieve their energy goals and objectives.

2.4.2.3. The Weatherization Assistance Program

The Weatherization Assistance Program (WAP) is a federally funded program aimed at helping homeowners and renters keep heat in their homes by reducing heating and cooling costs of low-income families while ensuring their health and safety. It is part of Worcester Community Action Council (WCAC) which has contracted with Department of Energy (DOE) and local utility companies to improve energy efficiency. WAP is funded by the annual grant from the DOE and services delivered by a network of local agencies. About \$4500 or less is spent on efficiency measures per qualified household. With the help of a certified auditor, the buildings are assessed for conservation needs free of charge (Mass.gov, 2015).

Weatherization subsidy programs include MassSAVE that is concerned with helping Massachusetts's residents save on energy costs. This involves online assessment of home free energy. Weatherization requires that families and units must meet maximum gross income limits for all the occupants (Worcester Energy Barnraisers, 2014). The table below summarizes the income limits to qualify for weatherization.

| Household Size: | 1 Person | 2 People | 3 People | 4 People | 5 People |
|------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Annual Income: | \$22,340 | \$30,260 | \$38,180 | \$46,100 | \$54,020 |
| Monthly Income: | \$1,862 | \$2,522 | \$3,182 | \$3,842 | \$4,502 |

Figure 14: Income qualifications for Weatherization via WAP (Community Action Center, 2011).

2.4.2.4. Next Step Living

Next Step Living is a home weatherization company based in Boston, Massachusetts which serves customers throughout Connecticut, Massachusetts and New York. This company is different from a non-profit because it has paid employees, and it charges for its services. They focus on and provide services in the follow categories; home energy assessment, weatherization work (air sealing and insulation), roofing and windows, heating and cooling (ductless mini splits, HVAC systems) and solar panel installation. With similar weatherization procedures as the Worcester Energy Barnraisers, Next Step living performs an energy audit of a home, but depending on the building’s location, the service may not be free. In this audit, an expert will complete top-to-bottom inspection of the home and provide recommendations for saving money and if needed “Instant Savings Measures” such as high-efficiency light bulbs, water-saving fixtures and programmable thermostats can be provided. Energy-efficient CFLs (compact fluorescent lamps) can save you \$40 over the life of the bulb. As well additional information can be provided on “rebates and incentives” could be provided in the initial home energy audit.

Next Step Living is a BBB Accredited Business with an A+ rating and has more than 800 employees in Massachusetts, Connecticut and New York. It claims “Since 2008, Next Step Living has

helped homeowners achieve more than \$26.8 million in energy savings, which is expected to grow to more than \$135 million over the next five years. The estimated impact of the tens of thousands of homes we've served is an annual carbon emissions reduction of more than 100,000 metric tons. That's the equivalent of removing more than 21,000 fossil fuel-burning cars from the road" (Next Step Living, 2014). Though Next Step Living is a for-profit business, it does help its customers save money, especially in helping them to take advantage of federal and state incentives.

2.4.3. The Important Role of the Worcester Energy Barnraisers organization

Weatherization is in fact a great idea because it saves the homeowner money on electric bills, reduces consumption and overall improves the quality of the environment by alleviating climate change. So then, in this respect, why is every single building in Worcester not weatherized? The answer to this question is that building managers and homeowners need guidance and assistance, and many of them are not served by the existing programs. This means that there is no non-profit weatherization organization, besides the federally funded MassSAVE program and the Worcester Energy Barnraisers, that provide such services to building managers and homeowners.

The Barnraisers, one nonprofit organization that performs weatherization in Worcester, make it their mission to provide weatherization to not only low-income families, but to other residents who are deprived the services of organizations such as HEET. As mentioned earlier, the Worcester community has a large old housing stock, and since these buildings were built at a time when energy efficiency was not prioritized, weatherizing all these buildings becomes a huge task. This creates a great deal of work for the Barnraisers to do. Also the location of Worcester, away from other nearby weatherization organization headquarters, is in itself a secondary reason why most buildings in the community are not

weatherized. This is a big gap the Barnraisers and the few other nonprofit organizations in Worcester look to fill.

CHAPTER 3: Methods

The project on the whole challenged us to explore and better understand the difficulties the Barnraisers were facing, and to offer informed recommendations that can help the organization. Our mission was to provide organizational guidance to help the Worcester Energy Barnraisers. The project team adopted a systematic approach to solve the problem, which involved first understanding the issues and the status of the Barnraisers, and then obtaining a first-hand understanding the “barnraising” process through participatory planning of an energy barnraising event, as well as raising awareness of the Worcester community through outreach events. We then developed recommendations and some other supplemental materials to assist the running of the WEBr organization.

The project was organized around four major project goals, which are listed below and subsequently described in this chapter.

1. Understanding the current status of the Barnraisers organization
2. Understanding the Barnraisers’ process through a participatory planning of a weatherization event.
3. Raising awareness through outreach events
4. Developing recommendations for the Barnraisers regarding organizational processes

3.1. Understanding the Current Status of the Barnraisers Organization

We decided to obtain information from the organization itself so we contacted Peter Cutting and Judy Diamondstone at the beginning of our project to plan for interviews. This method was our best way of obtaining useful information about this non-profit organization. In total, there were two interviews conducted with the core organizational leaders that took place at Nu Cafe, a local coffee shop

in the western part of the city of Worcester, and the second one in the Odeum Center of the WPI Campus Center. The first meeting involved the project team, Judy and Peter only, but for the second meeting, our advisor Professor Stephen McCauley attended.

In the first interview that we conducted with Peter Cutting and Judy Diamondstone we learned that the organization had no current weatherization projects planned at that time, and also had no actual plans of finding any new ones, even though they expressed a great desire to get involved again and to serve their community.

The reason for this inactivity was because of the lack of volunteers, and graduating college students who mainly helped out and volunteered during their summer vacation months. This non-profit organization in their early first years was ran by Clark University students, who organized monthly meetings between the members, generated leads for potential barnraisings, and also who found volunteers to participate in these weatherization projects in the Worcester County. Unfortunately when these students graduated from college and moved away from Worcester, the Worcester Energy Barnraisers could not maintain the zeal of the students, and eventually started to become more and more inactive and dormant.

The second interview with Peter Cutting and Judy Diamondstone was very educational for us because they shared their knowledge and expertise in the areas such as how to organize a barnraising, and all of the logistics that come with that process. They showed how to prepare for a barnraising, how to provide entertainment and food in the event, how to handle liability forms for the event, how to properly advertise for the event, and how to find volunteers for this events.

Two other members of Worcester Energy Barnraisers Peter and Judy offered us to connect with, were Mike Sutton and Scott Guzman. Mike Sutton was the person in charge of keeping physical weatherization tools and equipment, as well as some educational items. After contacting him by phone, we met and interviewed him at his own residence. Mike Sutton was very generous of not just inviting us into his home, but also he took the time to show us all of the tools and miniature versions of typical items to look for in a building during an energy audit, like a mini-chimney and a mini-door. He demonstrated and taught us the use of each item in preparation for the Sustainability Fair at Worcester State University on the next day.

3.2. Understanding the Barnraising Process through a Participatory Planning of a Weatherization Event

This part of our methodology makes up most of our research and engagement activities concerning the project. The project team thought it wise to provide good advice to the Barnraisers by better understanding the process involved in organizing a weatherization event. This process allowed us to be acting members of the Barnraisers leadership, and allowed us to gain first-hand experience and understanding of the barnraising process. We broke this exploration down into four parts:

- Recruitment and assessment of interest level of potential volunteers
- Identification of potential projects
- Development of communication and supplementary materials
- Conducting a preliminary energy audit

3.2.1. Recruitment and Assessment of Interest Level of Potential Volunteers

From our research, we learned that nonprofit organizations rely heavily on the efforts of volunteers (Dang et al., 2014). As such, in advance of identifying a barnraising location, we assessed the interest level of potential volunteers. This was done mainly through community outreach to increase the volunteer pool of the organization for upcoming barnraising events. We targeted student volunteers because this demographic usually looks for volunteering opportunities that they can put on their resumes. We first thought of obtaining these volunteers by distributing flyers to the various schools in the Worcester community. This method was determined to be inefficient and costly, and so we decided to ask students from WPI or other schools, to volunteer when we gave presentations to a group of students, especially at outreach programs. The email addresses of these students were obtained and added to the contact list to be made for the WEBr.

3.2.2. Identification of Potential Project Sites

After going through the volunteer acquisition process and recruiting quite a number, the next step was to explore and identify potential sites for barnraising. Among the target locations were local churches, fraternity houses, residential houses and apartments.

Local churches were selected to be the most viable because Peter Cutting had a good relationship with a few of the churches in the community. The team went on a trip to visit churches on a walk-in basis and the churches considered were Emmanuel Baptist Church, Pentecost International Worship Center and Iglesia Defensores de la Fe, all in the Worcester community. After visiting the churches, Pentecost International Worship Center was chosen due to the sufficiently large size of both the building and its compound, for some entertainment activities that could be held outdoors as the weatherization was going on inside the building.

3.2.3. Development of Communication and Supplementary Materials

To ensure that the team's volunteer and project location acquisition efforts were worthwhile, we maintained constant communication with the WEBr coordinators and spread the word about the organization informally by mouth as we went about our daily routines. We thought this would help us both and the WEBr by keeping our minds on the project constantly, and also giving the Barnraisers some popularity. This was done through meetings with groups of students or other demographics we encountered, both individually or as a team, and also through emails and phone calls. Good communication was also maintained with the current elder of Pentecost International Worship Center, Elder Isaac Ameyaw, to follow up with the "request to weatherize".

The team also redesigned the brochure of the WEBr, created a pitch guidelines document that touches on important points of focus during a meeting for a potential barnraising location and also a concise mailing list of all people who had positive interests in the progress of the Barnraisers.

3.2.4. Conducting a Preliminary Energy Audit

In planning a barnraising event, one of the initial steps is doing a weatherization walk through or what's called an energy audit. The audit serves three major purposes in planning for a barnraising event, which are identifying where and what the problem areas are, roughly estimating how much it will cost to fix problems, and developing a plan for fixing the identified problems. This is very important because a total cost must be established that can be reported back to the sponsor, for fundraising and budgeting purposes.

To learn these energy audit skills we needed a hands on experience. Drawing on our connections on the WPI campus, our team received permission to conduct an audit at the Zeta Psi

Fraternity House at 32 Dean Street, Worcester, Massachusetts. Accompanied by Peter Cutting, the Barnraisers' BPI certified auditor, we investigated the fraternity house.

This audit was a systematic approach to record the various weatherization tasks that would be performed. This was representative of a typical audit, having a weatherization professional, preferably having a BPI certification, investigating each room/area one at a time. This investigation focused on the boundary walls (outside walls) looking for any leaks, gaps, and cracks. These cracks and gaps can allow cold outside air to permeate the insulated space. A simple way to test if these gaps are problematic is to use your hand and feel for drafts and air movement. A visual key is also the presence of spider webs. Spiders place their webs where air, and in their case hopefully bugs, passes through. Locations and size of these gaps are recorded. The size matters because it will determine what is needed to patch it. For small gaps and cracks, clear silicone caulk can be used. For larger gaps, expanding insulating spray can be used. An important consideration is that, often, gaps occur close to chimneys, stove flue pipes etc., and for those applications the "high temp" spray is needed to prevent a fire hazard.

Electrical outlets on the boundary walls were checked and we found them to be lacking insulation. The number of outlet insulating pieces that were needed were recorded. Radiator and other pipes that protruded through the walls from other parts of the building, like the basement or ceiling, were checked as well. Often the holes created for the pipes are larger than the pipe itself and such a difference creates empty space where drafts flow through. The radiators in 32 Dean St. were a great example, because many of them contained these spaces. Locations were noted and the amount of high temp spray foam needed was recorded.

Doors and windows are also a very important place to investigate. The windows were well constructed but the main entrance door, proved to have many gaps. Weathering stripping would need to be applied to the inside seam of the door frame, so when the door was shut, the weatherstripping was compressed slightly. Door sweeps would also be need to be affixed to the bottoms of the door and act to seal the bottom gap. During the audit measurements of the door will be taken to ensure the correct size sweeps and amount of stripping. Windows in at Zeta Psi but as to train us for other audits we investigated. As we did this, Peter informed us of the several products that can be used to weatherize windows. For winter specific weatherization a clear heat shrink film can be applied to increase the heat retention. While most weatherization audits look for the same issues – in particular gaps, doors, holes and windows – sometimes location specific problems create weatherization challenges. Larger gaps can be sealed with Plexiglass and silicone. In Zeta Psi's case, a window connecting the entrance way with the main room, could use a plexiglass window installed. Attics are a major factor in most audits, but Zeta Psi at 32 Dean St. does not have an attic. In other audits, the attic would certainly be investigated.

As mentioned earlier, the audit serves to create a bill of materials for the weatherization event. With it, our expert could produce an estimation of the amount of outlet insulation, both normal and high temp spray foam, door sweeps, length weatherstripping and other materials needed for the weatherization event. A successful weatherization audit leads to a smooth barnraising.

3.3. Raising Awareness through Outreach Events

Awareness raising was the next major thing to do for the Barnraisers after team discussions. Although a bit of such awareness was raised as we were planning the weatherization event, some other more hands-on approaches were taken to fulfilling this goal. Our team found presentations to large

groups of people interested in environmental preservation to be a great method to get the word out about the Barnraisers. As such, we performed a couple of outreach events through presentations to the Green Team, and Energy project forum, and through table-holding at Worcester State University's Sustainability Fair and University of Massachusetts Medical School's annual Earth Day celebration.

3.4. Developing Recommendations for the Barnraisers regarding

Organizational Processes

After working closely with the WEBr, we understood the current status of the organization and planned a barnraising and outreach events. This enabled us to better understand flaws and formulate solutions. To establish viability of each recommendation, we focused primarily on difficulties we faced with the process involved with planning the barnraising events. These difficulties were basically ones the Barnraisers faced as they sought barnraising locations, organized and scheduled events as well as performed outreach activities. Our team recommended some better organizational management strategies as the keys to success for the longevity of the Worcester Energy Barnraisers. After conducting research, and our yearlong project participation, relevant suggestions were then identified after our team brainstormed and discussed overall recommendations.

CHAPTER 4: Findings and Accomplishments

The team decided that in order to accomplish the project goals, recommendations needed to be developed to further the Barnraisers in their mission and goals. Over this past year, we tried to understand the Worcester Energy Barnraisers and how they accomplish their mission. As students and researchers, we were able to see the organization as a whole, identify successes and shortcomings. To delve into the topic and get a feel for what the organization's mission, procedures and dynamic was, we sought out to plan a Barnraising, the WEBr's highlight event. This proved to be a great catalyst to developing our team's findings and subsequent recommendations. The majority of the findings revolved around the organizational structure of the Barnraisers that was in need help, and these findings we obtained from the project were covered in a manner corresponding to the methods chapter, whereas the accomplishments are presented as a list. Through these channels we have been able to generate a comprehensive list of recommendations, and we believe that following these recommendations could ensure sustained organizational growth of the WEBr.

Starting in the fall of 2014, our IQP team strived to improve the viability of the Worcester Energy Barnraisers. Getting this project off the ground was difficult due to the scattered nature of the current organizational strategy. Originally the Barnraisers were a student organized group with support from a broader group of engaged community members. Unfortunately, when the students graduated and moved on, the motivational and organizational gap left contributed to the dwindling of active members over time which in turn led to a halt in the WEBr progress. This put the organization in a difficult position since managing and running a non-profit organization with few volunteers is a very challenging task.

We were tasked with identifying the organizational main issues and coming up with solutions. Our objective was to solve these so the organization can flourish in the future. We found that Peter

Cutting, Judy Diamondstone, and Mike Sutton were the only active members in the leadership group of the WEBr, with the two former as the most active of the three. Peter is the technical side of the organization and is BPI certified. Judy on the other hand is a community outreach organizer and coordinator, having many connections in the local area.

4.1. Status of the Barnraisers Organization

Through various interviews and meetings with main correspondents of the Worcester Energy Barnraisers, Peter and Judy, we realized that this non-profit organization has been quite dormant, in the sense that it was having difficulty in achieving their main mission statement. The main goals of the Barnraisers, including engaging in grassroots energy efficiency projects to create inclusive community solutions to climate change, to inspire the community to take energy conservation into their own hands, to support environmental sustainability throughout central Massachusetts, have been rendered difficult to accomplish every year due mainly to the Barnraisers' pertinent organizational difficulties. We found that the WEBr was operating with a small core leadership team and this weakened the organizational productivity and management, since too much responsibility was placed on only a few individuals to run the non-profit organization. The effect of this WEBr organizational structure was that there were no upcoming projects in their near future, which meant a small volunteer pool for weatherization events. This is so because volunteers can only be recruited for projects when there are projects to be completed.

Looking into our interactions with Peter Cutting and Judy Diamondstone, we determined that much of the organizational leadership relied on two individuals. Judy takes on a community outreach role staying current on local happenings and events, whereas Peter is the weatherization professional with the technical knowledge and certifications to complete weatherization work. Currently in the

organization of the WEBr, there is only activity when there is a weatherization project, or when an outreach event is being sponsored by the organization.

We learned that the Worcester Energy Barnraisers have not had a project in a while, with their last barnraising at 43 Orne St. in the spring of 2014. This was evident from information obtained from the organization's leadership. Our research has revealed that the reason for this low activity or dormancy is mostly due to:

- Small size of the dedicated organizational leadership
- Lack of ongoing commitment among organizational members
- Low public interest and knowledge about the organization

The first two reasons we found combine to lead to a shrinking network of supporters and less opportunity to make connections in the community, which manifest in an inadequate number of readily available volunteers for projects.

While barnraising events have been slow to develop, we found out through our outreach events that there is still an interest in completing projects among the organization as a whole. Even old Barnraisers we met at sustainably fairs still wanted to see the organization back on its feet and completing projects. A multitude of students want to become involved as well for various reasons. The hands on skills and networking possibilities are very attractive to college students. That said, we feel there's work to be done to improve the organizational structure and management styles, with suggestions we make as recommendations later in the report.

4.2. Insights Revealed through Planning a Barnraising Event

Through this project we have found out firsthand the trouble spots as well as selling points of this organization. Trouble spots of the WEBr begin most with the fact that since the organization is mainly people-driven, its biggest challenges is to hit “critical mass” in order for it to self-perpetuate. The time required to actively seek projects has proved larger than the organization's resources can cover, which sometimes causes the organization to fail.

Communication is a big tool in reaching out to members and assigning roles or coordinating to work as a team. Based on our findings, the non-profit organization has a dormant or semi-active communication. The interaction is not consistent and there is lack of follow-ups thus making the organization weaker and less effective on achieving their goals.

An important finding we have concluded over the course of the project is that finding volunteers was not as challenging in comparison to finding suitable project sites. Volunteers just had to sign up and wait for roles to be assigned. On college campuses, students have a desire to “get their hands dirty” and learn helpful money saving skills. Also events like this give the opportunity to meet new people which also is attractive for this demographic. This evidence was communicated to our team when we presented to WPI’s student run sustainability group, The Green Team, after our team’s informational presentation.

Project sites, and more specifically sites in need, are more difficult to find and prepare for a barn raising event. The planning, signoffs, approvals, and lead time all need to be taken into consideration. Projects needed approval from those in charge of or in ownership of the building before auditing and performing the actual barnraising. This would take approximately 3 weeks or more depending on how

busy a potential site is and the number of leaders it had. In between, there would be obtaining of materials and even training some volunteers to share duties.

Over the course of our project we looked at quite a few number of possible project sites. Some had definite need, whereas others had uninterested owners despite the draftiness and hence inefficiency of the buildings. Furthermore other sites, if used for a barnraising event, would be a great benefit to the community though there would not have been enough of actual weatherization work to be done. Sadly, such locations were excluded from consideration after discussions with Peter Cutting since a successful barnraising could not be hosted at those locations. We found out from this activity that advising the Barnraisers on better site searching would be a very important aspect of our project, which should leave a lasting impression to better help the WEBr.

On a positive note we found our community's reaction to the mission and organization has been very good. We completed table sitting events, recruited volunteers and outreach events, and overall locals were excited with the idea of helping people and groups, reduce their energy bills and carbon footprint.

4.3 Accomplishments

As the most important accomplishment, the team ***planned a typical barnraising event***. Our team visited and communicated with many churches in the Worcester area, to hopefully secure a project site for a barnraising event. At the same time, we reached out to students groups from outreach events we participated in to find interested volunteers for the event. When a particularly good church barnraising site was found, that is P.I.W.C. on 5 Blackstone River Road in Worcester, we talked to Peter to arrange an audit and check the validity of the site. We conducted a preliminary unofficial energy

audit, that were based on the main points Peter taught us during our audit of the Zeta Psi fraternity House at WPI, to produce an estimate of cost and a list of materials and tools needed. This information was then communicated to the church's Elder Ameyaw to see if we could move forward with the project. Since volunteer acquisition and project site location were the most difficult challenges the Barnraisers were facing, after completing those two activities, the next steps to organize and solicit food, entertainment and transportation were not performed.

The team ***raised awareness about the Barnraisers*** through interaction with other project teams from the Energy Project Forums at WPI, tabling events at both Worcester State University and University of Massachusetts Medical School on their annual Sustainability Fair and annual Earth Day celebration respectively, and presentation meetings with other similar goal-oriented groups like the Green Team at WPI.

We also ***recruited more volunteers for the Barnraisers***. This was done usually whenever we met other groups of people for awareness raising events. In all we recruited 41 potential volunteers, with a majority of them especially interested in volunteering during the summer and winter break periods of the year.

We ***visited the Green Team on the Worcester Polytechnic Institute campus***. This group, among the variety of extracurricular groups at WPI, is labeled as the group that advocates energy efficiency and carbon emissions reduction. We felt they would be a great connection for WEBr's and introduced the idea of working together. As such, we made efforts to attend several club meetings to learn from the club and also recruit any interested available parties.

The team **identified several potential weatherization barnraising sites** with the latest, most promising one being Pentecost International Worship Center (P.I.W.C.). This church is willing to work and meet with the Barnraisers leadership in order to proceed with an official energy audit, and subsequent barnraising.

We also **hosted some presentations** aimed at educating the interested parties on the importance of barnraising. We presented once to the Green Team, and two presentations were made to the Energy Project Forum. This allowed us to share ideas on how the Barnraisers seek to improve the use of energy in the community. These presentations gave a more detailed introduction of the WEBr, what the organization does and where their current status is.

Our team **conducted an energy audit on one potential barnraising building**, the Zeta Psi fraternity house at WPI. Being led by Peter, we were able to learn about the common leakage prone areas in and outside the building including materials that would be needed to weatherize it. Among the common spots identified in the auditing and training were the main entrance to the building, entrance to the basement, pipes to and from the basement, and even power outlets and pipes that run through the walls to the outside.

CHAPTER 5: Recommendations and Conclusion

5.1 Recommendations

After collating and discussing our results with each other, the following recommendations were developed in order to offer more direction to the structural organization of the Worcester Energy Barnraisers.

We recommend ***organizing a large overarching Worcester Energy Barnraisers member meeting*** which will be required to get the non-profit organization functioning at full capacity. This should include old Barnraisers, other personnel with some experience with the organization as well as new potential members. The potluck model would be a perfect grassroots style gathering to allow for discussion of a multitude of important topics. Stories about past successful barnraisings, community impact and fun activities could start the meeting. The main agenda of the first meeting however, would be on the important topic of organizational structure and management. The meeting or retreat even, would be a great to be organized annually, though the first meeting should cater to working on solving the roadblock of organizational structure and management.

We recommend ***the assignment of key leadership roles*** whose duties will in effect, maintain momentum throughout the year. The positions we idealized are *Project Manager, Volunteer Manager, Scheduler* and *Corresponding Secretary*. Regular changes in positions should be considered annually, during the annual meetings or retreats, in order to ensure rotation of duties, fresh ideas and constant organizational improvement. This is also to ensure that members learn about new duties and don't feel bored in one position or the other that might require a lot of tasks.

Along with the establishment of these new positions, we suggest having the entire organization involved in generating ideas for the next phases of the Worcester Energy Barnraisers in accordance with the Barnraisers current method of decision-making on a consensus basis. This communal brainstorming should look towards the future, in terms of years and not just months.

After the first big meeting the Barnraisers hold to start things up, we recommend the positions elected might have their own meeting to discuss leadership roles, ideas and who might take on what. We have outlined the majority of each position's duties below. These duties or assignments listed primarily serve as a means of separation of powers and sharing of roles or responsibilities. This will help the Barnraisers avoid overloading one person with most of the work or responsibility. The people who would assume the four roles mentioned above would work together to best complete the Barnraisers' mission.

- The Project Manager will lead the search for project sites, manage tools and materials for the Barnraisers and with the Corresponding Secretary, will maintain contact with potentials leads. In general, this person should have good interpersonal skills and should be very knowledgeable about the barnraising process to sell the pitch to churches and other possible project sites.
- The Volunteer Manager will be chief in organizing the manpower of the Barnraisers. It would be optimal for this person to be a local student or other local member, who would have the ability to advertise on school campus and connect with other schools or student sustainability groups. WPI's Green Team was contacted and informed about the Barnraisers organization, and was interested in volunteering. As a team we felt a long term connection would be a great symbiotic relationship for both groups, and as such we included main contact details in the concise mailing

list for the Barnraisers. One could see the Volunteer Manager as a liaison between the WEBr and other volunteer or student groups such as the Green Team.

- The Scheduler is another immensely important role that must be taken into high consideration. This person would be in contact with all the other leadership officers, maintaining great coordination between them in order to establish the best timelines for their activities. The scheduler would report directly the Corresponding Secretary who would in turn report to the rest of the organization.
- The Corresponding Secretary position works in both directions as he/she would receive leads and other forms of information from members and outside parties. The Corresponding Secretary should be able to interpret this information and pass it on to the officer most relevant to handle it. We advise that digital communication be the main method to maintain contact with members, both within and out of the Worcester Energy Barnraisers.

We recommend ***establishing a communication platform***, which could be email newsletters, an online forum, or improvement of social media outlets. Stronger communication with internal members and external interested personnel is crucial in any organization and in any team structure in order to ensure successful implementation to the main outlined goals and organizational objectives. The communication methods for the organization could be improved. The lack of a specific way to reach all the members at once, might be one of the reasons information didn't reach everyone. A newsletter and specific update mailings could prove effective. Regular email blasts before events could consistently remind volunteers, and allow them to get in touch with the organization about their availability or reservations prior to planned barnraising dates. An online forum or improvement in social media outreach could be a possible solution. The solution the Worcester Energy Barnraisers choose should best fit the entire group.

We recommend ***connecting with student sustainability groups***. WPI's Student Green Team is a great connection to have. Our IQP team has planted the seeds by talking with Green Team members and giving presentations to the group. Interest seemed high, especially the hands on nature of the barnraisings. The Worcester Energy Barnraisers was started by students which played a large logistical role in the organization. These student groups could help address, and support the organizational core leadership issue. We advise that the barnraisers cultivate leadership within the Green Team to have more available personnel to solve the issue of the inadequate number of people in the leadership team.

We recommend ***continuously following up on barnraising search leads***. Continuous barnraising site search is a very important role for a non-profit organization like WEBR's because through continuous project search, this organization would ensure identification of possible project sites in the Worcester community. This effort will primarily be spearheaded by the project manager. The more projects the organization identifies, the more possible barnraisings will be conducted. Therefore the bigger energy sustainably impact the organization can have.

We recommend ***continuing participation in current outreach events and looking to attend others***. Outreach is an important aspect of a non-profit organization. Other organizations like HEET, do outreach on a regular basis in order to spread the word about their organization and educate the general public. Seeing that HEET is currently a successful organization, it makes sense for the WEBR to emulate their practices in order to reach that status of success. Therefore, in regard to the Barnraisers, the Project Manager, Volunteer Manager and Scheduler can work together to organize outreach events primarily for volunteer acquisition; public education and awareness; sharing and gaining of knowledge from meeting other people interested in energy efficiency and home-heating; and maintaining WEBR member involvement when there are no barnraising projects to work on at the time. As a bonus,

outreach events will expose the organization to a myriad of experienced and skilled personnel, and hopefully allow the organization to establish contact with BPI certified individuals who would be interested in becoming volunteers with the WEBr. After such events, the Corresponding Secretary would take over in terms of maintaining contact with new contacts and volunteers, through digital communication, that is by emailing or even conference calling.

5.2 Conclusion

Based on the overall experience with the Worcester Energy Barnraisers, research conducted, and hands-on activities over the course of our year-long project, we conclude that this non-profit organization has the potential to achieve its missions and goals in the Worcester community. Improving the energy efficiency of homes and other buildings is a great start to creating a larger impact. This type of organization is key to addressing energy sustainability and justice on a grass roots level. While some organization issues have hindered the impact of the Barnraisers there is a need in the Worcester area and throughout the Commonwealth of Massachusetts. With renewed interest, student group connections, and better organization management. The Worcester Energy Barnraisers can fill the need for energy awareness and sustainability in Worcester. To reach this potential, we strongly believe that this organization follow our recommendations and try to implement them as fully as possible to achieve the greatest effects, and hopefully snowballing into a larger a more prevalent nonprofit organization.

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APPENDIX

A. Worcester Energy Barnraisers Contacts List

NOTE: The tables with contact information below have some empty spaces. This was done intentionally to allow for future addition of information in the event of acquiring a new supportive contact.

Worcester Energy Barnraisers (WEBr) Personnel and Affiliates

| <i>Name</i> | <i>Contact Information</i> | <i>Notes</i> |
|----------------------------|--|--|
| Judy Diamondstone | jvdiamondstone@gmail.com | Current WEBr Leader (More community-inclined) |
| Peter Cutting | pcutting67@gmail.com; (508) 410-2003 | Current WEBr Leader (More technical) |
| Michael Sutton | msutton2@worcester.edu; (774) 670-8620 | Current WEBr Member (Communications and Mini-weatherization tools and equipment) |
| Scott Guzman | (774) 695-5243 | Current WEBr Member (Absent on travel during project) |
| | | |
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| | | |
| Professor Stephen McCauley | mccauley@wpi.edu | Project Advisor |
| Professor John Orr | orr@wpi.edu | Project Co-Advisor |
| Ato Howard | aahoward@wpi.edu | WPI WEBr IQP Team member |
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| Petro Papi | ppapi@wpi.edu | WPI WEBr IQP Team member |
| Raymond Otieno | rhotieno@wpi.edu | WPI WEBr IQP Team member |

Important External Personnel

| <i>Name</i> | <i>Contact Information</i> | <i>Notes</i> |
|--------------------|---|---|
| Lucas Glenn | lucas@thewoo.org; (774) 292-9201 | Pastor at the Woo Church |
| James Bond | bonds@bondsdevelopment.com | N/A |
| Cassandra Bensahih | Cassandra.epoca@yahoo.com | Organizer at EPOCA |
| Suzane Wood | Suzanne.Wood@umassmed.edu; (508) 856-6324 | Sustainability & Energy Manager (UMass Medical) |
| Steven Bandarra | sbandarra@worchester.edu; (508) 929-8332 | Sustainability Coordinator (WSU) |
| Elder Isaac Ameyaw | (508) 615-7712 | Church Elder at P.I.W.C. |
| | | |
| | | |
| | | |
| | | |
| | | |

Student Volunteers

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Supportive Organizations

| <i>Name</i> | <i>Contact Information</i> | <i>Notes</i> |
|-----------------|----------------------------|-----------------------------|
| Worcester Roots | | Fiscal sponsors of the WEBr |

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| StoneSoup | | |
| 350.org | | Greenhouse gas emission awareness organization |
| HomeDepot | | Main source of weatherization tools and equipment |
| Regional Environmental Committee (REC) | | |
| Home Energy Efficiency Team (HEET) | | Non-profit organization based in Cambridge |
| Emmanuel Baptist Church | | Local church in Worcester |
| P.I.W.C. Worcester | | Local church in Worcester |
| The Woo Church | | Local church in Worcester |
| First Baptist Church | | Local church in Worcester |
| Green Team (WPI) | studentgreenteam@wpi.edu | WPI student sustainability group |
| UMass Medical School | | Local undergraduate school in Worcester |
| Clark University | | Local undergraduate school in Worcester |
| Worcester State University | | Local undergraduate school in Worcester |
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