Mohawk Trail Woodlands Partnership

Final Phase I Energy Report: Municipal Building Heating Load Analysis and Recommendations

For

Hawley, Massachusetts

September 6, 2017

Prepared by

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Summary of Findings and Next Steps

As part of the Mohawk Trails Woodlands Partnership (MTWP), the town of Hawley invited UMass Clean Energy Extension (CEE) to analyze thermal energy use in its municipal buildings with the goal of identifying opportunities to reduce municipal energy consumption, greenhouse gas emissions, and operating costs. Using municipal building information and historical heating data, our findings related to building heating operations include the following:

1. **Highway Garage**: The Highway Garage accounts for more than 67% of the Hawley total heating demand. Our analysis indicates that this facility could benefit greatly from potential efficiency measures to reduce heat loss from the building envelope. Therefore, improvements at the garage should be prioritized.
2. **Fire Station**: The Fire Station uses roughly a quarter of Hawley's heat load and similar to the highway garage, could benefit from reducing heat loss from the building envelope. Given the lower energy consumption relative to the highway garage, retrofit investments at the Fire Station should be evaluated after the garage.
3. **Town Office**: The Town Office contributes to slightly more than 10% of Hawley's total heating load. The Town Office has the lowest energy usage per square foot (energy use intensity). Based on these characteristics, efficiency investments may have a smaller impact on reducing Hawley's total heating load, though may still be financially feasible and evaluated after the garage and fire station.

While addressing energy savings opportunities, Hawley may want to consider installing clean heating technologies to reduce or eliminate dependency on fossil heating fuels in these buildings. The next steps towards identifying and implementing energy projects begins with a review call with the CEE staff. This discussion may include review of our analysis, target strategies for energy usage reduction, clean energy opportunities, and support from the Green Communities program. Typically, a municipality will schedule ASHRAE level-II energy audits of their town buildings to develop more comprehensive analyses and scopes of work, which can be used to contract for project implementation. Given that Hawley has identified potential projects (insulation and air sealing, lighting retrofits, and a solar photovoltaic system), these will be discussed as well.

Lastly, UMass CEE requests that **Phase II Heating System Information be provided at this time** if you have not already done so. This information includes detailed municipal heating system such as heating system age, capacity, and efficiency, among other data. This information will enable CEE to better serve the MTWP initiative and provide the ability to conduct more detailed analyses of energy opportunities. Tools and instructions for gathering this information are at https://ag.umass.edu/clean-energy. Please contact CEE for assistance in collecting this information (413-545-8510, energyextension@umass.edu).

1. Introduction

1.1 Purpose of this Report

UMass Clean Energy Extension (CEE) has been engaged by the state Department of Energy Resources (DOER) to support the Mohawk Trail Woodlands Partnership (MTWP), a planning and public outreach process exploring interest in a new partnership with State and Federal agencies for 21 municipalities in northwestern Massachusetts. Working in Collaboration with Franklin Regional Council of Governments (FRCOG) and Berkshire Regional Planning Council (BRPC), CEE is providing technical and analytical support to municipalities related to their heating fuel and overall energy consumption. The purposes of this report are to:

- Identify the heating load requirements and energy usage intensities in Hawley's municipal buildings (described in **Section 2**);
- Introduce Hawley to a range of technologies and strategies to manage energy consumption, including clean heating technologies, energy efficiency best practices, and strategies to reduce vehicle fuels (described in **Section 3**);
- Determine priority targets to reduce heating loads in municipal buildings (described in **Section 4**); and
- Provide additional detailed building analyses to support further engineering studies and/or the solicitation of contractor quotes (described in **Appendix A**).

1.2 Green Communities Designation

Hawley is a designated Green Community within the DOER's *Green Communities* program and, as such, has populated and manages a MassEnergyInsight (MEI) account. The MEI platform enables Massachusetts cities and towns to develop an energy use baseline, track and analyze energy use and costs, prioritize energy projects, and communicate about its municipal energy use and greenhouse gas emissions. Additionally, we have included a comprehensive, all-fuels energy (i.e., heating fuels, transportation, electricity) usage analysis in **Appendix A**. Beyond this analysis, MEI can serve Hawley in identifying, evaluating, prioritizing and implementing clean energy projects.

Per the Town website (www.townofhawley.com/options-green-community-funding/), Hawley is considering ways it can use the Green Communities funding (up to $136,920) to help the Town conserve energy. According to Lloyd Crawford, who has taken the lead on the funding application process, while several options are possible, three projects seem most practical and doable in the near future. They are:

- Adding insulation and improving seals on both the Town Office and the Highway Department garage;
- Upgrading the lighting to a higher efficiency level in Town facilities; and,
- Installing a solar power facility.

1.3 Data Sources and Accuracy

Data used in the CEE analysis was provided directly to CEE by Hawley officials or sourced from Hawley's MEI account. In coordination with town officials, CEE has ensured that the data used is accurate and current to the best of its abilities.

2. Heating Fuel Baseline Analysis

Quantifying the heating fuel baseline across the various building allows CEE to more effectively compare and interpret energy trends and prioritize investments in energy efficiency, as discussed later on in this report. This section inventories energy related accounts (Section 2.1) and documents key heating consumption characteristics and performance metrics associated with Hawley's municipal building stock (Section 2.2). Furthermore, this section will review energy usage intensity (Section 2.3) and building heating efficiency (Section 2.4) in relation to the key findings and data interpretations.

Although this section solely examines heating fuels (e.g. No. 2 fuel oil, propane, and natural gas), as designated in the MTWP scope of work, a comprehensive energy usage analysis for all-fuels, including but not limited to electricity, gasoline, and/or diesel is also provided in **Appendix A**.

2.1 Energy Account Inventory

The data included in this report has been organized in alignment with the Massachusetts Fiscal year (July 1st to June 30th). As of FY 2016, Hawley's energy consumption of all-fuels is billed to **9** accounts: **4** electric, **3** propane, and **2** transportation fuel related.

2.2 Heating Fuel Consumption

CEE has created a baseline inventory of all municipal buildings and their individual contribution towards Hawley's total heat load by fuel type. A heat load can be generally defined as the total energy consumption needed to maintain given interior temperatures. Understanding relative energy consumption can assist in prioritizing various building and energy opportunities.

It is important to note that while the focus of this inventory is geared towards fuel consumption related to space heating, there is often fuel consumed for domestic hot water heating or process uses. The Massachusetts heating season can be generally defined as October 15th through May 15th, though may vary based upon local operations and conditions.[1] To give a typical representation of associated energy consumption year-to-year, fuel consumption (MMBTU) has been averaged between FY 2014 – FY 2016.

Hawley currently owns three buildings: the Town Office building, the Fire Station, and the Highway Garage. As of 2017, All of Hawley's buildings are heated by propane-fired systems. As shown in **Table 1**, the Highway Garage heat energy use is substantially higher than the other building, comprising 67% of the town's total heating consumption. Additional information on other non-heating accounts is shown in **Appendix A**.

[1] Minimum allowable temperatures in buildings may vary by use and type (e.g. school or office) within the Commonwealth.

Table 1: Heating characteristics in Hawley's municipal buildings

Building	Building Area (ft²)	Fuel Type	Fuel Consumption, gallon/year*	Average Energy Usage, MMBTU/year*	Percentage of Total Municipal Heat load*
Fire Station	1,620	Propane	1,190	108	22 %
Highway Garage	6,400	Propane	3,621	330	67 %
Town Office	1,056	Propane	618	56	11 %

*Average over FY2014 – FY2016 heating years

2.3 Building Energy Use Intensity

Energy Use Intensity (EUI) shows the energy consumption on a building area basis (typically kBtu/ft²). By quantifying the EUI, the relative energy usage of a set of buildings can be more easily compared and ranked by energy performance, regardless of building size. As shown in **Figure 1**, the heating fuel energy use intensity is relatively comparable across the three buildings, with the Highway Garage and the Fire Station approximately 49 kBtu/ft², and Town Office approximately 42 kBtu/ft² or 14% lower. The EUI in **Figure 1** was calculated for each building based on annual heating fuel consumption and building size.

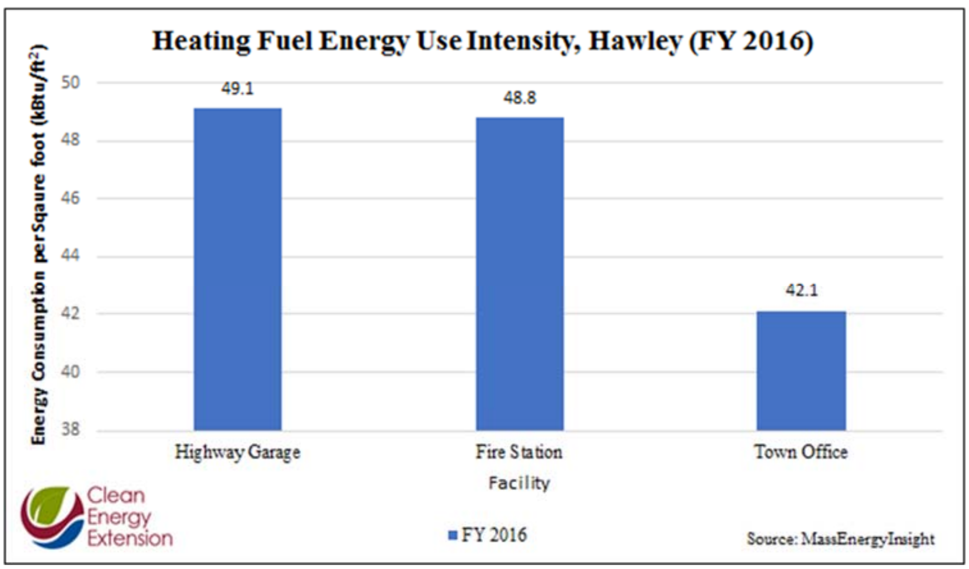

Figure 1: Heating Fuel Energy Use Intensity (EUI) in Hawley's municipal buildings

2.4 Thermal Performance of Key Buildings

The relationship between energy consumption and efficiency is not always clear. For example, a building may not consume a significant amount of energy, yet it can be highly inefficient. Alternatively, a particular building may use a large amount of energy efficiently. Although EUI provides an evaluation to compliment overall fuel consumption, additional thermal performance analyses are required to better understand energy metrics.

Key buildings were selected for further analysis based on their heating fuel consumption and EUI. Buildings that both consume a significant energy and have a high EUI suggest that improvements would have the greatest impact in reducing municipal energy consumption. Buildings not chosen for further analysis were believed to either:

require too much investment for comparable results, and/or alterations would have a marginal impact on total heating load. Given the small number of buildings in Hawley, this analysis was completed for all three buildings.

As represented in **Table 2**, CEE has conducted an analysis that compares the pattern of fuel consumption with weather data (outdoor temperature) to identify the 'balance point' for that particular building. The balance point is the outdoor temperature at which internal systems turn on to heat the building. A building with a balance point that is higher than 60°F is a good candidate for lifestyle (e.g. keeping overhead garage doors closed) or structural changes (e.g. adding Insulation) that would decrease the building's heat loss through the envelope.[2] Our analysis indicates that all three Hawley buildings vary from the standard of 60°F by roughly 5°F, indicating that they are good candidates for envelope improvement measures. Additional information on the statistical tests used to determine the balance points, and comparison of year-to-year heating fuel consumption is included in **Appendix D**.

Table 2: Municipal building balance points

Facility	Balance Point (°F)
Highway Garage	64.8
Fire Station	64.8
Town Office	64.7

2.5 Energy Analysis Interpretations

Based upon energy consumption and building characteristics identified in the previous sections, it is possible to establish a framework for prioritizing projects. **Table 3** below describes heating load characteristics and reduction opportunities in Hawley's municipal buildings based on fuel consumption in 2016. This assessment is not exhaustive of potential building efficiency projects, but are generated to serve as a tool to assist in informing an ASHRAE Level-II energy study or supporting engagement with implementation contractors.

Table 3: Hawley heating load characteristics and reduction opportunities (FY 2016)

Building	Consumption (MMBtu)	EUI (kBTU/ft^2)	Balance Point (°F)	Key Interpretations
Highway Garage	314.5	49.1	64.78	The Highway Garage accounts for approximately 67% of Hawley's total heating demand. Typically 60°F is a standard balance point for commercial buildings, yet for this particular building it would be 50°F or lower, accounting for fluctuations in occupancy. During working hours the thermostat should bet set around 60°F, otherwise it should be allowed to float back close to 40°F. Aggressive thermostat management has the potential to significantly reduce energy use. Based on its deviation from the balance point and high EUI, this facility could benefit greatly from potential efficiency measures to reduce heat loss from the envelope.

[2] A building's envelope is the interface between conditioned and unconditioned spaces, typically the exterior walls.

				There is also an increase in heating consumption per HDD from FY15 to 16. This could be due to an added heating load, or may indicate a heating load that is less responsive to weather. If the garage has a heated, uninsulated slab the system is effectively heating the ground even when outdoor temps are moderate. If this is the case, an outdoor reset control or simply shutting off the loop could provide significant savings.
Fire Station	79.1	48.8	64.77	Like the Highway Garage, the Fire Station deviates from the standard balance point and has a high EUI. However, the Fire Station uses roughly a quarter of Hawley's heat load; therefore, given the relative lower energy consumption, retrofit investments should be considered after the Highway Garage has been assessed.
Town Office	44.5	42.1	64.74	The Town Office contributes to slightly more than 10% of Hawley's total heating load. The Town Office has the lowest EUI and the balance point is comparable to the Highway Garage and Fire Station. Based on the low EUI and overall consumption, further efficiency investments should be evaluated after the other two buildings.

3. Introduction to Clean Energy Technologies and Best Practices

Understanding baseline energy conditions, as analyzed and discussed in Section 2, provides a strong foundation to develop and implement energy infrastructure improvements. The information presented in this section covers clean heating technologies, energy efficiency best practices, and strategies to reduce vehicle fuel usage. This information is provided solely to familiarize Hawley with potential options, which will be discussed in more detail with CEE when this report is reviewed with Hawley.

3.1 Clean Heating and Cooling Technologies

As a means to substantially reduce or eliminate the use of traditional fossil fuels, the heating and cooling of Hawley's municipal buildings can be provided by or supplemented with established renewable thermal technologies such as air-source or ground-source heat pumps, solar thermal heating, and modern wood heating. The Massachusetts Clean Energy Center's (MassCEC) Clean Heating and Cooling programs offer rebates to support the installation of renewable heating, hot water, and cooling technologies at facilities across the Commonwealth. These technologies are generally more cost-effective to operate than traditional fossil-fuel systems and may reduce greenhouse gas emissions, all while maintaining a high level of comfort, automatic operations, and reliability. MassCEC has announced a $30 million commitment to these technologies through 2020. More information on the programs, technologies, and participating vendors can be found on the Massachusetts Clean Energy Center (MassCEC) website (http://www.masscec.com/government-non-profit/clean-heating-and-cooling), as well as in **Appendix B** of this report.

In addition to MassCEC, the state Department of Energy Resources is finalizing its Alternative Portfolio Standard regulation that will provide important incentive for the operation of clean heating technologies; and grants received by Green Communities may be applied to clean heating applications upon review with DOER.

Additionally, municipal buildings are often clustered together, which can provide the opportunity for district heating where one heating system can be used to heat multiple buildings. Where this is possible, this may reduce the capital and operational costs for new clean heating systems.

3.2 Energy Efficiency Best Practices

Energy efficiency can help lower energy bills, reduce emissions of greenhouse gas and other air pollutants, and increase energy security. These opportunities may include equipment upgrades and envelope improvements, as well behavioral changes, maintenance practices, and the use of automated controls. The capital required for these improvements can range from no-cost behavioral strategies to major investment retrofits, such as distribution or central heating system upgrades. Additional information on best practices is provided in **Appendix C** of this report.

3.3 Reducing Vehicle Fuel Usage

For some Massachusetts communities, vehicle fuel accounts for as much as 25% of total municipal energy consumption (in Hawley it is 31%). While replacement of the most inefficient vehicles will provide substantial savings, these are several other ways to reduce fuel use:

- Right-size vehicles for their tasks
- Optimize vehicle routes
- Regularly check and maintain air pressure in tires
- Educate employees on vehicle idling protocol
- Evaluate hybrid or electric vehicles for major energy consuming vehicles such as high-mileage passenger cars and heavy duty municipal or DPW vehicles
- Consider fuel efficiency in all new vehicle purchases, including those that are exempt from Green Communities criterion 4 requirements

4. Recommendations and Next Steps

CEE is grateful to Hawley town officials for their assistance in developing this Municipal Heat Load Analysis. Combined with existing town interests and efforts, the availability of potential municipal clean energy funding sources, and support from CEE and other agencies, Hawley is well positioned to pursue clean energy opportunities across its municipal facilities. Based on the above analyses and associated findings, recommendations and next steps for Hawley to consider pursing include:

1. **CEE Review Meeting**: This is typically a phone call or conference call with CEE and town officials to discuss the findings of this report, better understand Hawley's interests and priorities, and develop target strategies for energy usage reduction, clean energy opportunities, and to review current participation status within the Green Communities program.
2. **Phase II Heating System Information**: Provide detailed municipal heating system information to CEE, including heating system age, capacity, and efficiency. This information will enable CEE to conduct a wood heat screening analysis, if desired. Tools and instructions for gathering this information are at https://ag.umass.edu/clean-energy. Please contact CEE for assistance in collecting this information – we are happy to walk you through this process.
3. **Clean Heating Screening Analysis**. At the town's request, a screening analysis will be completed for 2-3 buildings selected in coordination with each town. The screening analysis will provide a pre-feasibility evaluation of the investment cost, available incentives, and lifecycle economic savings of technologies such as air or ground-source heat pumps or modern wood heating systems**.**
4. **Energy Assessments**: If not already completed, the town should consider scheduling energy audits of Hawley's town buildings. Where applicable, these audits should meet ASHRAE level-II requirements and specifically address the opportunities to reduce envelope heat loss in buildings as informed by this report. Level-II audits should provide a strong basis for soliciting contractor quotes at some point in the future.

Please contact CEE (413-545-8510, energyextension@umass.edu) to schedule the 30-minute review conference call, or with any other questions in the interim.

Appendix A – Additional Municipal Energy Assessment Charts

Based on Hawley's designation as a Green Community, and with permission by the town of Hawley, CEE has the ability to review Hawley's MassEnergyInsight (MEI) account. Access to this data enables CEE to provide further energy usage analyses of Hawley's total energy 'footprint'. In addition to the analysis provided in the body of the report, this analysis takes all fuels into consideration including electricity, gasoline, and diesel. As with the heat load-only analysis in the body of this report, total energy consumption, Energy Use Intensity (EUI), and a breakdown of energy consumption by fuel type are included in this Appendix.

The analysis included in this section is by no means exhaustive, but seeks to highlight observations from each figure representing a more complete picture of Hawley's energy trends.

- As shown in **Figure A.1**, diesel usage is the largest single point of energy consumption within the town at 608 MMBtu/yr;
- As indicated in **Figure A.2**, the Highway Garage has the overall highest energy consumption for heating fuels and all energy consumption (e.g. propane & electricity);
- Displayed in **Figure A.3**, the Town Office has the largest EUI despite having the smallest energy consumption, and has the highest proportion of electric use;
- As Shown **Figure A.4**, more than half of Hawley's energy consumption is propane (62%), followed by diesel (28%), electricity (7%), and gasoline. More than 30% of the Hawley's total energy use is consumed by the municipal fleet.

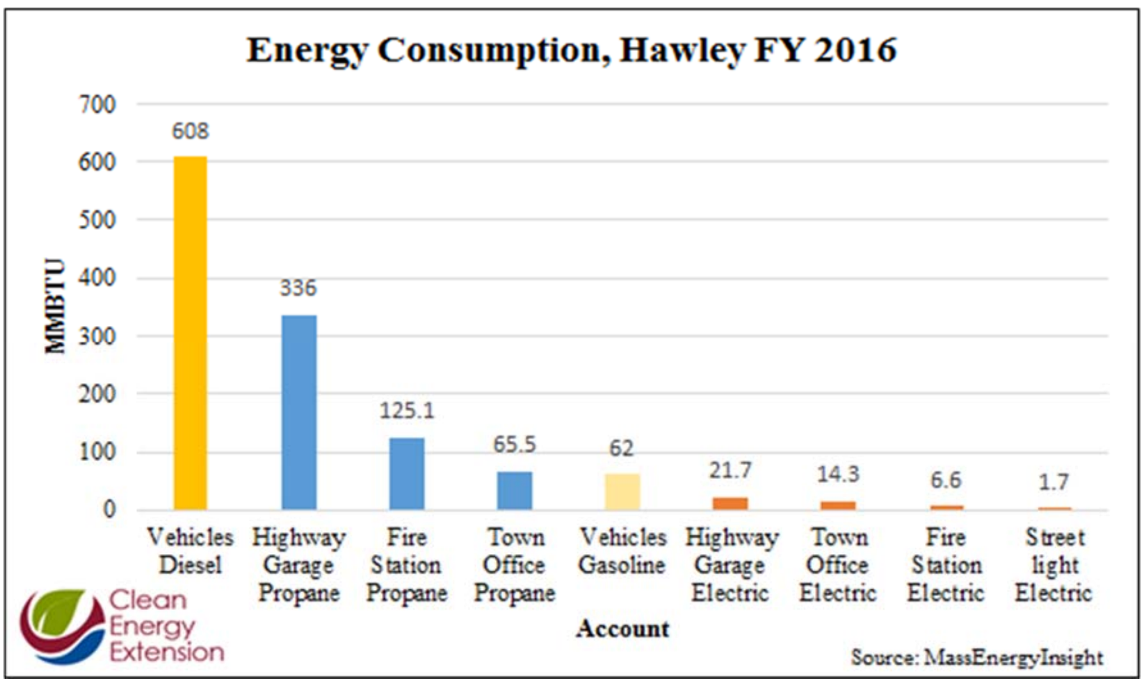

Figure A.1: Hawley's total energy consumption by building and/or fuel type - largest to smallest consumers.

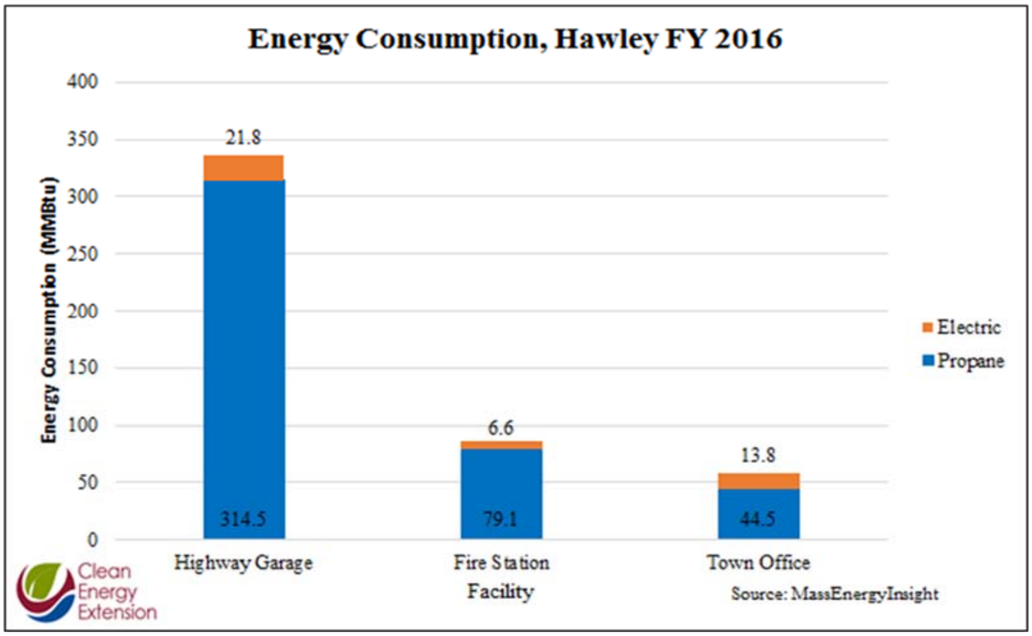

Figure A.2: Largest to smallest energy consumers (all fuels and electricity) by building and fuel type.

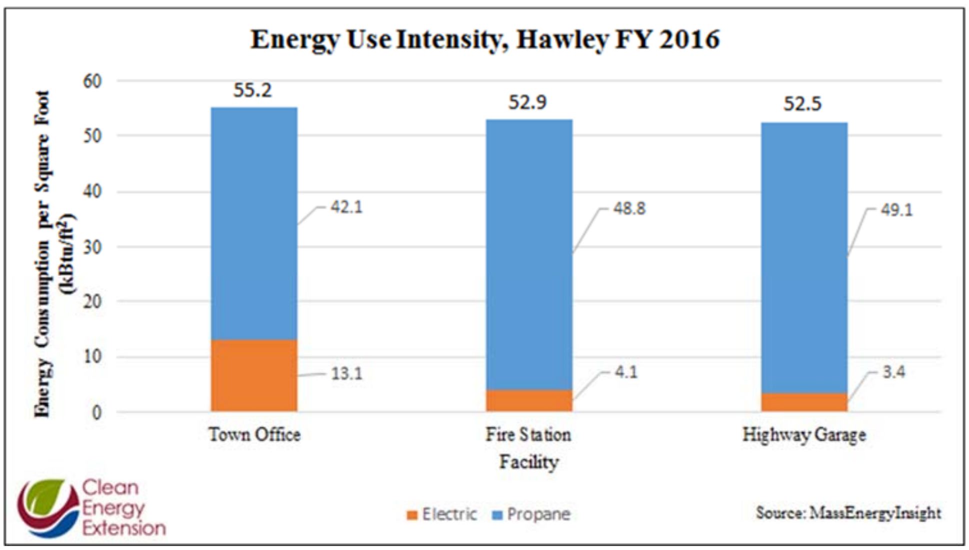

Figure A.3: Energy Use Intensity in kBtu/ft^2 was calculated for each building based on total energy consumption and building size.

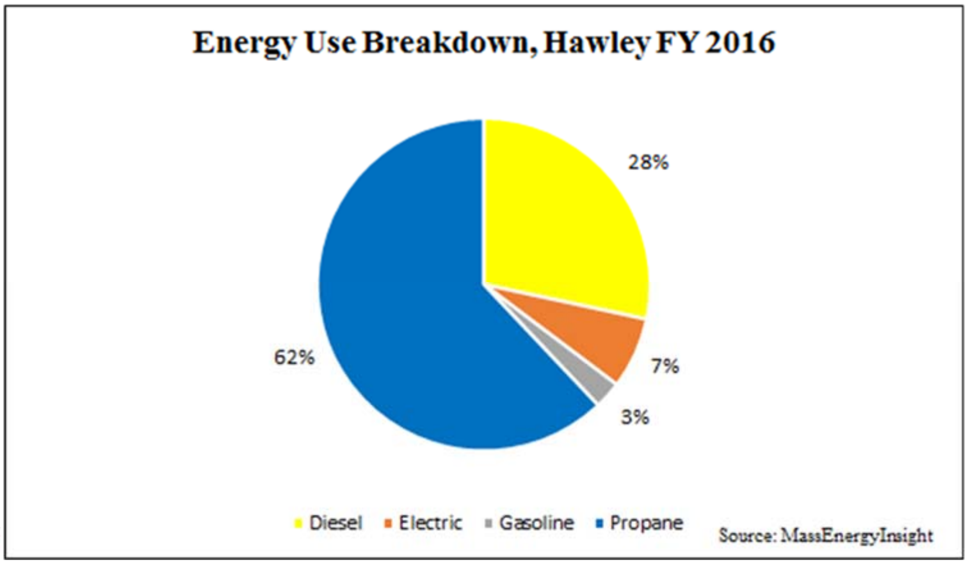

Figure A.4: Total consumption of each energy type and its percentage of the towns total energy consumption.

Appendix B – Clean Heating Technology Summaries

In addition to traditional fossil fuels, the heating and cooling of Hawley's municipal buildings can be fully provided by or supplemented with established renewable thermal technologies such as air-source or ground-source heat pumps, solar thermal, and modern wood heating. The following technology descriptions can be found on the Massachusetts Clean Energy Center (MassCEC) website, and they are provided here for convenience. Additional information related to these, and other, clean energy technologies can be found at www.masscec.com.

Air-Source Heat Pumps

Air-source heat pumps (ASHPs) can provide cost-effective and energy-efficient heating and cooling for your building's space. While traditional systems burn fuel to create heat, a heat pump instead works by moving heat into or out of a space. Though they require electricity to operate, efficient ASHPs use 40-70 percent less electricity than traditional electric-resistance heating. Rebates of up to $210,000 are available for commercial-scale systems, and up to $6,000 for residential installations.

Key Points

- Easy to install in existing buildings and compatible with any type of existing heating system
- Often installed to supplement existing heating systems
- Provide both heating and cooling in a single, efficient unit without the need to install ductwork
- Lowest up-front cost of any clean heating and cooling technology, and can be more cost effective to operate than traditional oil, propane, or electric heat

Modern Wood Heating

Modern wood heating systems use wood chips or wood pellets to produce heat, much in the same way traditional boilers or furnaces use oil, propane, or natural gas. Modern woodheating systems can often integrate into existing heating systems, and can fulfill all of a building's heating and hot water needs. Systems are typically fully-automated, and require limited maintenance. Wood chip and pellet delivery is available in most parts of the Commonwealth. Rebates of up to $250,000 are available for commercial-scale systems and $27,000 for small-scale systems.

Key Points

- Typically installed in buildings with baseboard hot water heating, but furnace options are also available for buildings with forced air heating
- Can be more cost-effective than heating with traditional oil, propane, or electric heat

Ground-Source Heat Pumps

Ground-source heat pumps (GSHPs) can provide cost-effective, energy-efficient space heating and cooling, hot water and process heat by utilizing the nearly constant temperature underground to transfer heat between the ground and your facility. GSHPs are typically the most efficient type of heat pump. Though they require electricity to operate, efficient GSHPs can provide the same amount of heating for substantially less than traditional electric heating. Grants of up to $250,000 are available for commercial-scale systems and $25,000 for small-scale systems.

Key Points

- Great option for new construction, but can also replace existing forced air or hydronic heating systems
- High installation costs are offset by long-term energy cost savings compared with electric heat, oil, propane, or even natural gas heating plus highly efficient cooling

Solar Hot Water

Solar hot water systems use the energy of the sun to heat water for use in your home's hot water system. Solar hot water systems reduce the usage of traditional water heating fuels (such as oil, electricity or natural gas) and thereby reduce the amount you spend purchasing these fuels. Rebates of up to $100,000 are available.

Key Points

- Great option for both existing buildings and new construction
- Can reduce water heating costs and greenhouse gas emissions at your facility
- Especially cost-effective for buildings currently heating water with oil, propane or electricity

Appendix C – Municipal Energy Efficiency Best Practices

The UMass Clean Energy Extension recommends that Green Communities and all municipalities consider the following energy efficiency best practices for municipalities.

Optimize Building Controls

Many buildings have building/energy management systems or programmable thermostats that are not operating to their full potential. These control systems need to be properly programmed and maintained in order to be effective in optimizing building operation and energy use. Energy efficiency opportunities may be identified by periodically reviewing and updating these systems, or reviewing temperature setpoints and schedules and comparing these to building occupancy. Necessary adjustments can be made and tested to make sure that the related equipment is operating as intended.

Control systems may record environmental conditions and operational parameters, and review of this data can be very helpful in maximizing the value of the system and identifying any performance problems with HVAC equipment.

For selected buildings, utility companies may be able to provide electrical billing data in 15-minute intervals, which can also be very useful in understanding electricity use patterns throughout the day/week and identifying opportunities to optimize building operation.

Some Green Communities have seen great benefits from these practices, some with the assistance of fault detection and diagnostic software or circuit-level monitoring by consulting companies. Utility pay-for-performance programs may provide incentives based on the achieved savings.

Install/Upgrade HVAC controls

Advanced controls can improve the efficiency of some HVAC systems without the substantial investments required to replace major equipment. These technologies include:

- Energy recovery ventilators or heat recovery ventilators use a heat exchanger to preheat or precool incoming fresh air by reclaiming energy from the outgoing exhaust air.
- Demand control ventilation (DCV) automatically adjusts the amount of outside air let into the building to optimize energy use while providing occupants with the right amount of fresh air.

Integrate Energy Efficiency into Purchasing Decisions

Efficiency ranges widely for many types of energy-consuming equipment. Incremental costs vary depending on the product type, but sometimes there is little to no added cost for high efficiency models of new equipment. Information about efficiency of many types of products – including appliances, commercial kitchen equipment, electronics, office equipment and more – is available from the ENERGY STAR program at http://energystar.gov/products and http://energystar.gov/purchasing.

Use Power Management Software on all Computers

The ENERGY STAR program offers free support on computer power management to reduce electricity consumption when computers are not in use, detailed at http://energystar.gov/powermanagement.

Implement an Energy Engagement Program

Some Green Communities have had success with programs that educate municipal employees, students and other building occupants about their energy reduction goals and encourage simple behavioral actions such as turning off lights, computers and other equipment when not in use.

Investigate Energy Efficiency Opportunities in Water and Wastewater Treatment Plants

Water and wastewater treatment plants are often among the highest energy consuming facilities in cities and towns. Our partner organization, the UMass Center for Energy Efficiency and Renewable Energy offers free, in-depth assessments of plants with annual energy costs of at least $100,000. The Center conducts a site visit with a thorough review of equipment and processes, then provides a detailed report with recommended energy efficiency opportunities, including estimates for energy and cost savings and implementation costs. More information is available at http://ceere.org/iac.

Appendix D – Extended Building Analyses

Comparing year-to-year total heating fuel consumptions will help distinguish any trends or anomalies **(Figure 1)**. These trends may be representative of abnormally cold or mild winters, or could be caused by alterations to the building. To parse out these effects, the data was adjusted to account for variation in weather, or weather normalized **(Figure 2)**. Weather normalization allows us to determine if trends in the total heating fuel consumption are due to building operation or infrastructure alterations or to weather related effects.

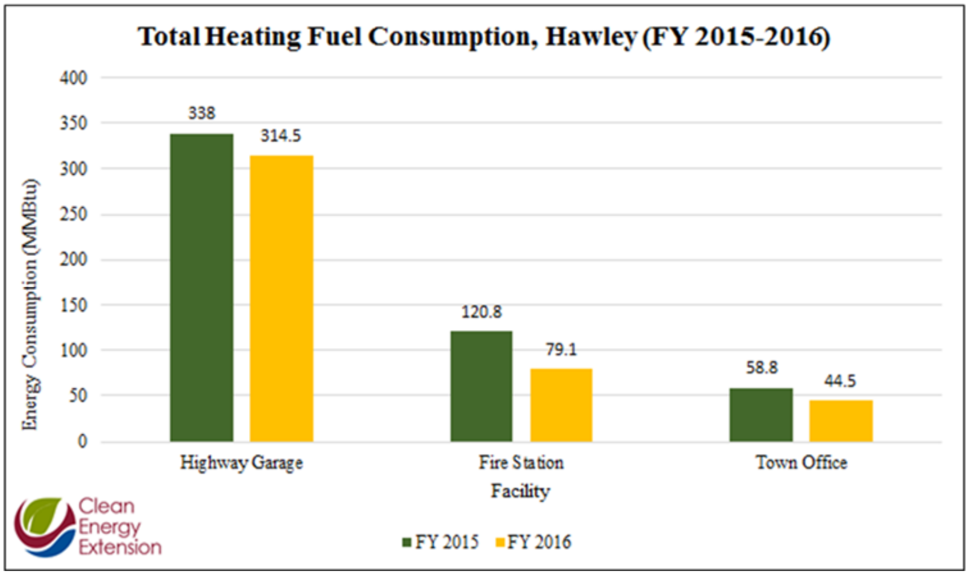

Figure 1: The total heating fuel consumption for each building in Hawley is compared on a yearly basis. This data can distinguish trends and anomalies in energy consumption.

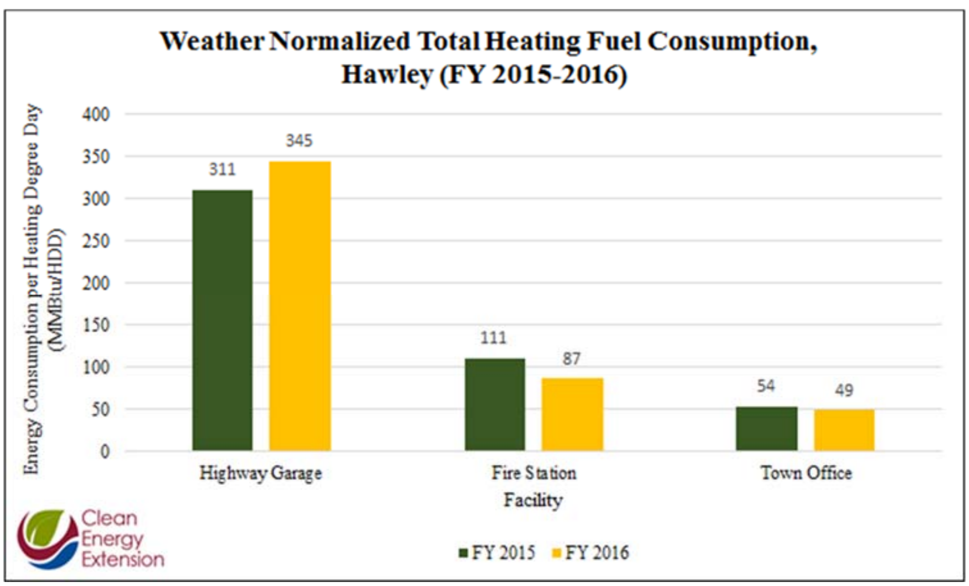

Figure 2: The heating fuel consumption is divided by the number of heating degree days (HDD) for that year. This gives the heating fuel consumption per HDD. A significant difference from year to year indicates that a building alteration may have occurred.

Regression Analysis

Regression analyses compare historical energy consumption to historical weather conditions to determine the relationship between energy consumption and weather. From this comparison, the balance point can be calculated. The balance point is the outdoor temperature at which internal systems turn on to heat the building. For internally dominated buildings (e.g. office buildings) a typical balance point is 50°F. For envelope dominated buildings (e.g. traditional house) the typical balance point is 60°F. A building with a balance point that is higher than 60°F is a good candidate for lifestyle or structural changes that would decrease the buildings heat loss through the envelope. This analysis is useful to quickly identify buildings that would benefit from retrofits that could reduce the buildings energy usage per Heating Degree Day (i.e. increased insulation, improved air barrier).

The regression analysis, utilizing fuel delivery data from MEI for the three buildings along with local temperature data, are shown on the following pages.

Highway Garage

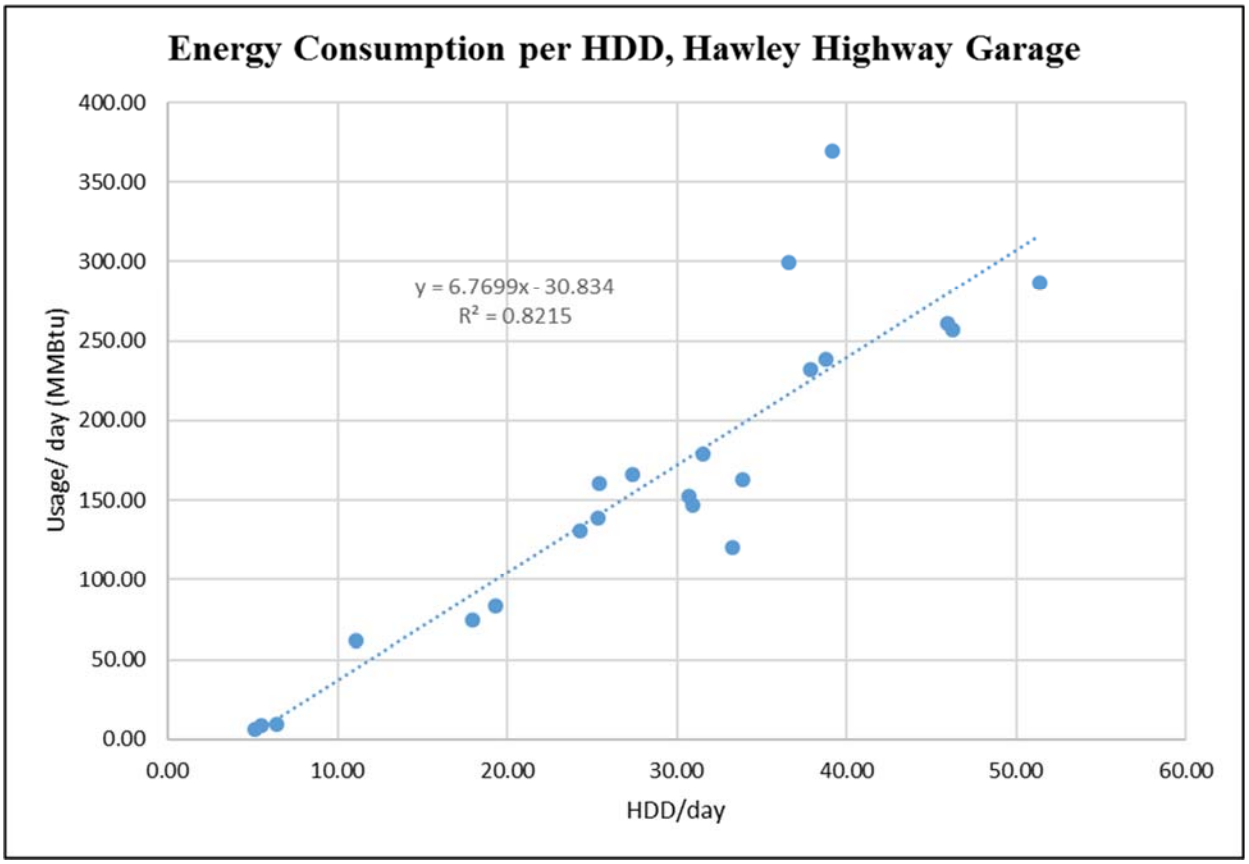

Figure 3: Regression plot of total energy consumption per heating degree day.

Table 1: The baseload, balance point, correlation and heating sizing of the building is calculated and displayed in the table below.

Baseload	
Intercept	**15th Percentile**
-3.38	6.98

Correlation	
R^2	**Pearson**
0.821	0.906

Slope (energy unit/°F)/intercept (energy unit)	0.74
Balance Point (°F)	64.78
Heating Sizing (MBtuh)	552.42

Town Office

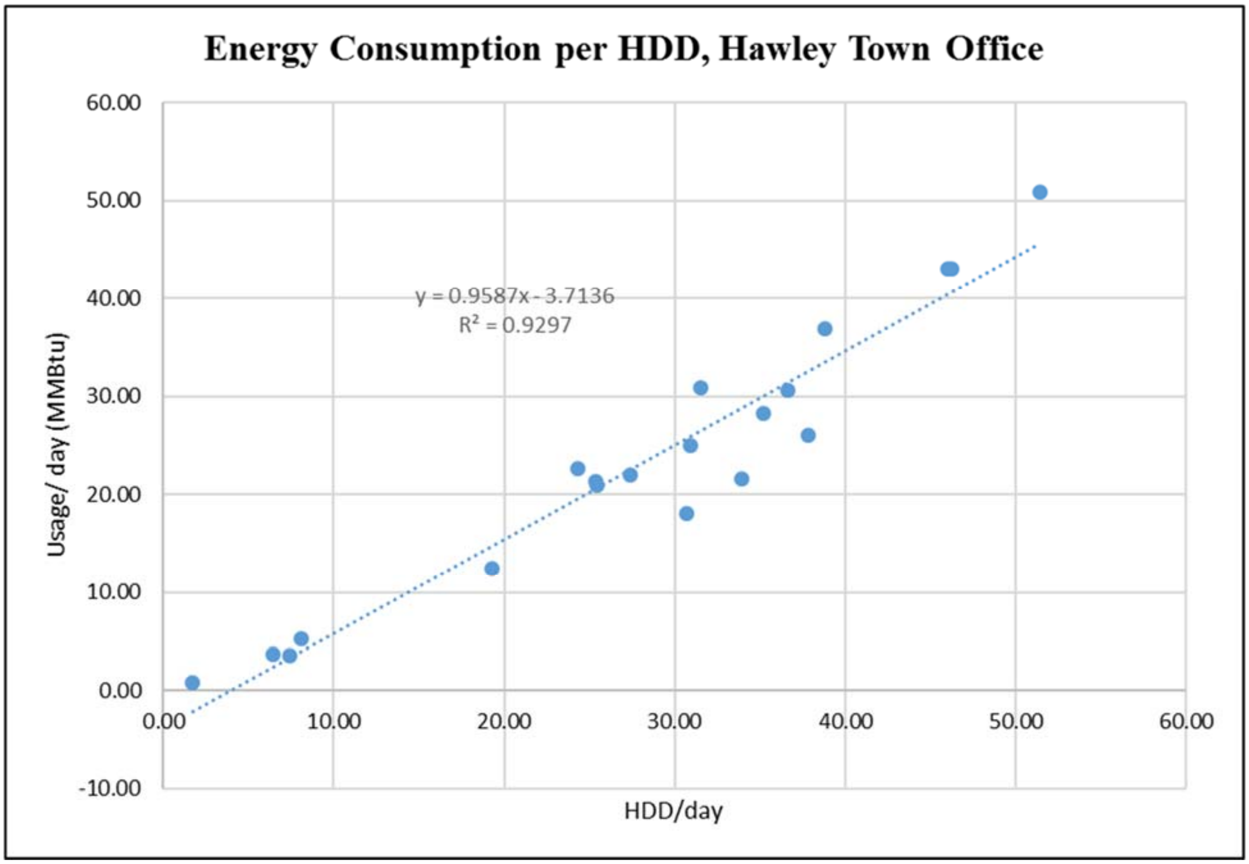

Figure 4: Regression plot of total energy consumption per heating degree day.

Table 2: The baseload, balance point, correlation and heating sizing of the building is calculated and displayed in the table below.

Baseload	
Intercept	**15th Percentile**
-0.41	0.54

Correlation	
R^2	**Pearson**
0.930	0.964

Slope (energy unit/°F)/intercept (energy unit)	0.10
Balance Point (°F)	64.74
Heating Sizing (MBtuh)	78.23

Fire Station

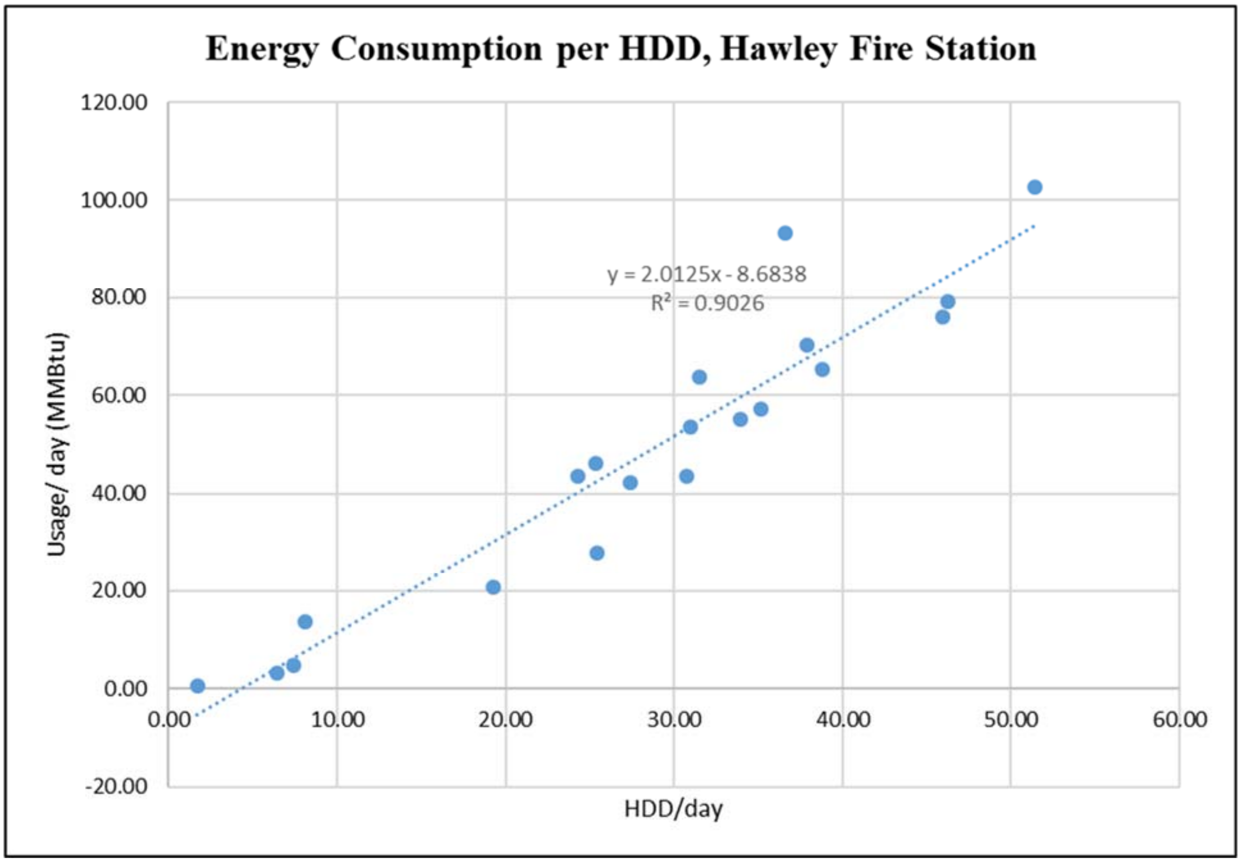

Figure 5: Regression plot of total energy consumption per heating degree day.

Table 3: The baseload, balance point, correlation and heating sizing of the building is calculated and displayed in the table below.

Baseload	
Intercept	**15th Percentile**
-0.95	1.34

Correlation	
R^2	**Pearson**
0.903	0.950

Slope (energy unit/°F)/intercept (energy unit)	0.22
Balance Point (°F)	64.77
Heating Sizing (MBtuh)	164.22