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Quantifying Greenhouse Gas and Financial Impacts of Energy Use in L/A Area Businesses

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ENVR 417: Community Engaged Research
Final Report

Community Partner: Shanna Cox,
Lewiston Auburn Metro Chamber of Commerce

Executive Summary

Human economic activity has contributed massively to the emission of Greenhouse gases (GHG) since the industrial revolution. Commercial businesses, no matter any size, shape or form cannot function without the use of energy, especially without electricity and heating. Within Maine, the vast majority of GHG emission is from transportation. However, electric power, commercial and industrial sectors, which links to the process of operating businesses, account for 27 percent (Maine DEP, 2021). This project works to provide resources to improve efficiency in energy use to help lower the contribution of Maine's businesses to that 27 percent slice. The main goal is to reduce GHG emissions by businesses in the Lewiston Auburn area by providing solutions to make changes to increase energy efficiency and reduce fossil fuel combustion. Though it may seem easy to tell businesses to reduce their emissions through efficiency upgrades, the biggest barrier that needs to be addressed is Maine's businesses are small with limited financial capabilities as their bottom line is to make revenue for survival. They are limited financially and time-wise to explore different efficiency upgrade options. To address this barrier, our project will help businesses to identify different methods of upgrades while also providing methods of financing by recommending existing federal and state rebate programs.

The aim of this project is to aid the Lewiston Auburn Chamber of Commerce, project's community partner, in providing information and education to local businesses with the goal of increasing energy efficiency for the purpose of lowering business operating costs and reducing GHG emissions. To achieve this aim we would provide attractive and easily digestible fact sheet as deliverables and tackle the following objectives: Identify where businesses use energy and categorize consumption, recommend actions for businesses to improve energy efficiency in areas of high consumption supported by Federal and or State Efficiency Programs, and show businesses how they can potentially save money with energy efficiency programs and reducing

energy consumption. Our project seeks to help business owners who have very limited time and resources to research energy upgrades to look at the deliverables and gain all the necessary information from one location.

Commercial sectors in Maine, especially in Lewiston and in Auburn, restaurant, office, manufacturing, institution, food sales (convenience stores), and retail were selected, and business profiles, sectors separated by size, were created to understand individual's divers of energy use. Calculations of monthly energy consumption were done to identify its biggest drivers and understand where to focus its efficiency upgrades to make the most effective and biggest effects to GHG emissions. Within the six sectors, HVAC system and appliance upgrades were identified to be the most commonly effective upgrade options. Federal and state rebate programs to finance these upgrades were identified. These suggestions were compiled into the deliverables, fact sheets for each business profile, for business owners to look at their identifiable business profile fact sheet and easily attain information for future changes.

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Background

Climate change is rapidly occurring on a global scale, creating massive environmental implications that will permanently alter the planet. The emission of greenhouse gasses (GHG) from human sources is a major, if not the largest contributor fueling this global change. Electricity and heat of residential and commercial buildings is the largest economic contributor to the production of greenhouse gases; this sector alone accounts for 25% of global human based GHG emissions (Global Greenhouse, 2021). This trend continues at a federal level within the United States, with electricity and heat combined producing 38% of the nation's GHG emissions (Sources of Greenhouse, 2021). Unabated GHG production will continue to exacerbate the current climate status, but strategies designed to lower emissions have been implemented at federal and state levels.

Strategies spearheaded by the Environmental Protection Agency for reducing GHG emissions include methods of improving energy efficiency, renewable energy, waste reduction and diversion strategies, methane emission reduction strategy, and decreasing fuel use in transportation and logistics (EPA, 2021). Most of these strategies are large-scale projects that necessitate large amounts of capital to implement. For example, the transition to renewable energy alone is projected to cost upwards of 4.5 Trillion USD for just the United States (Montaigne et al., 2019). Costs of small-scale projects are still expensive. Installing renewable energy sources to power and heat a small farm in Maine would cost upwards of eighty thousand dollars if the most cost efficient upgrades were completed (Yudkin et. al., 2015). Often overlooked is the strategy of increasing energy efficiency; increasing energy efficiency reduces the amount of energy consumed. Better energy efficiency can be implemented at a scale ranging from the small action of replacing a single light bulb that consumes less energy than its predecessor, or as large as upgrading entire energy production plants (Green, 2018). Paired with any sized reduction of energy consumption is the amount of money saved by completing efficiency upgrades due to less energy being purchased. Thus improving energy efficiency is a GHG reduction strategy that should be considered by any and all emitters with the two parallel outcomes of first saving money though the lowering of business operating costs and second reducing the amount of GHG emissions.

Emissions on both a global and smaller state level are largely driven by the commercial sector (Global, 2021, Maine DEP 2021). Globally buildings, heat and electricity production, and industry are responsible for 52% of all greenhouse gas emissions (Global, 2021). These three categories are all essential for the operation of any business. Energy consumption by economic entities within Maine follows a similar pattern, despite being at a significantly smaller scale.

the state's emissions stem directly from electricity production and the heating of buildings paired with the operation of commercial buildings (Maine DEP, 2021). Those emissions can be viewed as necessary due to the economic benefit they generate through usage by businesses. But within Maine, economic production has been found to not be directly dependent on the use of fossil

fuels or affected by efficiency improvement: since 2002 Maine's GDP has increased while both greenhouse gas emissions and fuel consumption decreased (Maine DEP, 2020). Fossil fuel consumption decreasing while GDP increasing demonstrates how business can still be productive while decreasing GHG emissions. GHG emission is driven by commercial activities at a global and smaller state scale, and reducing fossil fuel consumption driving emissions within Maine is a viable step economically demonstrated through its GDP and fossil fuel consumption not being strongly linked.

The responsibility of making a meaningful impact in lowering Maine's GHG emissions falls upon the shoulders of small businesses. Maine's business landscape is dominated by small businesses. Over 99% of Maine businesses fall within the federal definition of small businesses which is defined by the Maine Department of the Secretary of State as a business having 50 employees or fewer (Small Business, 2021). GHG reduction strategies within Maine must account for the limited resources of capital, time, and manpower present within the operation of small businesses. Further complicating the issue is that small businesses vary greatly in how they consume energy: a small restaurant will not use energy in the same areas as a small manufacturing plant. Thus, energy efficiency upgrades are an applicable strategy within Maine due to its lower demands on project size, cost, and time needed to implement paired with the sheer diversity of options. Furthermore, there are Federal and State run programs that provide financial incentives to businesses for completing energy efficient upgrades.

There are a multitude of programs available for businesses seeking to complete actions that increase their energy efficiency. These programs are implemented at both Federal and State levels, and provide financial support through rebates, tax rebates or reductions, loans, and grants. Notable federal programs include Energy-Efficient Commercial Buildings Tax Deduction (EPAct 179d) and Rural Energy for America (REAP) loans and grants among others. Efficiency Maine, the independent administrator for programs that improve energy efficiency within Maine, provides a broad range of diverse programs solely dedicated to that goal. The process of first learning about these programs and understanding what type of energy efficiency improvements they support is complex and time consuming.

Becoming more energy efficient is not a simple process for a small business. As previously identified, small businesses often lack the time to identify specifically where they consume the largest amounts of energy and resources to implement actions that increase energy efficiency in those areas. The issue is further exacerbated by a gap that exists between business owners' perception and understanding of sustainability and their actual commitment to the issue through their business (Battisti, 2011). This value-action gap is caused by the constraints owners have of limited resources to engage in environmentally responsible business practices, low levels

of eco-literacy, and lack of or inability to access information. Within that context, small businesses in Maine will need a resource that addresses the challenges of those barriers. The Lewiston Auburn Metropolitan Chamber of Commerce is a "a regional hub to fund new business ideas, launch entrepreneurs and attract new and expanding companies,"(LA Metro, 2019). They have over 3,000 business members, and advocate on their behalf as well as provide resources and

education so their members can thrive. They are an incredible resource for creating materials specific to their business members that provide information and education. Increasing energy efficiency is of two types of interest to both the Chamber of Commerce and its business members. First is the reduction of greenhouse gas emissions and its significance in helping avoid climate change. Second is the cost savings increasing energy efficiency provides; using less energy decreases operating costs of any and all businesses. However, small business owners lack the time to investigate where they use the most energy within their business and identify what actions, such as energy efficiency upgrades, can be used to lower energy usage in those areas. Costs of those upgrades can be outside the budget of small businesses, and despite the presence of federal and state programs offsetting the costs of efficiency upgrades, identifying which programs will be the most financially beneficial is challenging. There is also a lack of financial incentive present when businesses look into improving their energy efficiency. Benefits of improving energy efficiency do not always include consideration into the money saved through upgrades. A resource streamlining the process of identifying actions for improving energy efficiency while also prioritizing the cost savings to businesses alongside a decrease in GHG emissions would address those gaps and be beneficial to the Lewiston Auburn Metro Chamber of Commerce.

Aim

The aim of our project is to aid the Lewiston Auburn Chamber of Commerce in providing information and education to local businesses with the goal of increasing energy efficiency for the purpose of lowering business operating costs and reducing GHG emissions.

Objectives

Objective 1: Identify major sources of energy use for a commercial sector and how it varies across different types of businesses.
Objective 2: Recommend actions for businesses to improve energy efficiency areas of high consumption supported by Federal and or State Efficiency Programs.
Objective 3: Show businesses how they can potentially save money with energy efficiency programs.

Methodology

Research

Research was centered on two primary topics. First, energy consumption rates across different business types, sizes, and industries will be investigated using analysis from the US Energy Information Administration, Energy Profiles from Energy.gov, Commercial Building Interval Meter Data Analytics Studies, and any other resources available. Second, programs providing assistance to businesses seeking to complete energy efficiency upgrades will be identified.

Federal programs were researched across Federal Resources such as Energy Star, Energy.gov and similar resources. State programs were identified using the Database of State Incentives for Renewables & Efficiency (DSIRE).

Establish Business Profiles

Business profiles will be used to categorize different small businesses in Lewiston and Auburn due. Profiles are needed due to the diverse range of energy usage, and differences in specifically where energy is being used by businesses. Subsequently, recommendations for increasing energy efficiency and best programs will be made for each profile. The profiles will be categorized by: business type, size (sqft), and appliances.

Estimate Energy Use for Each Business Profile

Total amount of energy usage and specific sectors within that total energy usage were estimated using a variety of resources. Data collection to build accurate average energy use business profiles will follow the following path. First, each business profile will be divided into either two or three sub categories, and the specific differences between these subcategories will be determined by the information we find while exploring the sizes of businesses present within Lewiston and Auburn. For those profiles at each size. Energy usage including electricity and heating oils (such as propane, natural gas, and oil) will be estimated using a collection of resources. Electricity usage will be determined using the Efficiency Maine Commercial Building Interval Meter Data Analytics Study in conjunction with estimating appliance and lighting consumption from records of appliance usage taken from manufacturer's equipment ratings. Other energy consumption will be determined using appliance ratings and from records taken from manufacturer's equipment ratings as well. The different sources of non-electric energy will be aggregated into a single value. Emission levels, such as carbon, will be determined using a sum of eclectic and other energy consumption. Finally, the areas of energy consumption will be compiled into broader use categories including: appliances, cooling/ventilation, heating, lighting, and other.

Reach out to Local Businesses to Ground Truth Profiles

We will reach out to at least one small business in Lewiston Auburn that fits each business profile we have created to talk about their average energy usage and costs. This allowed us to make more accurate business profiles, and validate the assumptions we have made. The plan to do this is to see if Shanna, our community partner, knows of any small businesses that look similar to our profiles from each sector.

Research and Identify Energy Efficiency Programs

Energy programs identified in the first method will be examined using a series of questions to determine if they will be used within this project (Appendix 1).This process identifies what

specific energy efficiency upgrades will qualify, which sectors of consumption will be reduced, which business profiles will benefit the most from actions supported by the program, and how much GHG emissions will be lowered. Finally, a short summary that is easy for a business owner to understand will be written.

Compile summary for each program

Once our programs of interest have been identified, mainly from Efficiency Maine, we'll create summaries for them. These summaries will be boiled down versions of the information from the incentives tab on their website. The first facet of them will be a description of the upgrades in question, and its advantages over their older versions, including potential GHG reduction. This will be limited to non-monetary benefits. And then the second facet of the summaries will be an overview, likely a table, that shows rebate value, and payback time based on units installed. Based on these summaries, and our business profiles, we will be able to identify how sectors will benefit most from specific programs.

Identify Actions to Improve Energy Efficiency

For each business profile and each of those business sizes recommendations for actions improving energy efficiency will be made. These recommended actions will consist of upgrading appliances, fixtures, heating, cooling, ventilation, lighting systems, and or any other areas that consume electricity. Actions will be recommended with the following goals: reducing energy consumption in the highest use category, a low stakes (money and effort) option, and the option with the fastest payback period. All actions will be supported by programs, but options where rapid payback is present will be considered.

Link Appropriate Programs to Actions

Recommended actions will be explicitly linked to the Federal and or State programs that provide assistance. Actions that are supported by multiple programs will have both programs listed.

Results and Discussion

Business Profiles

Commercial sectors account for 11 percent of Maine's GHG emissions (Maine DEP 2021). Each commercial sector has different functions of energy use. For example, a restaurant does not consume energy in the same manner as a manufacturing plant. The purpose of the project is to provide information about energy use and methods for energy efficiency for local businesses. To account for the differences, creating business profiles would help to provide recommendations for action that is tailored to individual business types. There are many different types of commercial sectors, and as the project is based in Lewiston and in Auburn, narrowing down the sectors was necessary.

Efficiency Maine conducted a study called the Commercial Building Interval Meter Data Analytics, where they executed a commercial baseline energy usage and efficiency study (Johnson and Dietrich, 2015). The study selected eight sectors for the study that represented a majority of Maine's commercial building consumptions. The eight sectors selected were: office, retail, grocery store, restaurant, warehouse, hotel, lodging, and clinic. Looking at annual usage and number of accounts, these sectors were selected and this covers 76% of Maine's annual consumption (Johnson and Dietrich, 2015). These eight sectors were guiding principles for selecting our project's commercial sectors. Looking at businesses that exist in Lewiston and in Auburn, and with discussion with our community partner who works with many different businesses in the area, Shanna Cox recommended focusing on these six sectors: production, office, retail grocery store, education, and restaurant. This decision was made with the consideration of the ability of the owner and/or the manager of the business or building to have the capabilities and access to make changes to their existing energy use.

Not only does the type of sector determine how a business would use energy, the size of its operation becomes an important factor. The size would also determine the different energy consuming appliances a business owns that accumulate its use. In order for business owners, our intended audience, to easily relate their own business to a single business profile, we separated each selected commercial sector into two different profiles (Appendix 2). All, except for food sales, were categorized based on the square footage. Looking at the square footage of businesses within the sector in Lewiston and in Auburn, an average was taken and separated into two, shown in Appendix 2. For example, for restaurants, Johnson and Dietrich (2015) stated that the average floor space for restaurants in Maine is 3189 square feet. Being specific for Lewiston and Auburn, we measured the square footage of restaurants like Pure Thai Kitchen and Governor's Restaurant and Bakery, which were recommended by Shanna Cox. Measurement was taken using Google Maps and its area calculator feature. Pure Thai Kitchen is 1757 square feet and Governor's Restaurant and Bakery is 6403 square feet. With this data, restaurants were separated into two business profiles: small restaurant which is less than 2000 square feet and medium sized

restaurant which is less than 6000 square feet. With this categorization, restaurant owners can decide which business profile their restaurant would fit to. For food sales, the two business profiles were categorized based on whether the food sale store had set up a kitchen to serve hot food, as this changes its appliance installed. As each sector has 2 business profiles, a total of 12 business profiles were created.

Energy Consumption for Each Sector

Restaurant

Restaurants are an essential business for growing communities. In the Lewiston Auburn area, there are roughly 50 restaurants operating to serve different varieties of cuisines. However,

operating a restaurant can be energy-intensive, from installation of ventilation and heating systems to installing many different types of kitchen appliances to fit the needs of the restaurant. For the two business profiles within the restaurant sector that were divided by square footage, an assumed appliance list and hvac system was made. The difference between the two business profiles were the number of assumed appliances that were installed. A list of appliances for each business profile was created and the total monthly energy consumption was calculated (Appendix 3). Some examples of restaurants in the Lewiston Auburn area are Fishbones and Break Coffee where each has very different appliance needs as they serve such different products. These two restaurants were interviewed to ground truth some of the assumptions made to make energy use calculations. Unlike other commercial sectors, appliance use was one of the most significant energy use drivers, with 34.6 percent (Table 1). With this information, to effectively reduce energy consumption and cost, the suggested action would be to tackle a businesses' appliance use. Within the appliance, refrigeration was the biggest component of a restaurant appliance's energy use and taking action to switch to a more energy efficient refrigeration system would effectively help to reduce overall energy cost.

Office

There are many offices in the Lewiston Auburn area that vary in size. Some office businesses can be as small as one floor office space less than 3000 square feet with less than 15 workers. Some can be as large as 10000 square feet with almost 50 employees. There are many different types of office buildings and businesses in the area, and creating business profiles and calculating energy consumption that accommodate the different sizes can be difficult. However, like restaurants, an assumed list of appliances to meet the needs of the number of workers and HVAC system necessary for its square footage was assumed to make the calculations (Appendix 4). In order to create a comfortable and healthy working environment, the HVAC system and lighting are important factors to control the climate of the building. These two factors contributed the largest portion of energy use for offices, making them the most effective targets for energy efficiency; especially lighting as it can be one of the easiest and fastest payback fixes.

Manufacturing

Manufacturing businesses are prevalent within the Lewiston Auburn area. Examples of local businesses that fit within the manufacturing business profile include Proctor and Gamble, Poly Labs, Modula Inc, and Bachmann Industries Inc, among the other 20 businesses listed under manufacturing on the LA Metro Chamber of Commerce website. These businesses range in size from 5,000 $ft^2$to 120,00 ft^2, and employ between five and over 100 employees. Energy usage across manufacturing businesses is not large when viewed at a high level, but when looking deeper at the specific drivers of energy consumption, ideal areas for pursuing increasing energy efficiency are apparent. First, the majority of energy use (76%) is categorized as "Other" within Table 1. Processes specific to manufacturing and production, such as drivepower, process heating and cooling, and steam are the primary drivers behind energy consumed within this

category (Appendix 5). Implementing changes to a production line to increase efficiency are not ideal, due to the complexity of most production lines paired with the loss of income due to a production line being stopped to implement changes. These two points leave the “Other” category as undesirable for suggesting actions for increasing energy efficiency despite said categories' dominance of energy consumption within the profile. Suggested actions where then made regarding lighting and cooling upgrades due to the impacts of following the suggested actions not affecting production, rapid payback time, and are supported by both federal and state programs (Table 2).

Institution

Institutions within Lewiston Auburn consist of colleges, elder care facilities, and childcare facilities. Examples of institutions that fit within our profile are Central Maine Community College and the St. Mary's D'Youville Pavilion. Facilities ranged in size from 8,000 $ft^2$to over 300,000 ft^2, and the number of employees varied greatly. Energy use was concentrated upon heating, lighting, and cooling (Table 1). Recommendations for improving energy efficiency were thus focused on these sectors. Lighting was considered an ideal path for increasing energy reduction due to the ease of implementing upgrades (replacing fluorescent bulbs with LEDs), and in response to feedback received from Central Maine Community College detailing their successful reduction of energy consumption via that process. The “Heating” sector was driven by a combination of space and water heating; water heater upgrades were recommended due to both federal and state incentives helping to offset the costs of said upgrades (Table 1). Actions taken to increase energy efficiency can be completed in tandem with recommendations made within the small restaurant, as institutions often have commercial kitchens of similar size and make up.

Small food, convenience, and liquor stores

Convenience, small food, and liquor stores in Lewiston and Auburn all have similar energy consumption based on their energy end uses, and similar sized building spaces. So the profiles were separated by whether or not they have a kitchen. And unfortunately we didn’t

receive a response from any of the sample businesses we reached out to for these profiles, so this was a large assumption for this sector. But many of these types of stores have kitchens so they can serve some form of hot food, and it adds a significant amount of energy consumption. After creating the profiles, it was clear that heating, HVAC, and some appliances all led energy consumption, so these areas were focused on when considering how to lower that consumption. For heating, heat pumps seem like one of the best solutions through the Efficiency Maine heat pump rebate programs. For appliances, it could be seen that refrigeration made up a large portion of consumption in this section. So refrigeration upgrades were recommended that significantly increase their efficiency. And finally, a VFD (variable frequency drive) upgrade for HVAC was recommended because they significantly reduce HVAC energy use, and have a rebate program through Efficiency Maine.

Retail

Retail stores in Lewiston and Auburn have similar energy consumption end use percentages across different business sizes. These end uses are heating, HVAC, and lighting, and they also have similar shares of consumption within total consumption. So all three were looked at for energy use reduction. Lighting held a large share of total consumption compared to other businesses, so LED upgrades were recommended as they provide good energy use reduction compared to fluorescent, and Efficiency Maine offers up front discounts on the lights at certain sellers. Heat pumps and VFDs were also recommended to help reduce heating, and HVAC energy use for the same reasons they were recommended for small food, convenience, and liquor stores.

Sector	% of Appliance	% of Cooling / Ventilation	% of Heating	% of Lighting	% of Other
Restaurant	34.6	13.2	48.6 (natural gas)	3.7	
Office	19.1	52.5	5.2	23.2	
Manufacturing	4	10	4	6	76
Institution	20	15	30	20	15
Convenience, and small food stores, with kitchen	33.3	21.6	39.1	6	

Convenience, and liquor stores, no kitchen	24.9	24.3	44	6.8	
Retail	26.2	27.2	24.1	22.5	

Table 1: List of business profiles and percentage of energy usage by consumption sector.

Actions for Increasing Energy Efficiency

Lighting is a sector of energy consumption that is vital to the operation of any business and or facility. Thus, actions taken to increase energy efficiency of lighting can be used across all business profiles within this report. Physical upgrades to light sources is concentrated on the replacement of fluorescent and or incandescent lighting with LEDs. LEDs can consume up to 75% less energy and have a lifespan three to twenty-five times that of fluorescent counterparts (Kickman, 2012). However, LEDs are often more expensive than fluorescent light sources, but the decrease in operational cost and longer lifespan outweigh the larger initial investment. Due to that principle, and the lowering of LED costs through financial incentives, upgrading to LEDs is the primary suggested action to improve energy efficiency in the scope of this report. Other actions including motion activated lighting, timers, and simply turning off lights can further reduce energy consumption in this sector, but are not physical upgrades either increasing the output or decreasing the energy being consumed by lighting. Energy consumed by lighting will be primarily focused on the installation of LEDs.

Upgrading appliances to a newer energy efficient unit can be one of the easiest and common energy use fixes. Business owners can easily pick energy efficient appliances, as Energy Star would be labelled for indication. Energy Star is an international symbol of premium energy efficiency that is labelled on products that meet the strict energy efficiency technical specifications that are administered globally (Energy Star, 2012). Manufacturers who produce appliance products can only label their product as Energy Star certified if it meets the requirements. Purchasing Energy Star qualified products can overall save operating cost in the long run as it uses less energy to achieve the same or better performance than of conventional alternatives (Energy Star, 2015). Even with the incremental up-front cost of purchasing a new appliance, with its efficacy that reduces operation cost, it can result in quick payback. Especially for business sectors like restaurants where the biggest energy cost driver is appliances, changing existing conventional appliances to Energy Star certified products can be the most straightforward solution. However, when deciding to change the appliance, business owners

would be less inclined to if their current appliance is new and has many years left in its expectancy. Considering life expectancy when calculating upfront cost and payback is necessary.

Cooling and ventilation upgrades help reduce businesses AC/HVAC energy consumption. One of the best examples of these upgrades are VFDs (variable frequency drives). VFDs are advertised by some companies to reduce energy consumption in HVAC systems by up to 70% (therma.com). So they can have fast payback times compared to other upgrades, under a year is

pretty common depending on the model and current HVAC energy consumption. And Efficiency Maine also offers rebates on qualifying VFD models which further reduce payback time, but also reduce the upfront cost. The other big HVAC upgrade recommended is demand control ventilation. This upgrade offers variable speed ventilation based on real time data collected from sensors throughout the system. Efficiency Maine also has rebates for these systems that help reduce upfront cost, and payback time.

In Maine, heating costs constitute a large portion of most businesses' energy consumption. So actions to reduce energy use for heating have a pretty beneficial impact on their total energy consumption. The first example of a heating efficiency upgrade is a heat pump. Heat pumps generate heat through electricity in a much more efficient way than standard boilers or natural gas options, up to 35% energy reduction (energystar.gov). And Efficiency Maine offers rebates for qualifying heat pumps that reduce upfront cost, and total payback time. There are also different levels of rebates for more advanced heat pumps that reduce heating costs and energy consumption even further. This makes the heat pump program one of the most robust, and beneficial programs used in the study.

	Efficiency Maine	Efficiency Maine Small Business Loan	USDA REAP	EPAct 179d	NEID Fannie Mae Green Financing
Restaurant	**O**	**O**	**O**	**O**	**O**
Manufacturing	**O**	**O**	**O**	**O**	**O**
Institution	**O**	**O**	**O**	**O**	**O**
Food Sales	**O**	**O**	**O**	**O**	**O**
Retail	**O**	**O**	**O**	**O**	**O**

Table 2: Programs that each business profile will be able to utilize (O for yes, X for no)

Future Recommendations

When thinking about how the work we did for this project could be used and improved on in the future, the first thing that comes to mind is that our deliverables should be distributed or made public to local businesses so that feedback for them can be collected. Because we've obviously put a lot of work into the deliverables, but we still only had like 7 weeks, and had to make a lot of assumptions, so I'm sure they could be improved with feedback. The second big recommendation that comes to mind is to redo this project with actual business energy consumption data. That would give the deliverables we created a lot more credibility. Another

suggestion to improve credibility would be to do in person energy audits of willing businesses that would allow for more accurate business profiles. And the last piece would be to update the program recommendations as new ones become available, and the current ones we recommended are phased out.

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Appendix

Appendix 1: Program details

Program Identification Rubric

What sector of energy consumption is the program for?

a. Lighting, heating, appliances, ect.

b. Federal or state?

What type of business?

c. Any limitations?

What is the financial incentive?

d. Tax cut, rebate, loan?

e. What specifically qualifies?

f. Requirements to qualify?

Which profile will it be useful for?

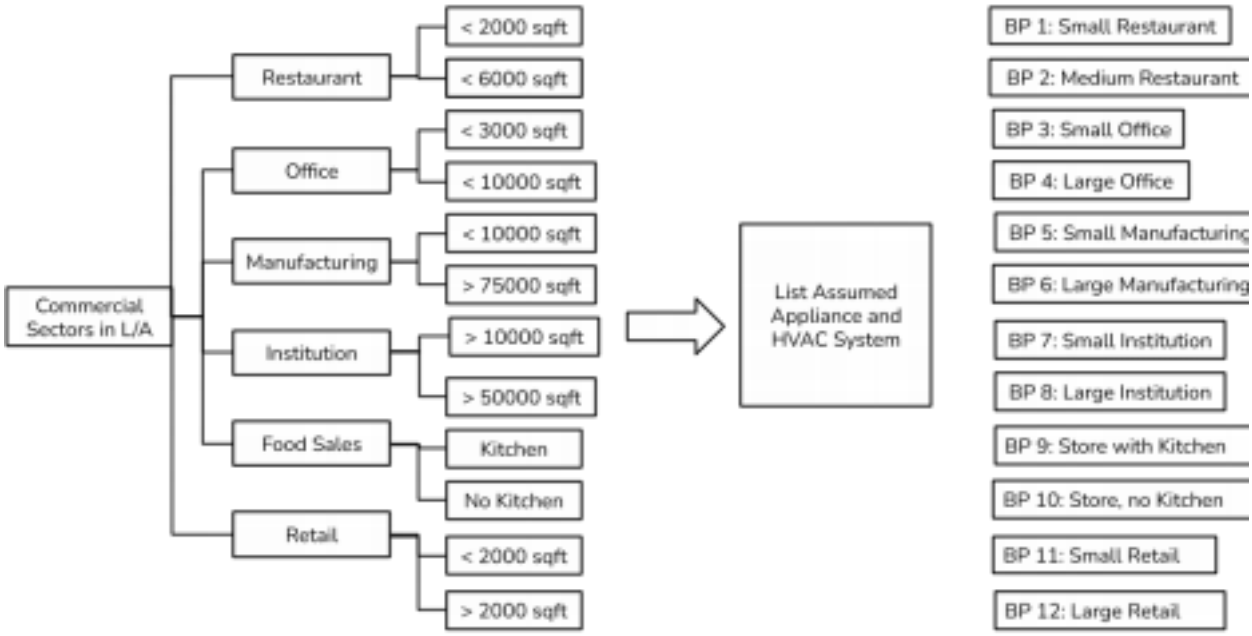
What is the payback period?

GHG Reduction?

g. Find a unit to express how much GHG that program will help save

Short summary

Appendix 2: Business Profile



Appendix 3: Restaurant Assumptions

a) Size: Looking at the list of restaurants in Lewiston Auburn area on the Chamber of Commerce website, use the area calculation feature on google maps to determine the size range for business profiles. With Shanna Cox's suggestion for focusing my two business profiles based on Pure Thai Kitchen and Governor's , I found out that Pure Thai Kitchen is 1757 square feet and Governor's Restaurant and Bakery to be 6403 square feet. Looking at the average of other businesses and using Johnson and Dietrich (2015)'s data of Maine's average restaurant size to be 3189 square feet, the two business profiles were categorized by less than 2000 square feet for small restaurants and medium sized

restaurants to be less than 6000 square feet. Restaurant owners with a larger floor plan than 6000 square feet can still reference the medium sized restaurant profile to learn about energy efficiency as their available rebate programs would be similar.

b) Appliance: Assumed commercial kitchen appliance list was made with online research on websites like webstaurantstore.com, a site where many restaurant owners buy their kitchen appliances (Table 3).

Appliance	Small Sized Restaurant (< 2000 sqft)	Medium sized Restaurant (< 6000 sqft)
Double Door refrigerator	2	3
Walk in Refrigerator	0	1
Double door Freezer	1	2
Refrigerated Display case	1	2
Single door Merchandiser Refrigerator	1	2
6 Electric burner + Oven	1	2
Floor Fryer (2 baskets)	1	2
Commercial Microwave	1	1
Single rack Dishwasher	1	2

Table 3: List and Count of Assumed Appliance for Restaurant

c) Appliance Energy Consumption Calculation: Using webstaurantstore.com, assuming the

brand for each appliance was necessary to figure out the energy use for each appliance. Webstaurantstore.com has varieties of options, we picked the most popular brand for each. Looking at the specs for the specific item, energy consumption was calculated. i) Amps * Voltage = Watts

20

The next assumption was the operating hour of the appliance. In order to calculate kWh, operating time was needed. Making educated guesses on what the time is, for example, refrigeration would be 24 hours, while ovens would be around eight hours which includes prepping and business hours. Assumed one month is 30 days

ii) Amps * Voltage * Time * 30 / 1000 = kWh per month

d) HVAC System and Lighting: Determined using EIA's Commercial Building Energy COnsumption Survey (CBECS) Table E5 Electricity consumption (kWh) by end use, 2012.

Appendix 4: Office Assumptions

a) Size: Looking at different office buildings and available office space listings on Real Estate website called loopnet.com, I determined that offices' business profiles should be categorized as less than 3000 square feet and less than 10,000 square feet. Using the Office Space Calculator feature on loopnet.com, a small office was assumed that it would be used by 10 to 20 people and large offices to be 30 to 40 people.

b) Appliance: Assumed office appliance was office related technology and breakroom appliances (Table 4).

Appliance	Office Multi Use P		
	Microwave (1hr.da	Small Office (< 3000 sqft)	20
Computers (on, s sleep)	Coffee Machine	Large Office (< 10000 sqft)	30
	Fridge (all day)		2
			4
			1
			2
			2
			3
			1
			2

Table 4: List and Count of Assumed Appliance for Office

c) Appliance Energy Consumption Calculation: Using officedepot.com, assuming the brand

for each appliance was necessary to figure out the energy use for each appliance. Officedepot.com has varieties of options, we picked the most popular brand for each. Looking at the specs for the specific item, energy consumption was calculated. (similar as restaurant appliance calculation)

i) Amps * Voltage = Watts

The next assumption was the operating hour of the appliance. In order to calculate kWh, operating time was needed.

ii) Amps * Voltage * Time * 30 / 1000 = kWh per month

d) HVAC System and Lighting: Determined using EIA's Commercial Building Energy COnsumption Survey (CBECS) Table E5 Electricity consumption (kWh) by end use, 2012.

Appendix 5: Manufacturing Assumptions

a. Size: Looked up all manufacturing businesses listed on the manufacturing section of the member directory on the Lewiston Auburn Metro Chamber of Commerce website on Buzzfile, a company information database. The median square footage was found to be 18,250 ft^2, while the average was found to be 95,880 ft^2.

b. Overall Energy usage: The following sources were examined to have a grasp on overall energy usage: Friendly Power (Friendly Power) and EIA survey data (Energy, 2016). This survey data gave an overview of what we have labeled "energy sectors", and was a reliable source of determining this information. c. Assumptions and calculations for Estimating Energy Usage

- Assumptions:
    1. Lighting
    2. 1800 ft^2 Manufacturing Plant Floor Size
    3. 100 foot candles of lighting on plant floor (Energy Trust of Oregon , 2016)
        a. Lighting requirement for detailed/fine detail manufacturing
    4. 1.4 lighting factor (Energy Trust of Oregon, 2016)
    5. Fluorescent Bulb 54 watts, 5,000 lumens output average, $16 per bulb
    6. LED bulb 42 watts, 5,000 lumens output, $25 per bulb
    7. 16 hours operation
        a. Two, eight hour shifts
    8. One month is 30 days
    9. Electricity Price: 13.15 cents per kWh (Central Maine Power , 2016)
    10. 1 ton AC per 500 ft^2

11. 1 ton AC consumes 12 kw electricity

- Lighting Calculations
    1. (Required lighting by ft^2) * (Operating Floor by ft^2) * (Lighting Factor) = Lumens Needed for Lighting
        a. 2,520,000 lumens
    2. (Lumens needed for lighting (Lumens)) / (Bulb lumen output (Lumens)) = # of bulbs needed
        a. 504 bulbs

    3. (# of bulbs needed) * (Bulb Energy (watts)) * (hours of operation) * (1watt/1,000 kw) * (30 days) = kwh of lighting
        a. Fluorescent bulbs: 13063 kwh/month
            i. Cost: $0.1315 * 13063 = $1,717
        b. LED bulbs: 10160.64 kwh/month
            i. Cost: $0.1315 * 10160.64 = $1,336
    4. [(Cost LED bulbs) - (Cost fluorescent bulbs)]/ (Cost savings per month) = payback time (months)
        a. 12 months
    5. Enter kWh savings per month into EPA Greenhouse Gas Equivalencies calculator (EPA, 2018)
        a. (Fluorescent lighting kWh/Month - LED lighting kWh/Month) = kWh Savings per month ($)
        b. 2.1 Metric Tons
- HVAC Calculations
    1. ([(Facility ft^2) / (AC Tons/ft^2)] * (12 kWh/AC Ton)) * (Operating Hours/ Month) = HVAC Load
        a. $3,408 / month
        b. 25920 kWh
    2. Upgrading system with Energy Star Appliance reduces load by 35% (Energy Star , 2020)
    3. ($ Operation by month) or (kWh per month) * 0.35 (35% reduction) = reduction after upgrades
        a. $1193 savings
        b. 9,072 kwH reduction
        c. 6 Metric Tons GHG
    4. HVAC calculations done by percentage of energy reduction due to the impacts of changing different components. The 35% reduction is an ideal system where every component is upgraded.

Appendix 6: Institution Assumptions

d. Size: Looked up all businesses that fit the institution type on the member directory on the Lewiston Auburn Metro Chamber of Commerce website on Buzzfile, a company information database. The median square footage was found to be 12,000 ft2, while the average was found to be 15,000 ft2.

e. The following sources were examined to have a grasp on overall energy usage: Friendly Power (Friendly Power) and EIA survey data (Energy, 2016). This survey data gave an overview of what we have labeled “energy sectors”, and was a reliable source of determining this information.

f. GHG Emissions

- Assumptions and calculations for Estimating Energy Usage
    1. Assumptions:
        a. Lighting
        b. Median facility size and 100,000 ft^2 used for the profiles. 100,000 ft^2 used b/c facilities of that size are present within the area. They are outliers.
        c. 57.5 foot candles of lighting on plant floor (Energy Trust of Oregon , 2016)
            i. Lighting requirement for school settings
        d. 1.4 lighting factor (Energy Trust of Oregon, 2016)
        e. Fluorescent Bulb 32 watts, 75 lumens output average, $8.50 per bulb
        f. LED bulb 42 watts, 5,000 lumens output, $13.19 per bulb
        g. 12 hours operation
            i. From facility opening to closing
        h. One month is 30 days
        i. Electricity Price: 13.15 cents per kWh (Central Maine Power , 2016)
    2. Lighting Calculations
        a. (Required lighting by ft^2) * (Operating Floor by ft^2) * (Lighting Factor) = Lumens Needed for Lighting
            i. 627,900 lumens
        b. (Lumens needed for lighting (Lumens)) / (Bulb lumen output (Lumens)) = # of bulbs needed
            i. 252 fluorescent
            ii. 286 LED
        c. (# of bulbs needed) * (Bulb Energy (watts)) * (hours of operation) * (1watt/1,000 kw) * (30 days) = kwh of lighting
            i. Fluorescent bulbs: 13063 kwh/month
                1. Cost: $0.1315 * 2,980 kWh = $392

ii. LED bulbs: 10160.64 kwh/month

1. Cost: $0.1315 * 1,583 kWh = $208

d. [(Cost LED bulbs) - (Cost fluorescent bulbs)]/ (Cost savings per month) = payback time (months)

i. 18 months (rounded up from 17.4 months)

e. Enter kWh savings per month into EPA Greenhouse Gas Equivalencies calculator (EPA, 2018)

i. (Fluorescent lighting kWh/Month - LED lighting kWh/Month) = kWh Savings per month ($)

ii. 0.99 Tons

3. Calculations redone w/larger facility size of 15,000 ft^2

a. Monthly Savings: $1,320

b. Monthly kWh reduction: 10038 kWh

c. GHG reduction: 12 metric tons GHG

■ Water Heater

1. Water heating demand calculated using the Pro Size Hot Water Heater sizing calculator (A O Smith)

a. 900 US Gallons demand for hot water found

b. 1100 USGPH Heater fit recommended sizing

i. Electric consumption taken from units of that size from A.O. Smith

ii. Energy Star upgrades are 15% more efficient (Energy Star)

c. Operating water heater 2 hrs per day due to variable demand (Energy Star)

d. (Hot water heater demand kW) * (Hours Operating) * (Days in Moth) = electric consumption per month

i. Followed steps in Appendix 1 for calculating energy consumption and GHG Emission

ii. 4 yr payback period, 0.86 metric tons

1. Cost was determined off of heater unit pricing on Efficiency Maine's product finder for a heating unit of the same capacity

e. Large Institution Sizing

i. Scaled all number up throughout the above process, and determined all findings in that method

Appendix 7: Convenience or small food store with kitchen assumptions

a. This profile is assumed to be under the food service category of the EIA survey. Because the average floor size for the category, around 4700 sqft, consumption values were divided by 2 to estimate consumption for a smaller floor size. And because there were about 177,000 food service businesses surveyed, consumption values were divided by that number as well.
b. The following appliances were assumed:

Refrigerators	6
Microwave	1
6 Burner Stove and Oven	1
Fryer	1
Coffe, and Slushee machines, and Hot Food Case:	3

c. Heating was determined using the EIA CBECS survey table C23, using the natural gas data.
d. HVAC was determined using table E3, using the cooling and ventilation data.
e. Lighting was determined using table E3, using the lighting data.

Appendix 8: Convenience or liquor store without a kitchen assumptions

a. This profile is assumed to be under the food service category of the EIA survey. Because the average floor size for the category was around 4700 sqft, consumption values were divided by 2 to estimate consumption for a smaller floor size. And because there were about 177,000 food service businesses surveyed, consumption values were divided by that number as well.
b. The following appliances were assumed:

Microwave	1
Refrigerators	8
Coffe, and Slushee machines, and Hot Food Case:	3

c. Heating was determined using the EIA CBECS survey table C23, using the natural gas data.
d. HVAC was determined using table E3, using the cooling and ventilation data.
e. Lighting was determined using table E3, using the lighting data.

Appendix 9: Retail assumptions

a. This profile is assumed to be under the Retail (other than mall) category in the EIA CBECS survey. Because the average floor size for the category was around 11,000 sqft, consumption values were divided by 5 to estimate consumption for a smaller floor size. And because there were about 438,000 retail businesses surveyed, consumption values

were divided by that number as well.

b. The following appliances were assumed: A microwave and a small refrigerator. c. Heating was determined using the EIA CBECS survey table C23, using the natural gas data.

d. HVAC was determined using table E3, using the cooling and ventilation data.

e. Lighting was determined using table E3, using the lighting data.

Appendix 10: Deliverables included in deliverable pdf document.