

# **Final Report**

## **McCandless Township: Energy Efficiency**

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Spring 2020

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## I. Scale of Action

McCandless may be socially understood as suburban, and while there are many distinctions between this township and the city of Pittsburgh, there are also many things that unite them. These spaces have a dualistic relationship that builds off one another to form the urban – but what is this? The urban is a space of human convergence – where people live, work, and socialize, and build connection with place. In many ways, the urban is an assemblage of the people, places, policies, and institutions that mold and modify it. In this sense, the urban is not a space that can be defined, but rather a process – or a psycho-spatial model. The urban is non-existent without the people, and in this way “cities are akin to living things that take in energy, metabolize material, and spit out waste. They consume and grow, using digestive, respiratory, and circulatory systems” (Gardner, 2016, p. 27). The metabolism to power the city requires a massive amount of resources, and the consequences of the use are startling. Urban (including suburban) areas occupy only 2% of the earth’s surface, but produce close to 80% of our greenhouse gas emissions, 50% of our global waste, and 75% of global energy use (Gardner, 2016, p. 74) [7]. The urban is a monumental strain on our global environment, but the critical mass of people allows for certain measures of environmental action that would be otherwise impossible. As Pittsburgh emerges from the shadows of industry into a new economy, we must look at it as both a source of environmental degradation, but also an environmental opportunity. We are on the brink of a climate crisis, and if we have any chance to meet the IPCC recommendations, McCandless township will be the scale at which we achieve it. The urban is the intersection between the built and natural environment, and it’s the site where the consequences of climate change will be most visible. Climate change is an anthropocentric phenomenon that will have devastating effects on anthropocentric spaces. McCandless township is both the problem and the solution, and our work with the township is just one-step of many in the process of moving them from the further to the latter.

## II. Background Information:

Our project is to work with McCandless township to reduce their energy expenditure and promote energy efficiency within the community. McCandless is a town about 10 miles north of Pittsburgh with a population of approximately 28,000, and a median family income of \$81,000 [6]. We discussed the project with the Town Manager Bob Grimm and one of the town’s council women, Angela Woods, at the beginning of the semester to learn more about the direction that they wanted us to head. The township asked us to find solutions for ways they can reduce the township building’s energy usage. The township building was built in the 1960s -- and the age is showing through the high utility costs. When we made our initial visit we took note of some aspects of the building. First, the HVAC system is very old and extremely complicated. There are five different components of the HVAC system, and the township has two different utility companies powering the system. Another thing we took note of was the amount of extra

appliances throughout the office. This included extra space heaters, printers at each employee's desk, and an old fridge. Our initial meeting, as well as our observations, have become the baseline for our project.

McCandless has been pursuing a certificate in PA sustainable communities. This certificate is run in partnership by the Pennsylvania Municipal Leagues and Sustainable Pittsburgh. The goal of the certificate is to help small communities across Pennsylvania set and achieve sustainability goals for their town. McCandless currently holds a gold status in the certificate. Part of the project will focus on helping McCandless get to a platinum status in this certificate.

Overall, our stakeholders include Bob, Angela, the township council members, and everyone who works in the township building. Bob, Angela, and the council members have the power to enact the changes and solutions that we suggest to them so we need our project to reinforce the guidelines and visions that they have for the town. The employees of the township building are affected by our project because we have the potential to change their workplace environment. Additionally, the entire McCandless community is included in our stakeholders because ultimately their taxes are affected. If McCandless chooses to invest in an energy efficiency project and ultimately save money on their utility bills, then the town residents might save money in their taxes, or those savings could be reinvested back into the community.

### **III. Project Vision and Goals:**

McCandless's ultimate goal is to upgrade from the gold status to the platinum status in the PA Sustainable Communities certificate. They're very close to reaching this next level – and have specifically identified improving the energy efficiency as an opportunity to jump towards platinum. Our research team has partnered with the township officials, and we've decided to help them achieve their goals by helping the township reduce their energy consumption in their municipal buildings. These are the direct tangibles we can impact, but the township doesn't want this to limit the scope of our project. They want this project to signal a new chapter for them. We hope that reaching platinum status will not be the end of McCandless's sustainability campaign – and that their new chapter is characterized by environmental action and stewardship. We understand that within a semester, we will be unable to transform McCandless from a sprawling suburb to a model for green development – but we hope that we can start a movement that will continue until these goals are accomplished. We hope that McCandless acknowledges the interdisciplinary nature of sustainability – and that investments in green energy are also matched with investments in equity and diversity. Strengthening one aspect of sustainability strengthens the others – and will go a long way to improving the resilience of the community. Finally, we hope that the community will be inspired by the actions of the township and that they will take action. Because of this, community engagement is a major aspect of our project. We hope to light the spark that becomes a wildfire of sustainable action throughout the township. We have many different ideas on how to engage the public – and we hope one of them will strike a chord and inspire action.



## IV. Analysis of Problem

McCandless's town hall and maintenance buildings are very outdated with their structure and HVAC system. The outdated nature of these buildings is causing energy inefficiency problems that in turn cause higher utility bills for the township. McCandless has already taken steps within the past ten years to understand their buildings' inefficiencies, and they have taken the initial steps to fix these problems. They completed an energy audit in 2010 which has helped our team understand what actions they have taken and what actions still need to be done. Since McCandless has a good outline of how they can achieve energy efficiency for their building, but are limited in two key resources: funds and man-power. McCandless township only has a small team at their office, and they have many other responsibilities to handle. Our team is stepping in to help with the man-power problem. However, our project was confined by time because we only have one semester to make progress on an issue that McCandless has been working on for the past 10 years, and since this is a school project, we were given no budget to complete the tasks on hand. Moving forward, the solutions we considered had to be analyzed with these restrictions in mind.

Since McCandless has already started their path towards sustainability, they have built a foundation that our team was able to use as our starting points. One of those starting points is the town's Sustainability Plan. McCandless's website has declared many sustainability goals for the town. Some of the goals were working toward eliminating discriminatory practices throughout the town which included adopting a policy in 2019 to ensure minority business enterprises and women business enterprises are considered for municipal purchasing bids and contracts. Other actions taken promoted environmental education including the town hosting its first ever Recyclable Art Show to display the designs of the recycled items and demonstrate how they can be repurposed in a meaningful way [5]. These goals were able to give us a sense of where McCandless was focusing its attention on and what steps had already been taken.

Another starting point, we had at our disposal was an energy audit conducted in 2010 for the municipal building. With the previous energy audit, we obtained background information on the building we were working with and a layout of its inefficiencies. The audit includes recommendations and establishes a baseline of energy usage. The baseline is critical for tracking energy usage because it marks the starting point of tracking a building's energy usage, and it allows you to see how changes made to the building are reflected in energy bills.

Our review of McCandless's PA Sustainable Communities score helped shed some light on their problem areas. In the area of community engagement relating to sustainability, McCandless was lacking in two categories. The first was conducting a sustainability assessment to evaluate municipal facilities, operations, and plans relating to conserving resources, saving money, and implementing policies. The second problem area was having procedures in place to measure and track the impact of their sustainability programs. We hope we can solve both of these through the overall scope of our project, including our energy audit and training a McCandless employee to use the Energy Star Portfolio Manager. Additionally, in the category of

municipal energy use, McCandless is also lacking in a few areas. Specifically, they haven't established goals based on the finding of an energy audit, they are not reporting yearly the progress made in improving based on a municipal energy study, and they have not established a greenhouse gas inventory as part of their audit. Finally, they are lacking in the areas of community energy use and renewable energy. In the community energy use section, McCandless didn't achieve points for supporting a public program to conserve energy, promote renewable energy resources, and mitigate carbon emissions. In the renewable energy implementation section, to qualify for points McCandless must purchase energy for municipal facilities from renewable energy resources or have installed renewable energy resources such that at least 10% of all municipal energy comes from renewables<sup>1</sup>.

Much of understanding of these subjects came from our 20 interviews with stakeholders in an energy-related field. After we had a little direction on what areas to attack with our project, we started interviewing professionals who were able to give us insights into energy efficiency projects and advice on the preliminary ideas we had conjured for the project. These professionals really helped us narrow actual tasks that our team is capable of completing within the timeline of our project. Throughout these interviews, we began to realize how little actions can make a big difference in energy savings. Although McCandless's energy expenditure could be fixed with a replacement of their HVAC system. The township is unprepared to take on a project this size because they lack the resources and labor to carry it out. So, we as a team had to realize our place within the township at this point, and the actions we could actually accomplish for them. These conversations that we had with our team, professionals in the field, and Bob and Angela helped us compile and then narrow down the solutions we can accomplish that will make the most impact for McCandless.

## **V. Critical Thinking Process**

Throughout the course of the semester we have considered countless solutions and our dominant ideas of how we should address the issue has also evolved as we completed more research and talked with more professionals. We entered the project with the mindset that we would focus on renewable energy as our paramount interest. In our initial interview at McCandless, we looked at various spaces for renewable installation. We were interested in all of the publicly owned green spaces that could be areas to locate this infrastructure. We surveyed the county lake and saw a potential source of hydropower. For a couple of weeks, we talked with organizations like Windstax and Scalo about the cost effectiveness and feasibility of the installation projects. While it was exciting to pursue these options, there were several reasons we decided to shift our work to other subjects. The primary factor was the practicality. As a team, we agreed that we wanted to be able to accomplish something feasible within the span of the semester. While we believe that renewable energy is the long term solution to powering McCandless, there needs to be incremental steps in between. One professional we interviewed

made it clear that the township should invest in their building efficiency before investing in renewables. It's impractical to find alternative sources of energy for a building that is currently wasteful. Quickly, our focus changed to improving the energy efficiency through various considerations – such as building envelope improvements, thermal comfort surveys, and energy vampires.

In other interviews with stakeholders, we learned about the importance of public engagement, and since the township wanted their project to inspire others throughout the community, we decided to prioritize this. Education is extremely cost-effective compared to our other ideas – and it also has the opportunity to contribute to massive savings, both environmentally and financially. The stakeholders presented us with the 300 – 30 – 3 energy model to help demonstrate their point. Each of the numbers represents the (potential) savings from a different approach to reducing energy expenditure. The 300 refers to public education, the 30 refers to building, and the 3 refers to the cost of the utility itself. The model tells us that by educating the individual you have the ability to save as much as \$300 or waste as much as \$300. This demonstrates the importance of public engagement in energy conservation. The lack of education has the capability of dramatically increasing costs and consumption, while proper initiatives create the opportunity for drastic savings.

This model helped shape our work for the rest of the semester. Everything we planned tried to blend practicality, cost effectiveness, and environmental impact. We want our project to have long term implications for sustainability in McCandless, but we also wanted to deliver something of use within the 15 weeks of our collaboration. We emphasized the issues we could tackle “now” while also laying the foundation for future projects. The climate crisis has been brewing for decades, and the solutions will come incrementally. But if we continue to think only in the future, we deter action from happening now – and sustainability is all about balancing current and future needs.

Here is a table that helps summarize the 300 – 30 – 3 model:

<b><u>300</u></b>	<b><u>30</u></b>	<b><u>3</u></b>
Person	Building	Utility
<ul style="list-style-type: none"> <li>· Environmental education video</li> <li>· PA Sustainable Community recommendations</li> <li>· Brochure and letter to the public</li> <li>· Environmental Advisory Committee</li> </ul>	<ul style="list-style-type: none"> <li>· Thermal comfort survey</li> <li>· Infrared Camera</li> <li>· Energy Vampires</li> <li>· Building envelope adjustments</li> </ul>	<ul style="list-style-type: none"> <li>· Alternative energy: Windstax, Scalo, hydroelectric</li> <li>· HVAC system</li> <li>· Stadium lighting</li> <li>· Electric vehicles</li> </ul>
Least costly	More Costly	Most Costly
Prioritize and produce deliverable.	Prioritize and produce deliverable.	Build foundation but allow township to pursue in future projects.

*Table 1: 300-30-3 Model*

## **VI. Final deliverables**

### **Energy Audit**

On February 28, we conducted our energy audit of the McCandless Township Building. We collected McCandless' utility bills (electricity, gas, and water) from the last full three years (2017-2019) and recorded the usage and price numbers. We then imported the data into the Energy Star Portfolio Manager to complete the audit and get the results. Energy Star uses the first-year data, the year 2017 in our case, as the Energy Baseline, and compares that with the most current data, from 2019. A month by month graph of McCandless' energy and water use can be seen in the graphs below.

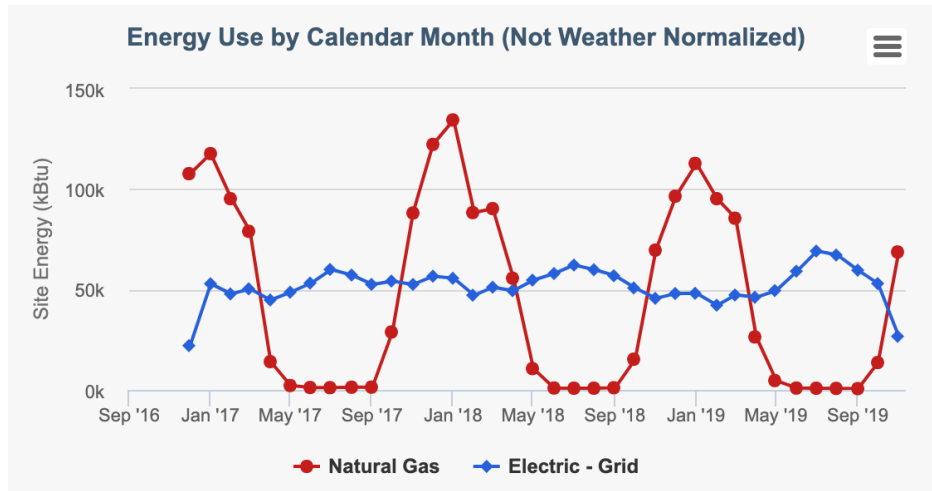


Figure 1: McCandless Township Energy Use by Calendar Month (2017-2019)

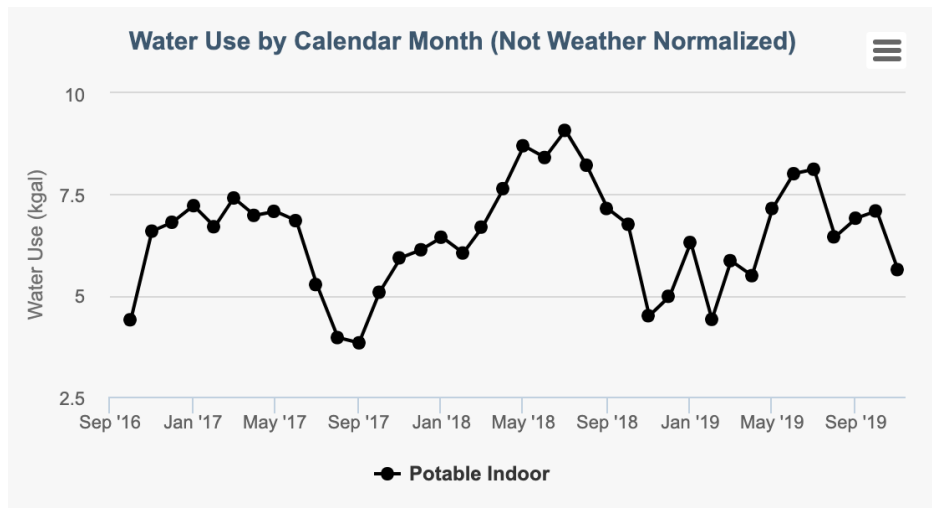


Figure 2: McCandless Township Water Use by Calendar Month (2017-2019)

From the data we gathered, Energy Star provided six separate metrics shedding light on the energy trends of the McCandless Township Building. The first of these metrics was Source Energy Use Intensity, or Source EUI. Source Energy Use is the total amount of raw fuel that is needed to operate a property. Source energy also includes losses that take place during energy generation, transmission, and distribution in addition to the on-site energy consumption of the property, allowing for a comprehensive assessment of energy consumption resulting from building operations. Source EUI is the Source Energy Use divided by the property square footage, typically measured in kBtu/ft<sup>2</sup>. The next metric provided by Energy Star was Site Energy Use Intensity, or Site EUI. Site Energy is the annual amount of all the energy a property consumes on-site, as reported on the property's utility bills. Site EUI is the Site Energy Use divided by the property square footage, typically measured in kBtu/ft<sup>2</sup>. The next Energy Star metric was Energy Cost. Energy Cost is simply the annual cost associated with a selected 1-year time period for a property or building. It is available for each individual energy type and also as

an aggregated value across all energy types. The next Energy Star metric type is Total Greenhouse Gas (GHG) Intensity. GHG Emissions are the carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O) gases released into the atmosphere as a result of energy consumption at the property. GHG emissions are expressed in carbon dioxide equivalent (CO<sub>2</sub>e), a universal measurement unit that combines the quantity and global warming potential of each greenhouse gas. The emissions in our audit are reported in three categories, Direct Emissions, Indirect Emissions, and Total Emissions, each is available as a total amount in metric tons (Metric Tons CO<sub>2</sub>e) or as an intensity value in kilograms per square foot (kgCO<sub>2</sub>e/ft<sup>2</sup>). Direct Emissions are emissions associated with onsite fuel combustion such as combustion of natural gas or fuel oil. Indirect Emissions are emissions associated with purchases of electricity, district steam, district hot water, or district chilled water. These emissions occur at a utility plant, but they are a result of the property's energy consumption and therefore contribute to the overall GHG footprint. Total Emissions is the sum of the Direct Emissions and Indirect Emissions. The penultimate Energy Star metric is Water Use. This is simply the sum of the measurements from all the water meters for a year, typically measured in kilogallons. The final metric given is an Energy Star Score of the property. The Energy Star Score is a measure of how well a property is performing relative to similar properties, when normalized for climate and operational characteristics. The score is based on data from national building energy consumption surveys, which allows key variables affecting a building's energy performance, including climate, hours of operation, and building size, to be controlled. The score is on a 1-100 scale where 1 represents the worst performing buildings and 100 represents the best performing buildings. A score of 50 indicates that a building is performing at the national median, taking into account its size, location, and operating parameters<sup>2</sup>. Now that all Energy Star metrics have been explained, a deeper analysis of McCandless' Energy Audit can be completed. McCandless' metric summary is shown below in Figure 3.





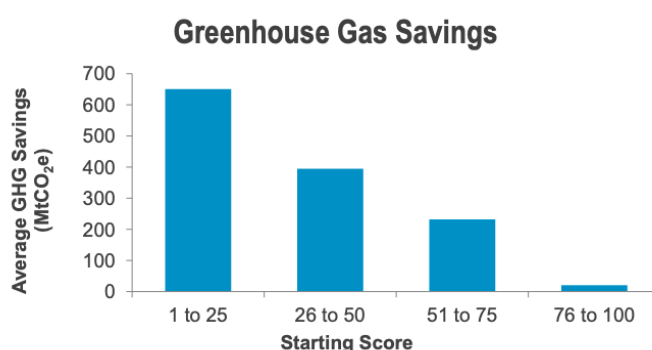
Metrics Summary			
Metric 	Dec 2017 (Energy Baseline) 	Oct 2019 (Energy Current) 	Change 
ENERGY STAR Score (1-100)	49	52	3.00 (6.10%)
Source EUI (kBtu/ft <sup>2</sup> )	128.1	126.1	-2.00 (-1.60%)
Site EUI (kBtu/ft <sup>2</sup> )	64.6	62.4	-2.20 (-3.40%)
Energy Cost (\$)	22,179.31	20,027.95	-2151.36 (-9.70%)
Total GHG Emissions Intensity (kgCO <sub>2</sub> e/ft <sup>2</sup> )	7.3	7.2	-0.10 (-1.40%)
Water Use (All Water Sources) (kgal)	72.4	75.3	2.90 (4.00%)

Figure 3: McCandless Township Energy Star Metrics from 2017-2019

As evidenced

by their slightly higher than average Energy Star Score, McCandless' metrics were slightly better than the median office property in all areas. It can also be seen that McCandless has shown positive trends in all of the Energy Star metrics except water use over the last three year, but they still have a lot of improvements to make.

We created goals for McCandless to strive for over the next handful of years using Energy Star. These goals were created with the target of reaching an Energy Star score of 75, the score where a property is eligible to earn an Energy Star Certification. Certified buildings not only perform better than typical buildings, they also have reduced their greenhouse gas emissions by an average of 10 percent since first benchmarking in Energy Star. Collectively, they reduce 1.8 million metric tons of CO<sub>2</sub>e every year, which is equivalent to the emissions from the annual electricity use of more than 270,000 homes<sup>3</sup>. A graph displaying the average GHG savings of certified houses based on their starting Energy Star score is shown below.



*Figure 4: Potential Greenhouse Gas Savings based on Energy Star Starting Score*

This certification as well as the PA Sustainable Communities Platinum Certification could be achieved simultaneously with enough improvements. If McCandless continues their current trajectory of the last three years, they wouldn't achieve an Energy Star score of 75 until after 2040. So, we set a slightly easier score of 65 to work towards first, before eventually trying to earn the certificate. The necessary metrics needed to achieve the score of 65, as well as the metrics of the median property, are shown in the table below.

Metric	Dec 31 2017 (Energy Baseline)	Oct 31 2019 (Energy Current)	Target*	Median Property*
ENERGY STAR score(1-100)	49	52	65	50
Source EUI(kBtu/ft <sup>2</sup> )	128.1	126.1	106.2	130.2
Site EUI(kBtu/ft <sup>2</sup> )	64.6	62.4	52.5	64.4
Source Energy Use(kBtu)	2346553.5	2310959.9	1945120.3	2384986.8
Site Energy Use(kBtu)	1183391.2	1142562.6	961687.7	1179162.3
Energy Cost(\$)	22179.31	20027.95	16857.40	20669.51
Total GHG Emissions(Metric Tons CO <sub>2</sub> e)	134.3	132.6	111.6	136.8

\* To compute the metrics at the target and median levels of performance, we will use the fuel mix associated with your property's current energy use.

*Figure 5: McCandless Township Energy Star Metrics compared to Target Goals and Median Property Metrics*

As part of McCandless' journey to achieve this score, it is vital that they keep benchmarking their energy data after our work with them is done. This can be as simple as continuing to upload their utility bills into Energy Star every month. Data has shown that buildings using the Energy Star Portfolio Manager to track and manage energy use end up saving energy. Over 35,000 buildings entered complete energy data in Portfolio Manager and received Energy Star scores for 2008 through 2011. These buildings saw savings every year, as measured by average weather-normalized energy use intensity and the Energy Star score, which accounts for business activity. Their average annual savings is 2.4%, with a total savings of 7.0% and score increase of 6 points over the three-year period of analysis<sup>4</sup>. A graph displaying these energy savings can be seen below.



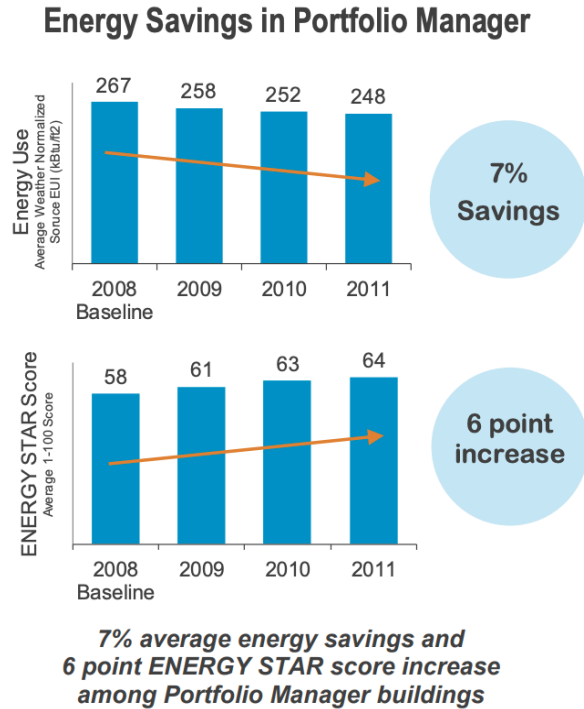


Figure 6: Energy Savings and Energy Star Score Trends when Benchmarking Energy Use

Additionally, buildings that start with lower Energy Star scores and higher energy use achieve the greatest savings. In fact, buildings starting with below average energy efficiency in 2008, a score under 50, saved twice as much energy as those starting above average. Since McCandless currently has a score in the 51-60 range, they would roughly achieve 8% savings over a three-year period from simply benchmarking and recording their energy data, as shown in the below graph.

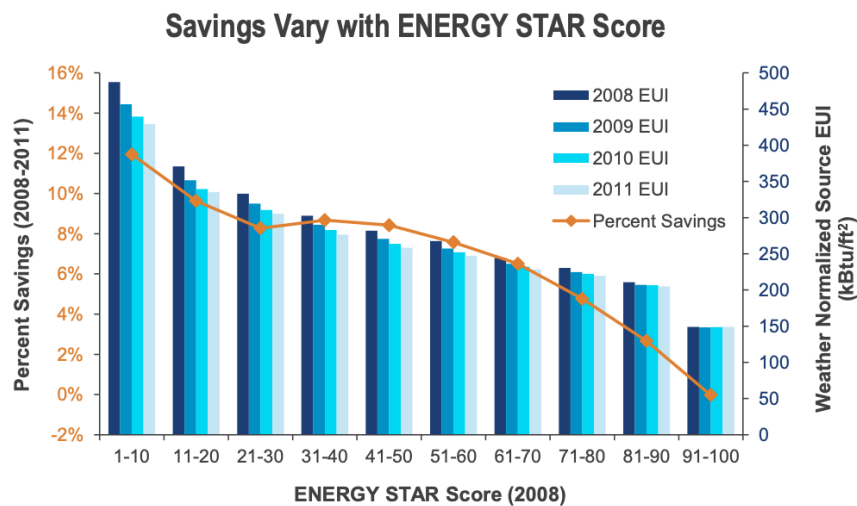


Figure 7: Percent Savings and Source EUI Vs Starting Energy Star Score

Lime Energy Consulting and Technical Services completed an energy audit for the McCandless township building in 2010. In this audit the consultants acquired the buildings utility bills including electricity, gas, and water from the following year. They published this data in the report showing the total consumption and total cost of that utility for that year. Electricity consumption data was complete, but no data was available for gas consumption and data was partially lacking for water consumption. Since the data for all utilities (electricity, gas, and water) was not available, we will not be able to make a full comparison of utility usage and cost changes during this 10-year period. However, we will focus our comparison on electricity since we have that complete data from 2010.

The report from 2010 made four energy saving recommendations for McCandless to consider that would make the most impact on their energy bills. The first was a lighting retrofit. The consultants conducted a lighting survey of all of the building's interior and exterior lights to examine the possibility of upgrading opportunities. They estimated that changing the light bulbs to LED light bulbs would save McCandless \$4,700 on their electricity bill a year. The next recommendation was to install an automatic thermostat system that would have better control on the buildings' the heating and cooling. The projected savings on this project are \$3,509 a year. The next recommendation was to install more insulation around the domestic hot water tank piping. The cost of the project is low (\$32) as well as the savings (\$3). The final recommendation is to upgrade faucets throughout the facilities with higher efficiency equivalents to provide better water conservation. The projected saving on water bills from this project is \$144 a year.

When comparing the energy usage from the 2010 audit to our own audit using Energy Star portfolio, we are able to see that energy usage at the town hall building has slightly decreased over this ten-year timespan. Lime Energy consultants reported a total of 187,920 kWh usage for the year 2010 and a total cost of \$17,681. In our report we found that total energy usage for the year 2017 was 184,880 kWh and a total cost of \$17,892.92. In 2019, the total energy usage was 187,232 kWh and the total cost was \$16,043.34. The cost of electricity usage seemed to have remained steady from 2010 to 2017, however we see a decrease in total cost from 2017 to 2019. In comparing the 2010 audit to the 2019 audit we completed, we can see that utility usage has not fluctuated much in this 10-year time span. To our knowledge, McCandless township has not made any changes to their facilities except for the lighting retrofit which accounts for the \$2,000 savings in electricity bills. If McCandless was to invest in the other recommendations made by Lime Consulting back in 2010 they would continue to see savings in their utility bills.

### **Infrared Thermal Imaging Camera Inspection**

Using an infrared thermal imaging camera inspections were made of various parts of the McCandless Town Hall building. The purpose of the inspection was to identify any points in the building where gaps in the insulation were allowing heat to escape. This information can be used to improve the building's heating and cooling efficiency, decreasing total energy usage and thus saving McCandless money.

Based on the results of the inspection, the main areas of heat loss in the building were through the windows. This was consistent across both floors, and in some cases, could even be observed in infrared images taken outside of the building. The windows are most likely the largest source of heat loss in the building, most likely due to them being only single or double paned glass. Upgrading these windows with more highly insulated glass would yield energy savings through reduced heat loss during the winter and reduced cooling loss during summer.

One other area of concern related to the inspection is the detectives' office on the lower level of Town Hall. Several officers mentioned how cold the space gets during winter. The thermal imaging camera showed a temperature of 60 degrees Fahrenheit on the exterior wall of the office. This would suggest that there is almost no insulation between the office and the outside. By renovating the area and installing insulation in the wall, it would reduce heat loss through the wall as well as the need to continue buying space heaters for the office each year.

Some images from this inspection are included in the Appendix section.

### **Thermal Comfort Survey**

An important part of our project was administering a thermal comfort survey for the employees of the town hall building. This survey was meant to help us gauge the employee's sense of comfort in their workplace and learn how we could better improve the building's energy efficiency. Below are some sample questions:

- How satisfied are you with the temperature in your space?
- In hot weather, the temperature is ...
- In cold weather, when is the temperature the worst?
- In what areas of the building do you feel most comfortable?

From the responses, we were able to conclude that many of the employees were dissatisfied with their environment, which was in result having negative impacts on their workplace experience and the building's energy usage. Unfortunately, we were only able to distribute ten comfort surveys (it was a late Friday), and we're unable to return to distribute more because of the pandemic. Still, the different sections of the building were well-represented in our results, and we believe that this will provide an accurate representation of the entire workforce.

One of the most striking results of the survey that was also reiterated by many of the employees was the diversity of comfort experiences throughout the building. Certain areas are extremely frigid while others feel like a preheated oven. Much of this variability could most likely be attributed to a poorly functioning central ventilation system. Because of this, many of the employees are forced to find ways to increase their comfort, some of which increase the building's energy burden. From the surveys, we learned that three employees use portable space heaters while another three use room air conditioning units. This highlights the failures of the central system and places a large strain on the building's energy expenditure. These pieces of equipment are extremely per capita inefficiency – and dramatically increase the energy costs and expenditure.

The information from the survey, combined with the IR camera, has shown that the windows in the town hall building are doing a poor job of regulating between the interior and exterior environment. Windows can be both a friend and a foe of energy efficiency. Proper windows can capture heat from the sun, while inefficient windows can leak heated or cooled air. In fact, windows are responsible for some 20 percent of a home's energy loss (Green Home Guide). Two respondents in the town hall building reported that the windows had strong drafts. Retrofitting the windows could block heat during the summer, while keeping it in during the winter. Six of the respondents claimed that their source of discomfort comes from incoming sunlight. The town hall building could use this natural light to reduce energy usage, while also implementing techniques to reduce discomfort like blackout shades. Blackout shades are particularly effective at blocking heat and maintaining coolness in the interior. The US Department of Energy estimates that reflective blinds can minimize heat gain by approximately 45 percent.

Additionally, three respondents recorded that air flow was low within the building. This is connected to the building's HVAC system. The 'V' stands for ventilation – and this is the process of exchanging air to remain indoor air quality. Indoor air quality is integral in protecting public health, and inadequate air flow can cause long term health consequences. The Environmental Protection Agency (EPA) wrote this about the dangers of low air flow:

If too little outdoor air enters indoors, pollutants can accumulate to levels that can pose health and comfort problems. Unless buildings are built with special mechanical means of ventilation, those designed and constructed to minimize the amount of outdoor air that can "leak" in and out may have higher indoor pollutant levels (EPA) [8].

The respondents wrote this when asked "If the air feels clean and if it has an odor?"

- "No. There is not usually an odor, except in the basement."
- "My office has a musty odor."
- "Occasionally musty or stale."
- "Air feels heavy & I sneeze often. Mold can be seen on most vents."
- "No – somewhat musty."
- "We deal with a lot of old documents so if the vents were cleaned that would be nice."
- "No way! Look at the vents. They are disgusting."

The indoor air quality must be improved to foster a healthy working environment, and replacing the HVAC system could achieve these desired effects. This mechanical improvement would help restore the air flow, remove moisture and unwanted odors, and limit bacterial growth and airborne gases. This would be a costly project – but the health of the employees should not be sacrificed for costs concerns. Furthermore, it would have a substantial impact on reducing the

building's energy expenditure, and ultimately move it closer towards the platinum status of the PA Sustainable Communities Certificate.

### **Education**

Our third deliverable is public education on energy efficiency to the town of McCandless. Based on our research in the 300, 30, 3 approach to attacking McCandless's energy issue, we found that the 300 section can save a lot of money for the town without needing as much investment into that section. The purpose of the "300" section is to tackle energy efficiency on a wider scale, and the scale in our project is people. We will reach our wider audience through public education. There are two messages our team would like to communicate with the McCandless community through our public education campaign:

1. Give citizens the tools and resources to control energy efficiency within their homes or business
2. Display McCandless's commitment to sustainability and energy efficiency.

Within our first message, our goal is to show the community that achieving energy savings is as easy as turning off your lights. Simple behavior changes and home improvements can end up helping the individual save immensely on their energy bills. Our goal is to show the community the energy usage that they have control over. The goal of our second message is to continue to promote McCandless's efforts toward sustainability so that the community becomes aware of their actions and then proud of their actions. We're hoping to create a positive feedback loop within the community of care for what the township is doing and then the desire to get involved.

Our method of executing a public education campaign are an educational video and brochure. The video is split into two halves. The first half will explain our project and the goals we have to help McCandless achieve their goal of energy efficiency. The second half will focus on explaining how energy efficiency works and how it can be achieved. The first half is focused on message #2 and the second half is focused on message #1. The brochure is focused on providing helpful tips to homeowners on projects that can take on to improve energy efficiency within their homes.

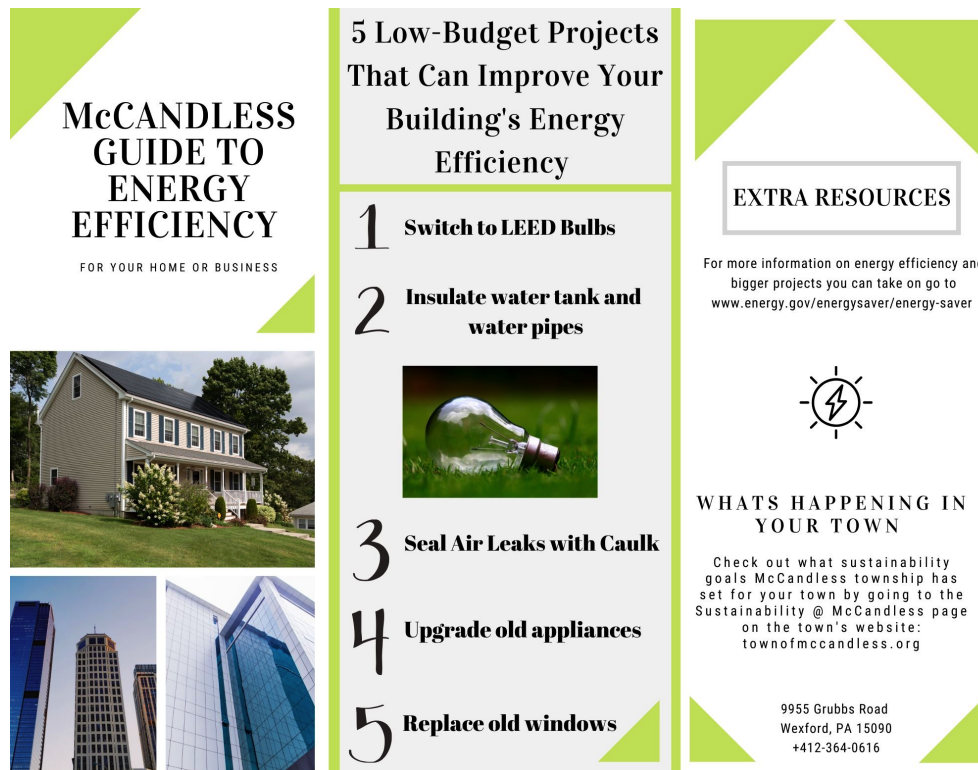


Figure 8: McCandless Guide to Energy Efficiency

We are discussing with the township the possibility of either sharing the video and brochure on their website or facebook page. Either possibility will help connect our content to the audience we wish to reach. Through the spread of these two critical messages, we will open up and continue the dialogue of energy efficiency within the town of McCandless. Furthermore, we wrote a letter that can hopefully be shared with the public to help inspire environmental action and stewardship.

#### Letter to the public:

I'm writing on behalf of a team of four Pitt students completing our "capstone" class for a sustainability certificate. We've partnered with McCandless Township representatives to work towards the implementation of collective environmental goals. McCandless Township currently receives *gold status* on the PA Sustainable Communities Certificate with an upgrade to *platinum* considered *attainable* in the near future. Our team is excited to collaborate with the citizens, schools, and civic organizations in pursuit of those goals. Our goals are very simple; we want a clean, safe, and sustainable future.

The township has identified reducing the energy expenditure of their town hall building as one of their main concerns of our project. For the past several months, we've been completing energy audits, using IR cameras, looking at building envelope models, discussing the feasibility of

renewable energy, and interviewing professionals for expertise. While all of these are practical interventions, it fails to fully address the root of the issue. There is a large place in sustainability for technological solutions, but it mustn't be the only. We would be wrong to think that we can innovate our way out of a climate calamity because, truthfully, we cannot solve these issues with the same thinking that created them. The township has taken on our help not only to reduce their footprint, but to signal their commitment to environmental advocacy in McCandless township. They want this project to be a benchmark that inspires all of you to rethink your relationship with nature.

A lot of people believe that environmental action only looks like putting solar panels on your rooftop – or driving an electric car, and while these are great projects, they're also financially exclusive. There are countless other projects you can take on that will be both friendly to the environment, and your wallet. There is no face, no archetype to environmental advocacy. You are not born an environmentalist, and there's certainly no frat party list keeping you from becoming one. Environmentalism has no face largely because those who stand to suffer the most severe effects of global warming have not yet been born. But this doesn't mean we can pretend all is well, and go about business as usual. We are on the brink of a climate crisis – which will have deep social, economic, and environmental implications throughout the world. Currently, we are beginning to see the consequences, and while milder winters might not seem like a terrible thing in Pittsburgh, it also shows through wildfires in Australia and the Amazon, hurricanes devastating coastal cities, and island nations succumbing to rising sea levels. For us it might be an inconvenience, but to others it's their livelihoods.

Every decision you make, no matter how small or big, has an environmental impact. It can manifest itself in things as simple as what did you eat for lunch or how did you get to work. It's easy to fall into the trap of thinking that individual actions are meaningless in the face of a global crisis, and while what you eat for lunch may not change the world – it will change you. And as the famous anthropologist Margaret Mead once said: "Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has." We have divorced ourselves from the land – we see it for the wealth it can create, rather than the intrinsic wealth it already has. It's important to remember that the environment is not our surroundings – it's our substance. It's the food we eat, the water we drink, and the air we breathe. We cannot keep distancing ourselves from the environment, because it has given us everything, but it also has the ability to take it all away.

Best,

The team

After the dialogue for energy efficiency education has opened within McCandless, we hope that the efforts to educate the public are continued. One way we have aided McCandless to plan for the future is by making them aware of the Environmental Education Grant given by the PA Department of Environmental Protection. This grant would allow McCandless to create long-lasting environmental education programs throughout their community, and set them on a path to educating future community members and leaders on sustainability topics that will make a lasting impact throughout McCandless.

## **VII. Further Recommendations**

### **HVAC**

The HVAC system in the Town Hall building is highly inefficient. Five different heating and cooling systems spread across three different manufacturers. Upgrading this system to standardize heating and cooling across the building would save McCandless thousands of dollars in energy costs over the lifetime of the new system. Further research would be necessary to determine the exact payback period for the system, but the Township officials are aware of the potential benefits of the upgrade. With this knowledge in mind, we can only reemphasize the need for the upgrade to be considered seriously in the future.

### **Electric Vehicles**

McCandless township is designed like most suburbs. The majority of it is zoned to be single use and low density. As a result, McCandless is highly dependent on personal automobiles for transportation and accessibility. While investing in alternatives to POVs would be highly beneficial for the sustainability of the township, we recognize that this is unlikely given our current infrastructure. Electric vehicles are a healthy compromise between environmental action and current needs. And while electrification is not without issues, it will undoubtedly play a role in the future of mobility in this country. Much of the hesitancy surrounding electric vehicles comes from the high start-up costs. While this is understandable, there are a number of funding opportunities to reduce the costs and help EVs find their way to roadways. Below we will list some of these opportunities.



<b>Name of Program</b>	<b>Institution/Agency</b>	<b>Information</b>	<b>Application Deadline</b>
Driving PA Forward -- Level 2 EV Charging Rebate Program	PA Department of Environmental Protection	The Level 2 EV Charging Rebate Programs provides rebates for the purchase and installation of Level 2 electric vehicle charging infrastructure on publicly accessible, government-owned or non-government-owned property or at workplaces or multi-unit dwellings that are not publicly accessible.	December, 31st
Alternative Fuel Vehicle Rebate Program	PA Department of Environmental Protection	This program provides rebates for consumers to purchase a new, non-leased, plug in hybrid vehicle.	Continuous
Volkswagen Zero Emission Vehicle (ZEV) Fund	PA Department of Environmental Protection	Volkswagen will be investing \$2.0 billion over the next ten years into zero emission vehicles and infrastructure. To apply, visit Volkswagen ZEV website.	Continuous
Plug-In Electric Vehicle (PEV) Rebate	PECO	PECO provides rebates of \$50 to residential customers in their service territory who purchase a new, qualified PEV. For more information, see the PECO Smart Driver Rebate.	Continuous
Federal Tax Credit	Federal government	The federal government provides incentives for certain types of alternative fuel vehicles and infrastructure. Certain types of EVs qualify for a federal tax credit. More information on federal incentives is available at: <a href="http://www.afdc.energy.gov/laws/fed_summary">www.afdc.energy.gov/laws/fed_summary</a> .	Continuous

*Table 2: Electric Vehicle Programs & Opportunities*

Furthermore, we are looking into opportunities to help McCandless township electrify their fleet. The US Department of the Energy and Environmental Protection Agency run a joint program aimed at helping fleets turn electric. We were also in discussion with Duquesne Light about a new pilot program they are launching. They are helping local municipalities electrify their fleets, and were interested in helping McCandless township with this opportunity. This

would be a statement by the township that they're committed to these processes, and it could also be an opportunity to educate the residents about the benefits over turning electric, and how they could make it a reality.

### **Energy Programs and Grants**

Our team was able to find some very helpful energy efficiency programs and grants that McCandless could qualify for with the help of the company CPower. Some of the programs through CPower that McCandless could potentially qualify for are the PJM Economic Loan Program, Energy Efficiency Program, Distributed Energy Resources (DER) Monetization, Alternative Fuel Vehicle Program, and the Stipulated Energy Savings Agreement. The PJM Economic Loan Program allows participating businesses to manage their electricity use in response to conditions in the wholesale market. Participants are notified when electricity prices are high and reduce their electric consumption, minimizing the impact of price spikes, reducing the need for expensive capacity generation. The Energy Efficiency Program compensates businesses for permanent load reduction resulting from energy efficiency projects that have been completed or will be completed in the future. The program pays organizations capacity revenue for up to four years following the completion of a qualified project. Qualified projects include efficiency upgrades in lighting, refrigeration, motors, compressed air, weatherization/building envelope, industrial process improvements, LEED/green building status, and more. DER Monetization is when organizations with DERs are enrolled in demand-side energy management programs, resulting in compensation that can even be used to reduce the underlying cost of the DER. DERs—like energy storage, solar, fuel cells, wind generation, combined heat and power, and more—are power sources that can be aggregated to provide the power necessary to meet regular demand.

## **VIII. Next Steps and Future Goals & Implications**

Our primary next step is to be available for McCandless Township in their journey to increase energy efficiency. This includes continuing to be accessible to answer any questions McCandless may have about our recommended actions for them or about sustainability in general. We hope the information and goals we have provided for McCandless will serve as an outline for them to proceed as they seem fit. The township has a plethora of improvement paths they can choose to take, such as pursuing energy efficiency grants or programs, educating their citizens, continuing to monitor and benchmark energy use, pursuing alternative energy sources, or improving the building envelope and the HVAC system. These improvements should vastly improve the Township Building and community's overall sustainability and ultimately lead them to a Platinum Certificate from PA Sustainable Communities.

Going forward, the implications of this project could prove to be transformative for McCandless. Through community education and leadership by example, the town government could spur its residents to implement many of the energy saving measures we have identified as

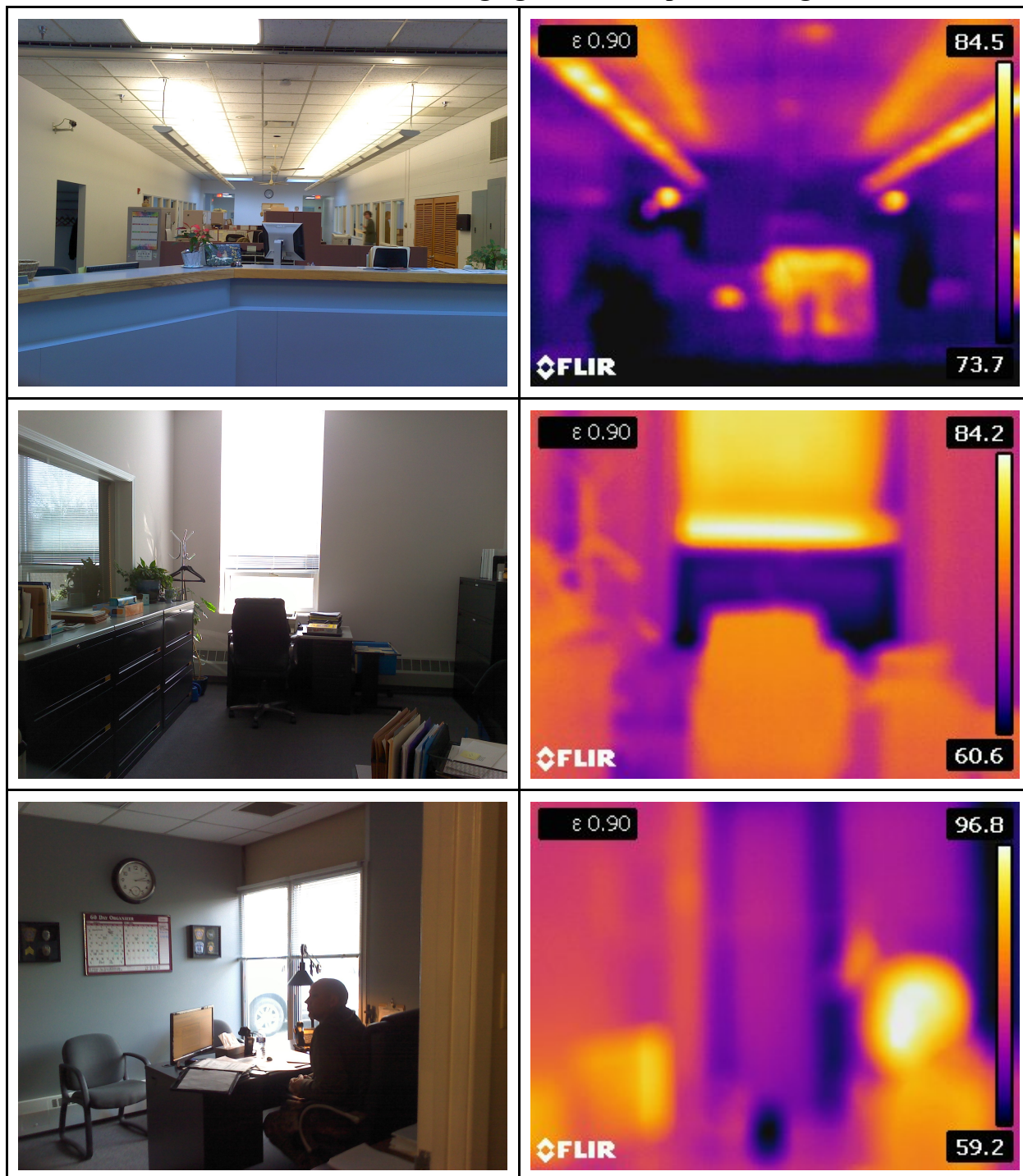
being beneficial for the Town Hall building. Furthermore, if demonstration green energy fixtures are installed around the Town Hall building, residents might also follow suit and begin installing them on their own homes and businesses. The result, of increased energy efficiency within buildings and green energy production within the township, could result in McCandless having a total carbon footprint at a fraction of its neighbors. This would be a point of prestige for McCandless among the other communities of the greater Pittsburgh Area.

## IX. References

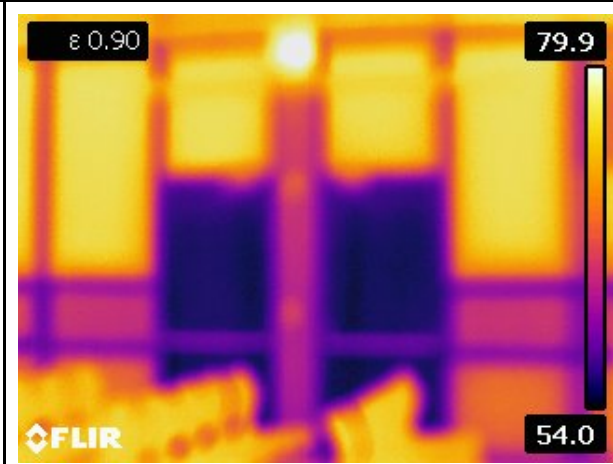
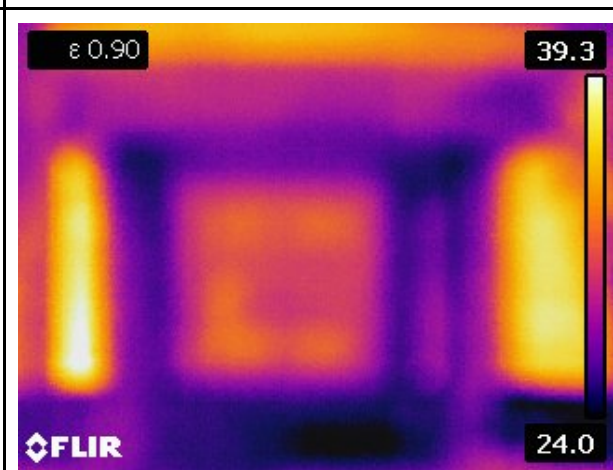
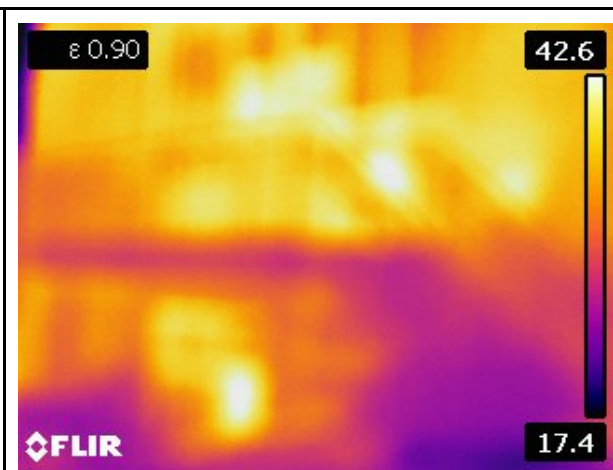
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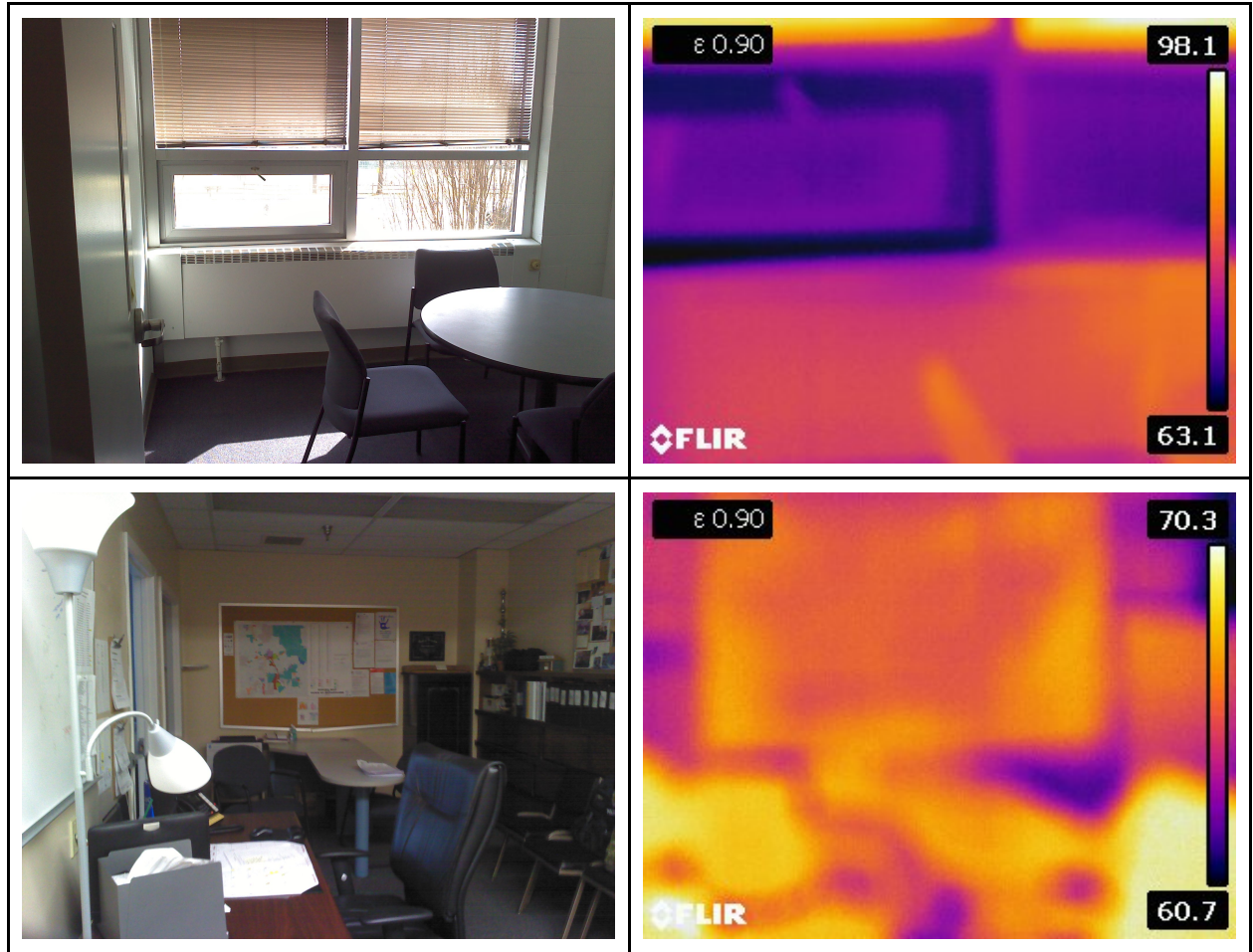
## X. Appendix

### Infrared Thermal Imaging Camera Inspection Images









### Thermal Comfort Survey

**Thank you for participating in this survey. We are trying to assess your comfort levels and learn how we can better improve the building's efficiency.**

1. Which of the following do you personally adjust or control in your space?

- Window blinds or shades
- Room air conditioning unit
- Portable heater
- Permanent heater
- Door to interior space
- Door to exterior space
- None of these
- Adjustable air vent
- Ceiling fan
- Adjustable floor air vent (diffuser)
- Portable fan
- Thermostat

Operable window

None of these

2. How satisfied are you with the temperature in your space?

Very satisfied

Somewhat satisfied

Slightly satisfied

Neutral

Slightly dissatisfied

Somewhat dissatisfied

Very dissatisfied

3. In hot weather, the temperature is ...

Always too hot

Often too hot

Occasionally too hot

Occasionally too cold

Often too cold

Always too cold

4. In hot weather, when is the temperature the worst?

Morning (before 11am)

Mid-day (11am–2pm)

Afternoon (2pm–5pm)

Weekends/holidays

Monday mornings

No particular time

Always

5. In cold weather, the temperature is ...

Always too hot

Often too hot

Occasionally too hot

Occasionally too cold

Often too cold

Always too cold

6. In cold weather, when is the temperature the worst?

Morning (before 11am)

Mid-day (11am–2pm)

Afternoon (2pm–5pm)

Weekends/holidays

Monday mornings

No particular time

Always

7. How would you best describe the source of your discomfort?

Humidity too high (damp)

Humidity too low (dry)

Air movement too high

Air movement too low  
 Incoming sun  
 Heat from office equipment  
 Drafts from windows  
 Drafts from vents  
 My area is hotter/colder than other areas  
 Thermostat is inaccessible  
 Thermostat is adjusted by other people  
 Clothing policy is not flexible  
 Heating/cooling system does not respond quickly enough to the thermostat  
 Hot/cold surrounding surfaces (floor, ceiling, walls or windows)  
 Deficient window (not operable)

8. Does the air feel clean? Does it have an odor?
9. In what areas of the building do you feel most comfortable?
10. In what areas of the building do you feel least comfortable?
11. What is the best way to engage the public in McCandless township?

### **Electrification**

Below are several links to learn more about electrification happening in Pennsylvania:

US Department of Energy: Alternative Fuels Data Center

<https://afdc.energy.gov/>

The Alternative Fuels Data Center (AFDC) provides information, data, and tools to help fleets and other transportation decision makers find ways to reach their energy and economic goals through the use of alternative and renewable fuels, advanced vehicles, and other fuel-saving measures.

US Department of Energy: Office of Energy Efficiency & Renewable Energy

<https://www.energy.gov/eere/electricvehicles/electric-vehicles>

This is the stakeholder solution center where you can learn how utilities, employers, states and municipalities, fleets and electrical contractors can help make EVs everywhere.

Pittsburgh Region Clean Cities:

<http://pgh-cleancities.org/>

Pittsburgh Region Clean Cities advances the energy, economic and environmental security of the United States by supporting local actions to reduce petroleum use in transportation. They support local infrastructure projects that are needed for alternative fuel programs, collaborate with various member organizations, and represent Western Pennsylvania for energy initiatives in urban sustainability.



Plug in America:

<https://pluginamerica.org/>

Plug in America helps make the consumer's experience of purchasing an electric vehicle as convenient as possible. They help you find the car that best fits your needs, learn about tax credits, rebates, and other incentives, and prepare your home for EV charging.

Electric Drive Transportation Association:

<https://electricdrive.org/>

The Electric Drive Transportation Association (EDTA) is the trade association promoting battery, hybrid, plug-in hybrid and fuel cell electric drive technologies and infrastructure. To advance their mission, they conduct public policy advocacy, education, industry networking, and conferences that engage industry, academia, policymakers and the public.

### **2010 McCandless Energy Audit**

McCandless's previous energy audit can be found at the URL below:

[https://www.townofmccandless.org/sites/mccandlesspa/files/uploads/energy\\_audit.pdf](https://www.townofmccandless.org/sites/mccandlesspa/files/uploads/energy_audit.pdf)

## **XI. Acknowledgements**

We would like to thank Angela Woods, Councilwoman from McCandless Township, and Bob Grimm, McCandless's Town Manager. They were great aids in finding out what areas would be best suited for us to focus our research on. We would also like to thank Danielle Bond, Senior Engineer from CPower, for providing us with valuable information on potential programs and grants, as well as her opinions on our project in general. Finally, we would like to thank Dr. Sanchez, Professor Kerzmann, and Joe for a great and educational semester.

Thank you The Shins and Sunny bird.