May 3rd, 2013

FLEXTECH STUDY

Town of Bedford – Public Works Garage

301 Adams Street
Bedford Hills, NY 10507

New York State Energy Research and Development Authority
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For questions regarding this report or other programs offered by NYSERDA, please contact Vanessa Ulmer at 866-697-3732 extension 3445 or by email at vmu@nyserda.org.

We hope the findings of this report will assist you in making decisions about energy efficiency improvements in your facility. Thank you for your participation in this program.

State of New York

Andrew Cuomo, Governor

New York State Energy Research and Development Authority

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EXECUTIVE SUMMARY

Project Overview

On December 19, 2012 Steven Winter Associates conducted a walk-through energy survey at the Town of Bedford Public Works Garage in Bedford Hills, New York. The survey was performed under the guidelines for an ASHRAE Level II Energy Audit as part of NYSERDA's FlexTech Program. The objective of the study was to determine if energy use at the building could be decreased, thereby increasing efficiency. This report will provide the Town of Bedford and the Public Works Garage with a technical and economic strategy by which to modify their energy systems and operating practices while improving occupant comfort and reducing energy consumption.

The Town of Bedford Public Works Garage is a single-story, 9,000 square foot office space and garage located at 301 Adams Street in Bedford Hills. Built in 1980, the building consists of two primary space types which are office space and the garage space. The two spaces are connected and access between the two spaces is permitted. The Public Works Garage also serves as a fuel depot for all of the town vehicles and a dispatch area for snow plows during inclement weather.

Utility billing for the Town of Bedford Public Works Garage was collected and entered into the U.S. Environmental Protection Agency's (EPA) Energy Star® Portfolio Manager Energy Benchmarking System. During the 12-month period from mid-November 2011 to mid-November 2012, the building consumed 51,516 kWh of electricity 657 therms of natural gas and 5,463 gallons of propane for a total annual consumption of 742 MMBtu of energy. The total energy cost for the period was $18,994, or $2.11 per square foot.

The Public Works Garage was categorized in Portfolio Manager as two different space types which are "Office" and "Garage (Other)". As a result of an "Other" space type being included the building has not received an Energy Star Rating®. However, for the period from November 2011 to October 2012 the Site and Source Energy Use Intensities (EUI) were calculated to be 83 kBtu/ft^2/yr and 130 kBtu/ft^2/yr, respectively. This compares to National Median Site and Source EUIs of 45 kBtu/ft^2/yr and 96 kBtu/ft^2/yr, respectively, indicating that the building performs more poorly than buildings with similar characteristics. However, as the National Median values represent a facility which is solely used as a garage they fail to capture the higher energy density which is associated with an office space.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The table below shows measures identified for potential energy reduction:

STRATEGY OF ENERGY SAVINGS								
Measure Description	Measure Status (See Notes)	Fuel Type Saved (See Notes)	Energy Saved in kWh	Energy Saved in kW	Energy Saved in MMBtu	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback in Years
ECM #1: Lower Garage Nighttime Setback	R	NGas	-	-	62	$805	$0	0.0
ECM #2: Insulate Heating Hot Water Piping	R	NGas	-	-	24	$311	$500	1.6
ECM #3: Weather-strip Exterior Doors	R	Elec, NGas	162	-	3	$59	$200	3.4
Total			162	0	90	$1,175	$700	0.6

Notes:

1. Measure Status: Implemented (I); Recommended (R); Further Study Recommended (RS); Not Recommended (NR)
2. Fuel Type Saved: Elec, NGas, Oil2, Oil4, Oil6, Coal, LPG. MMBtu = 1,000,000 Btu

BUILDING DESCRIPTION

Built in 1980, the Town of Bedford Public Works Garage is a single-story structure of approximately 9,000 square feet that operates 8AM to 5PM Monday to Friday with limited weekend use. The space is divided into two major areas which include the office space and garage space. The office space includes several offices for Public Works staff as well as conference/break area, locker room for garage personnel and several restrooms. The garage is broken up into two garage bays which are approximately the same size. In addition the garage space also permits access to a large parts storage area to store parts which are utilized in the maintenance of the public works vehicles. The Public Works Garage also serves as fuel depot for public works vehicles and as a dispatch for snow plows during in climate weather.

The Public Works Garage has approximately 6 occupants split between the two spaces. The building is primarily occupied from 8AM to 5PM Monday to Friday with limited weekend use. However, during inclement weather the space in utilized as needed as a fuel depot for all of the town vehicles and a dispatch area for snow plows.

NYSEG both supplies and delivers electricity to the Public Work Garage while Natural Gas is supplied and delivered by Con Edison. Propane is no longer utilized but served as the primary heating source prior to the gas line being installed.

SWA engineers completed the energy surveys and subsequent report for the Town of Bedford with full cooperation from the Public Works staff. There is no maintenance staff for the building but a facility conditions interview was conducted with the Town of Bedford Commissioner of Public Works Kevin Winn to acquire critical information including weekly hours of operation, occupancy, space temperature set points and other building operational details. The interview was followed by a comprehensive facility walkthrough and inspection of all major HVAC equipment, controls, lighting systems, and building envelope. MR. Winn accompanied SWA throughout the walk-through so as to best address any questions and concerns. SWA noted equipment conditions, operational deficiencies and concerns expressed by building staff.

Building Systems Narrative

Heating System

The Town of Bedford Public Works Garage is heated by two different systems which correspond to the two different space types. The office space is heated by a dual-fuel Buderus BG 142/45 condensing hot water heater which has a nominal output of 85,000 Btu/Hr with an efficiency of up to 95%. The HW is distributed by three constant volume pumps to perimeter baseboard radiators located throughout the offices, hallway, locker room and lunch room. The pumps are activated and hot water is distributed to the given zone based on two thermostats installed within the office space. The first thermostat located in the main office controls the delivery of hot water to the primary office spaces and the second thermostat located in the locker room controls delivery to the locker rooms, hallway and lunch room. The radiators are fitted with hand valves which are not modulated by the building staff. In addition to the hot water radiation one office was also equipped with an electric baseboard heater and the main office has a wall mounted electric heater to supplement the baseboard heat. The garage spaces are heated by four (4) Reznor UDA S125 dual fuel heaters which have a nominal output of 125,000 Btu/Hr. The heaters are ceiling mounted and each is controlled by a separate thermostat. The daytime set point for the garage space is 65°F while the nighttime setback set point is 50°F.

The heating hot water system is activated when the thermostat in the main office calls for heating. During the survey the set point was 68°F. Hot water supply temperature is based on an outdoor air temperature reset schedule. It was also observed during the site survey that several sections of the HW piping were inadequately insulated which results in additional natural gas consumption.

Cooling System

Cooling at the Town of Bedford Public Works Garage is provided primarily by window AC units. The window AC units which serve the office pace and the garage areas vary in age and size from room to room with all being permanently installed through the exterior wall. It was noted that the units appeared to be in good condition but the unit serving the garage storage room was blocked by various parts and materials used in the garage. This can result in impeded airflow and inadequate cooling of the space. As a result the items blocking the unit should be removed. As a general note, the production of R-22 will be phased out by 2020 in accordance with The Montreal Protocol[1]. Any new equipment to be installed should utilize refrigerant 410A or other similarly environmentally conscious refrigerant with no phase-out date.

Ventilation System

The garage portion of the facility is equipped with two (2) particulate removers and circulators. These are both located in the first garage bay as most of the maintenance is completed with that bay. This system serves to remove any harmful particulates that may exist as a result of the maintenance work being completed and circulate the air to better complete the process. Both systems are manually activated based on the current work being completed in the garage. Finally, the garage is also equipped with an exhaust removal system. Should there be a need to operate a vehicle inside the garage the exhaust system is use to removal any harmful exhaust fumes and gases. This system is also manually operated on a as needed basis.

Domestic Hot Water

The Town of Bedford Public Works Garage is provided DHW by a single electric Rheem Model 81V-660 hot water heater. Although the hot water heater is not equipped with any means of determining water temperature the water is delivered to the two (2) bathrooms located in the office space before returning back to the boiler to be reheated. It was noted that the DHW temperature appeared to be adequate when called for in the bathrooms.

Lighting

Interior lighting throughout the Town of Bedford Public Works Garage has been recently upgraded with efficient lamps and ballasts. The new fixtures are equipped with electronic ballasts and 32W lamps. The lighting is manually operated by wall switches. Exterior lighting around the building is provided by approximately 12 halogen flood lights and two (2) high pressure sodium lamps. The exterior lighting is used on an as needed basis during inclement weather. The exterior lighting is controlled by switches and is not used during normal operating hours.

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[1] http://www.epa.gov/ozone/intpol/

Controls System

The building does not currently use a centralized control system to monitor and control equipment. Instead the hot water heating system is controlled by an internal controller which activates when the measured space temperature is below the adjustable set point which was set at 68°F. The controller also serves to vary the water temperature based on outside air reset schedule. Hand valves isolate flow into the radiators and are seldom used. Heating within the garage is controlled by wall mounted thermostats. There is a thermostat for each natural gas fired heater and each is set the maintain 65°F during occupied hours and with a 50°F nighttime setback. Cooling is available year round as the window ACs units are not removed although no simultaneous heating and cooling was documented by building staff since the installation of the new hot water heater. The particulate removers and circulators are run as needed and are controlled by switches placed within the first garage bay.

Electrical Systems

Electric service to the building is provided by NYSEG with a single 10kW gasoline generator connected to provide backup power. The generator if needed supplies power primarily to the lights and fueling system. The generator is approximately four (4) years old and the staff of the Public Works Garage would like to upgrade to a larger capacity generator which is operated with natural gas.

Building Envelope

The Town of Bedford Public Works Garage's exterior walls are comprised primarily of concrete masonry units (CMU) with no insulation. Interior walls are also comprised primary of CMUs with no insulation. The exterior walls are penetrated by a mix of double-pane double hung aluminum frame windows and older single pane awning windows. Most of the office space windows are double pane with the exception of the second bathroom and locker room. The garage windows are all single pane and it was noted that one of the windows in the rear of the building was broken. As a result air infiltration was documented which results in increased energy consumption.

Access to the roof was not permitted during the site survey but building staff indicated that the roof was constructed with no insulation and the EPDM membrane was adhered to directly to the plywood decking. It was noted that the building was experiencing some minor leaks in the second garage bay roof but the issue was resolved prior to the site survey. Two (2) skylights penetrate the roof and provide natural lighting within the lunch room.

Access into the Public Works Garage is provided by two (2) swing doors in the office space and six (6) large roll up garage doors in the garage space. The first swing door is a glass with aluminum frame door and is the primary entrance door to the office space. The door was noted to be requiring weather-stripping as it was not creating an adequate seal. This allows conditioned air to escape the building and results in wasted energy. The second swing door which is a metal door with a small window provides an alternative means of access to another office and is rarely used. The weather-stripping for the second door appeared to be in good condition. The garage doors which are equipped with small double pane windows appeared to be in good condition and provided an adequate barrier for the garage spaces.

ENERGY USE ANALYSIS WITH EPA PORTFOLIO MANAGER RESULTS

Overall Energy Performance

Energy consumption at the Town of Bedford Public Works Garage is comprised of electricity propane and natural gas. Billing analysis and Energy Star® benchmarking was conducted for the 12-month time period between December 2011 and November 2012. Total energy consumption for the analysis period was 742 MMBtu, resulting in a utility cost of $18,994.

Town of Bedford - Public Works Garage - Annual Energy Consumption and Costs										
	Energy		*Site Energy in MMBtu*	*Source Energy in MMBtu*	*Cost*	*% Total Site Energy*	*% Total Source Energy*	*% Total Cost*	*Cost / Site MMBtu*
Electricity	51,516	kWh	176	587	$5,189	24%	51%	27%	$30
Natural Gas	657	Therms	66	69	$849	9%	6%	4%	$13
Propane	5,463	Gallons	501	506	$12,956	67%	44%	68%	$26
Totals			**742**	**1,161**	**$18,994**	**100%**	**100%**	**100%**	**$26**

SWA entered information about the Town of Bedford Police Department into the U.S. Environmental Protection Agency's (EPA) Energy Star® Portfolio Manager Energy Benchmarking System. The facility was categorized as both an "Office" and "Garage (Other)" space type. Currently, the system does not determine Energy Star Rating® values for "Other" space types. However, should Energy Star start providing garages with rating in the future a score of 69 is required for LEED for Existing Buildings certification and a score of 75 is required for Energy Star® certification. While an Energy Star Rating was unavailable, the system did generate Site and Source Energy Use Intensities (EUI). The Site EUI for the building is 83 kBtu/ft^2/yr and the Source EUI is 130 kBtu/ft^2/yr. This compares to National Median Site and Source EUIs of 45 kBtu/ft^2/yr and 96 kBtu/ft^2/yr, respectively, indicating that the building performs more poorly than other mixed office and garage spaces with similar characteristics. However, as the National Median values represent a facility which is solely used as a garage they fail to capture the higher energy density which is associated with an office space.

The EPA considers source energy (energy used at point of generation) a more equitable assessment of building-level energy efficiency than site energy (energy used in the building). Source energy incorporates system losses from transmission, delivery and generation, where as the site energy is a measure of the energy used by the building itself.

Energy Analysis

The annual energy consumption and costs are broken down in Figures 1 and 2 below:

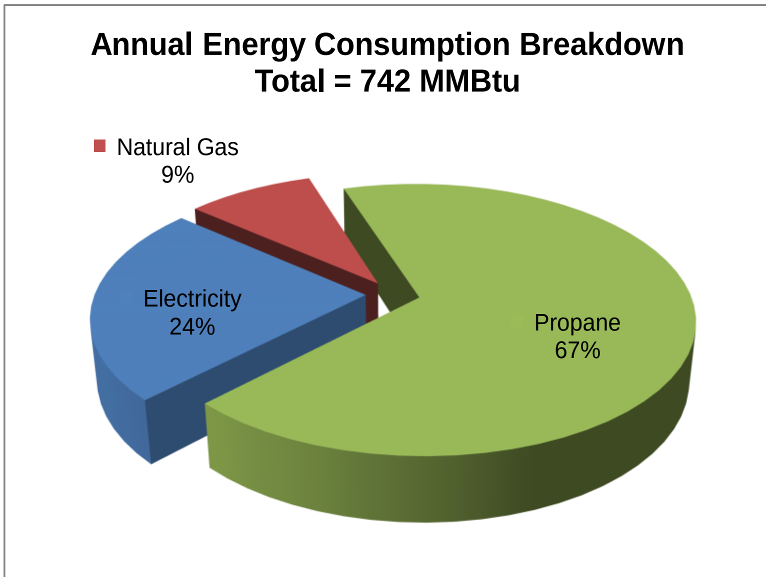


Figure 1

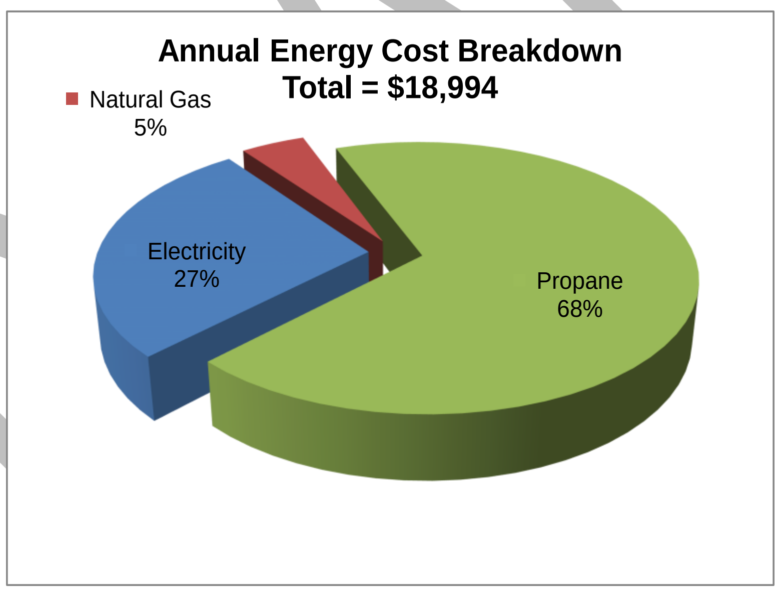


Figure 2

Electricity accounts for approximately 24% of the total energy consumption and 27% of the cost. Natural gas accounts for approximately 9% of the total energy consumption and 5% of the cost. Finally, propane accounted for approximately 67% of the total energy consumption and 68% of the cost. As such the cost per MMBtu for natural gas is nearly half that of electric and propane which are nearly the same.

The Town of Bedford does not currently employ the services of an Energy Services Company (ESCO). An ESCO is a business that, among other things, assesses a client's utility requirements and arranges for the client to procure energy commodities at the most competitive rates. SWA recommends that the Town of Bedford investigate ESCO options in order to ensure they receive the most attractive commodity pricing.

Utility consumption at the Town of Bedford Public Works Garage has been further broken down by major building end uses and because consumption is not sub-metered by separate end uses; the figures calculated in the breakdowns are estimates based on building and equipment information and facility-provided hours of operation. Figure 3.1 below shows a breakdown of annual energy costs by end use while figures 3.2 and 3.3 show site and source energy use broken down by end use.

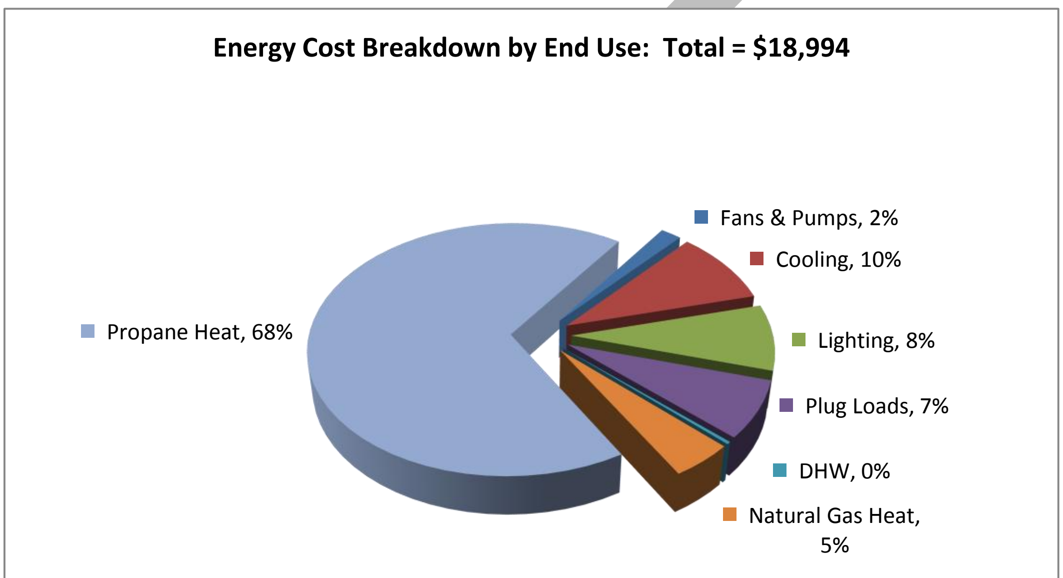


Figure 3.1

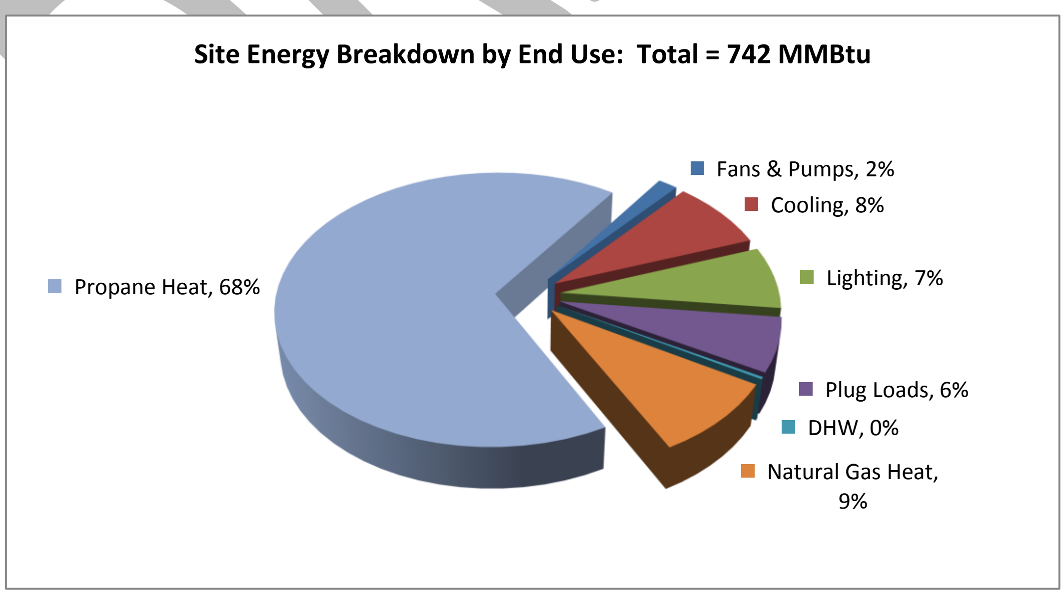


Figure 3.2

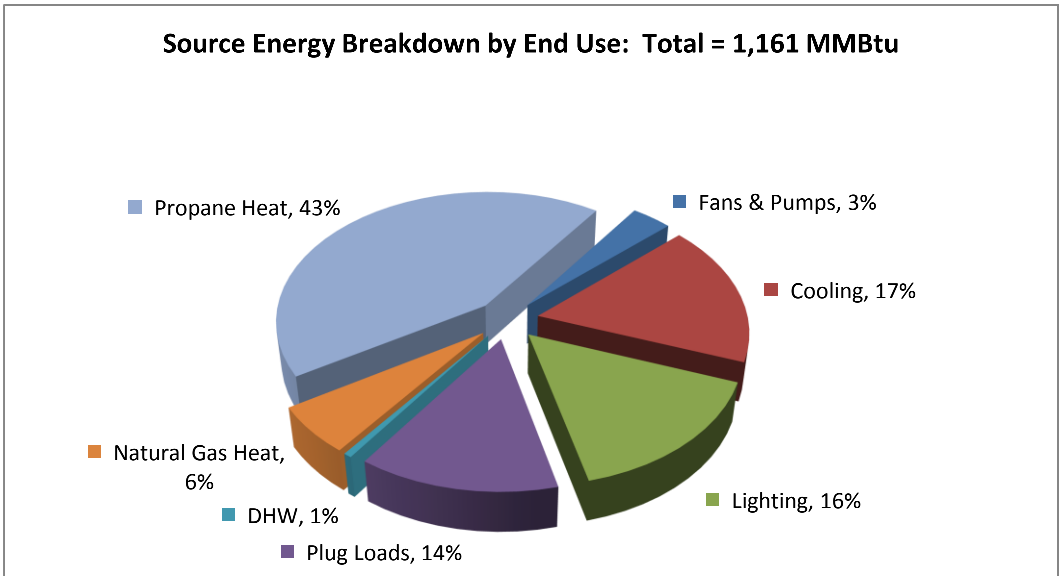


Figure 3.3

Because buildings are the major users of energy, they also contribute significantly to greenhouse gas emissions. Carbon dioxide is by far the most common greenhouse gas released during energy generation; however, others like methane and nitrous oxide also contribute. When analyzing a commercial building, Carbon Dioxide Equivalent (CO_2e) can be calculated based on the total energy consumed by the building. This calculation takes all greenhouse gases and energy generation methods into account and results in a single quantity for simple comparison. Annual energy use at the Town of Bedford Public Works Garage generates approximately 113,922 pounds of CO_2e. Figure 4 below shows a breakdown of the building's greenhouse gas emissions by end use:

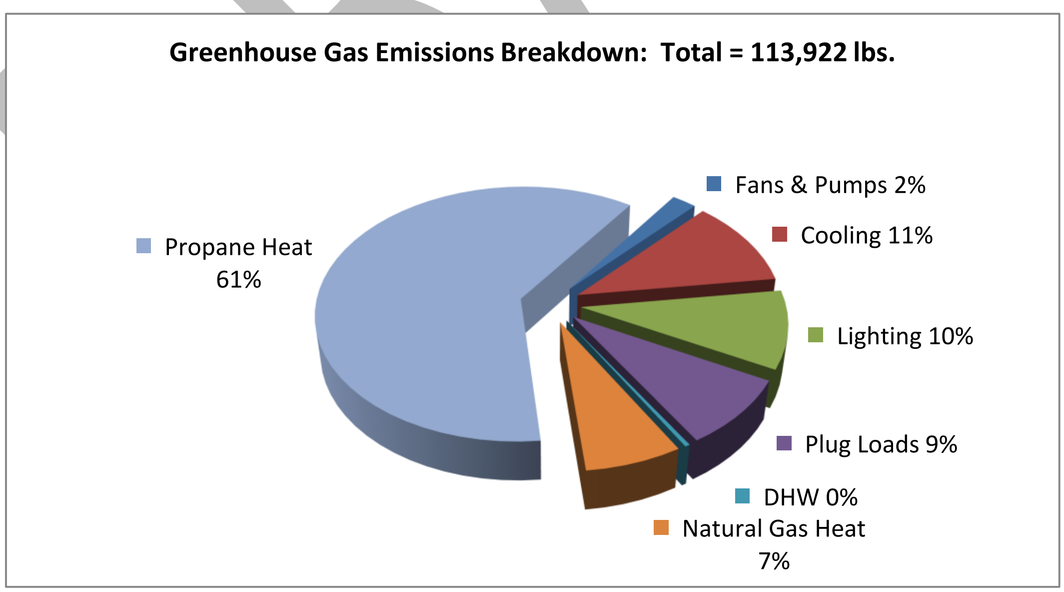


Figure 4

Electricity

Electricity is purchased and delivered to the building by NYSEG. A single electric service supplies the entire building. Annual electric consumption between December 2011 and November 2012 was 51,516 kWh, resulting in a total cost of $5,189 and an average aggregated rate of $0.10 per kWh. Consumption for this period was greatest during the period from mid-July to mid-September, when the building used approximately 11,580 kWh of electricity. During the same 12-month period a peak demand of 25 kW occurred during the period from mid-May to mid-July. Figure 5.1 below provides a breakdown of total electrical consumption based on end use.

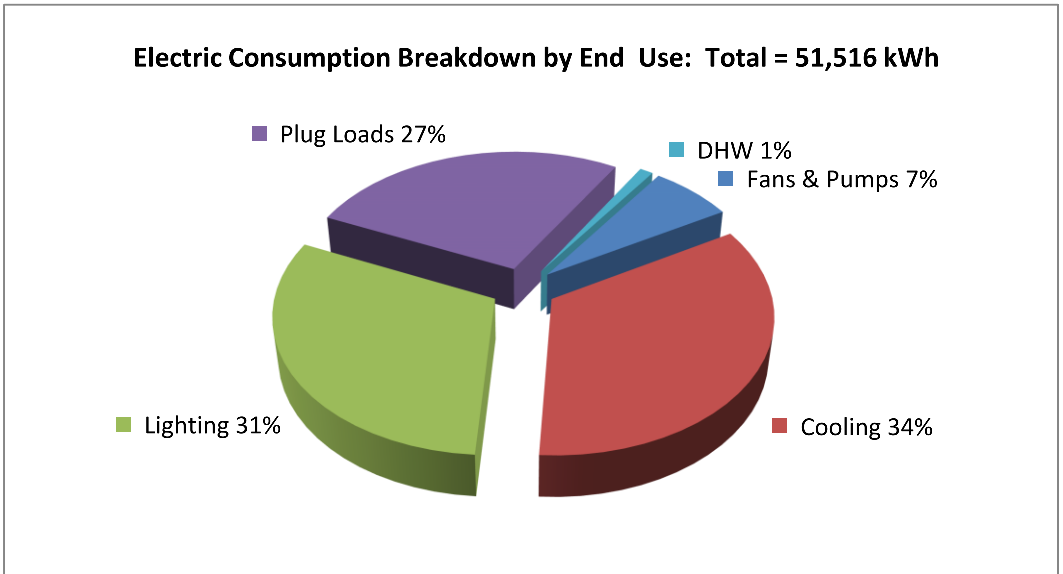


Figure 5.1

Figure 5.2 graphs a comparison of the building's monthly electrical usage for the previous two years. Overall, electrical use decreased by 18% when comparing the 2010-2011 period to the 2011-2012 period and is consistent throughout all of the periods except for the period between mid-March and mid-May where the margin is much smaller. The cause for the overall change in consumption is likely due to the installation of the upgraded lighting. However, for the period between mid-March and mid-May where little change in consumption occurred it is possible the increased CDD may have required more cooling resulting in the similar consumption for both years. In general it is noted that the shape of the consumption profiles is consistent from year to year. This suggests that the controls, set points, equipment or occupancy are also consistent. The graph also shows that the Public Works Garage's electric consumption profile does not follow a typical pattern for buildings of similar type; electric consumption should be at a minimum during the winter months when the window ACs are not in use. However, the high electrical consumption during the winter is likely the result of the HW circulating pumps and the fans integral to the garage heaters. The figure also shows the building's annual electric consumption or annual kWh, for a 12-month period ending with the period shown in the x-axis. For example, the last point indicates the total annual consumption for the last analyzed year. The following month will drop the oldest month from the 12-month period and adds the current period's electric consumption.

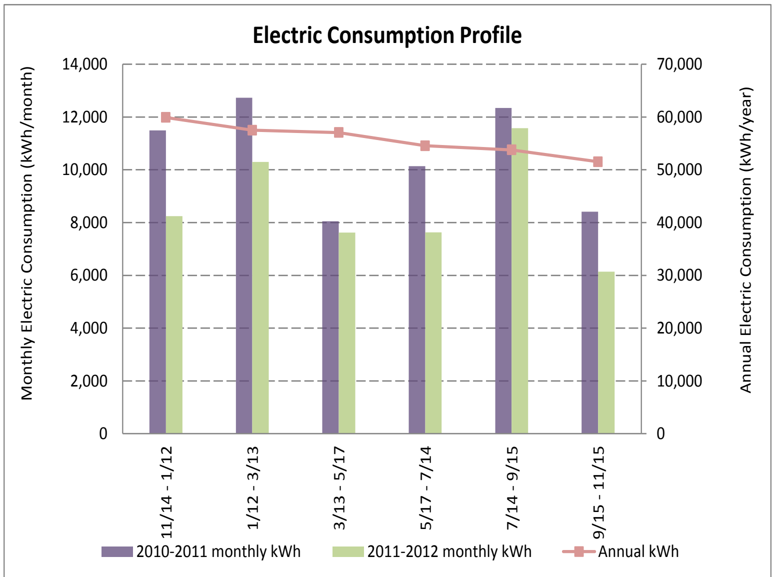


Figure 5.2

Figure 5.3 shows the building's monthly electric demand profile for the period between November 2012 and November 2012. Electric demand is the highest average kilowatts used in a thirty minute interval during the month. The graph shows the peak demand during each monthly billing period. During the analyzed period the highest electrical demand of 25 kW occurred in period between mid-May and mid-July. This is typical for a building with electrical cooling systems.

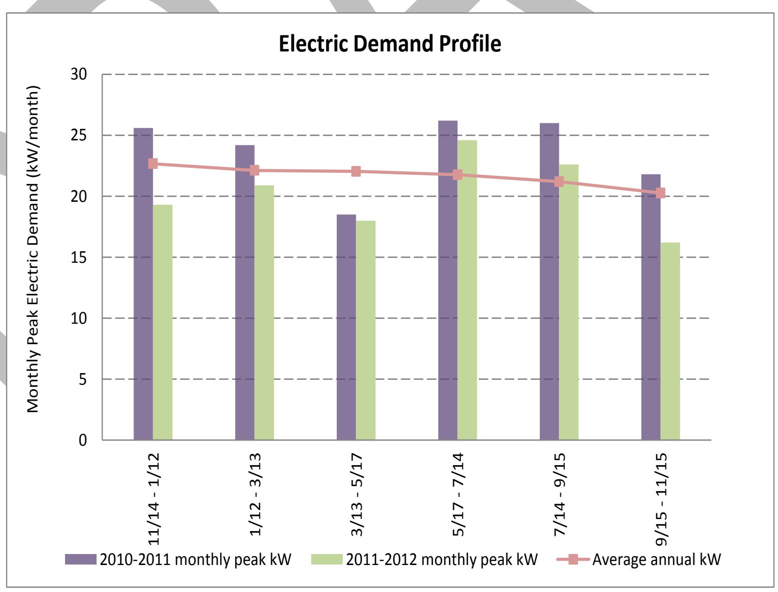


Figure 5.3

Natural Gas

Natural gas is supplied and delivered to the Public Works Garage by Con Edison. Natural gas is used by the hot water heater and natural gas fired heaters that provide comfort heating for both the office space and garage spaces. Natural gas consumption between June 2012 and November 2012 was 657 therms, resulting in a total cost of $849 and an average aggregated rate of $1.29 per therm. An entire year of data was not available at the time of the surveys as the building had recently switched to natural gas. As such comparison between this consumption period and previous periods is not possible. Figure 6.1 shows a comparison of the building's monthly natural gas consumption for available data.

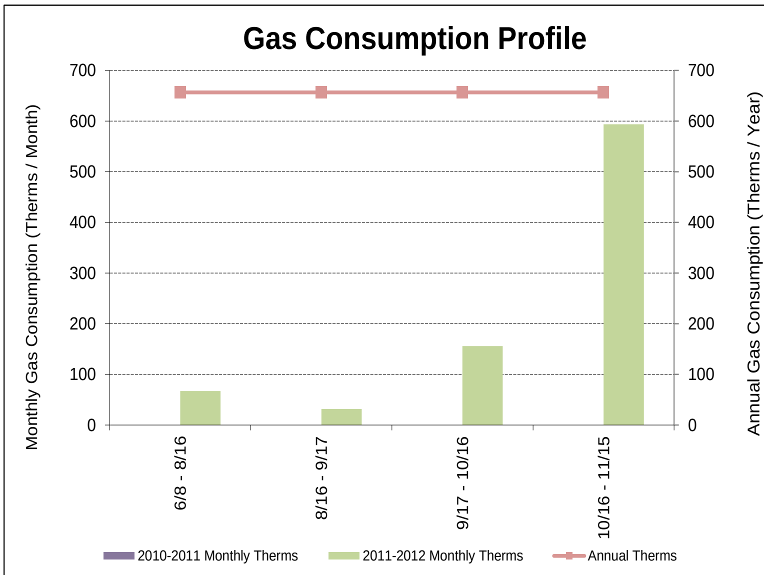


Figure 6.1

Figure 6.2 below relates the monthly natural gas consumption and the number of Heating Degree Days in that month. It is apparent from the graph that natural gas consumption closely correlates with the curve of HDD which is to be expected from a natural gas heated facility.

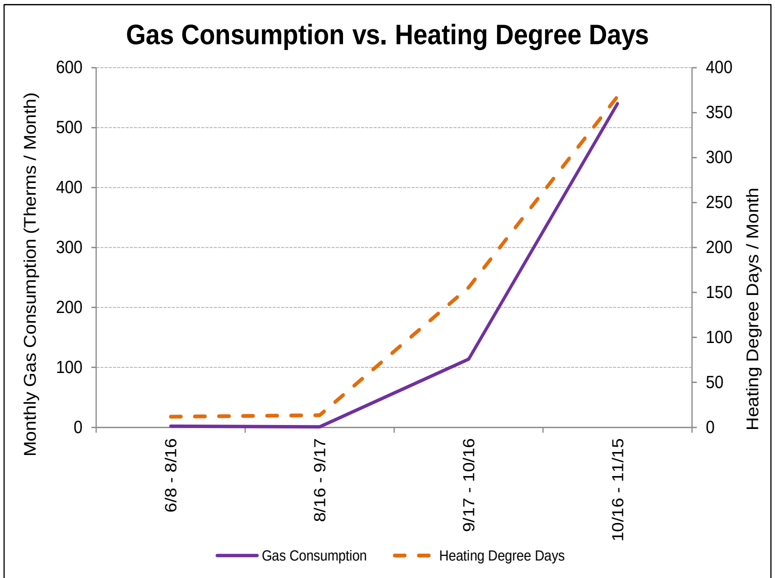


Figure 6.2

A figure providing the breakdown of total natural gas consumption based on end use is not included as the only systems to consume natural gas both provide space heating.

Propane

Propane is no longer in use at the Public Works Garage but an analysis has been included because the consumption contributed to total energy use within the last year. Propane was used by the hot water heater and dual fuel heaters that provide comfort heating for both the office space and garage spaces. Propane consumption between October 2011 and May 2012 was 5,463 gallons, resulting in a total cost of $12,956 and an average aggregated rate of $2.37 per therm. An entire year of data is not available as the building did not utilize propane for an entire year. As such comparison between this consumption period and previous periods is not possible. Figure 7.1 shows the bill date, gallons purchased and cost per purchase.

Billing Dates	Usage	Cost
11/18 - 12/13	516	$1,278
12/13 - 12/27	668	$1,655
12/27 - 1/16	516	$1,277
1/16 - 1/16	139	$335
1/16 - 1/24	720	$1,731
1/24 - 2/2	453	$1,089
2/2 - 2/10	308	$740
2/10 - 2/17	406	$977
2/17 - 2/21	303	$727
2/21 - 3/3	149	$358
3/3 - 3/13	348	$837
3/13 - 4/9	351	$715
4/9 - 5/18	434	$929
5/18 - 5/18	152	$308
Totals	**5,463**	**$12,956**

Figure 7.1

Figure 7.2 below relates the propane deliveries and the number of Heating Degree Days in that period. Due to the nature of propane purchasing, it was assumed that the delivery amount (gallons) during each period corresponds to the amount consumed in the previous period. This is indicated by the two offset trend-lines with similar curves.

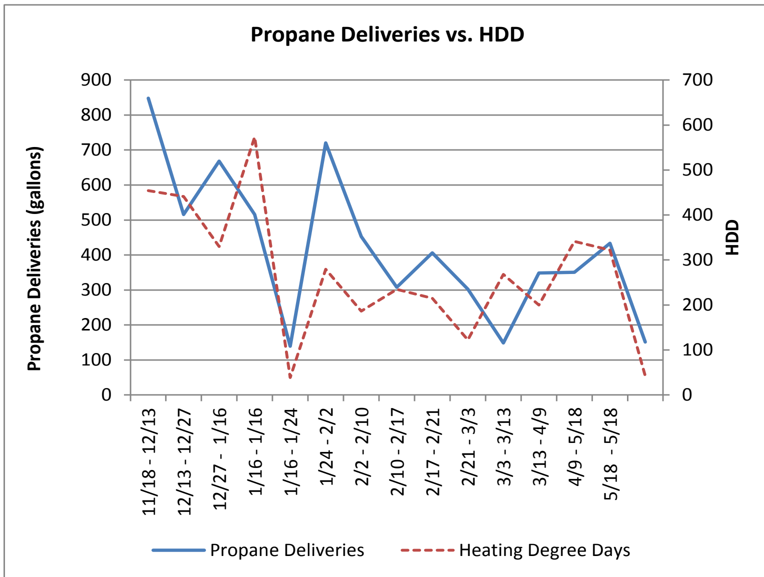


Figure 7.2

A figure providing the breakdown of propane consumption based on end use is not included as the only systems to consume natural gas both provide space heating.

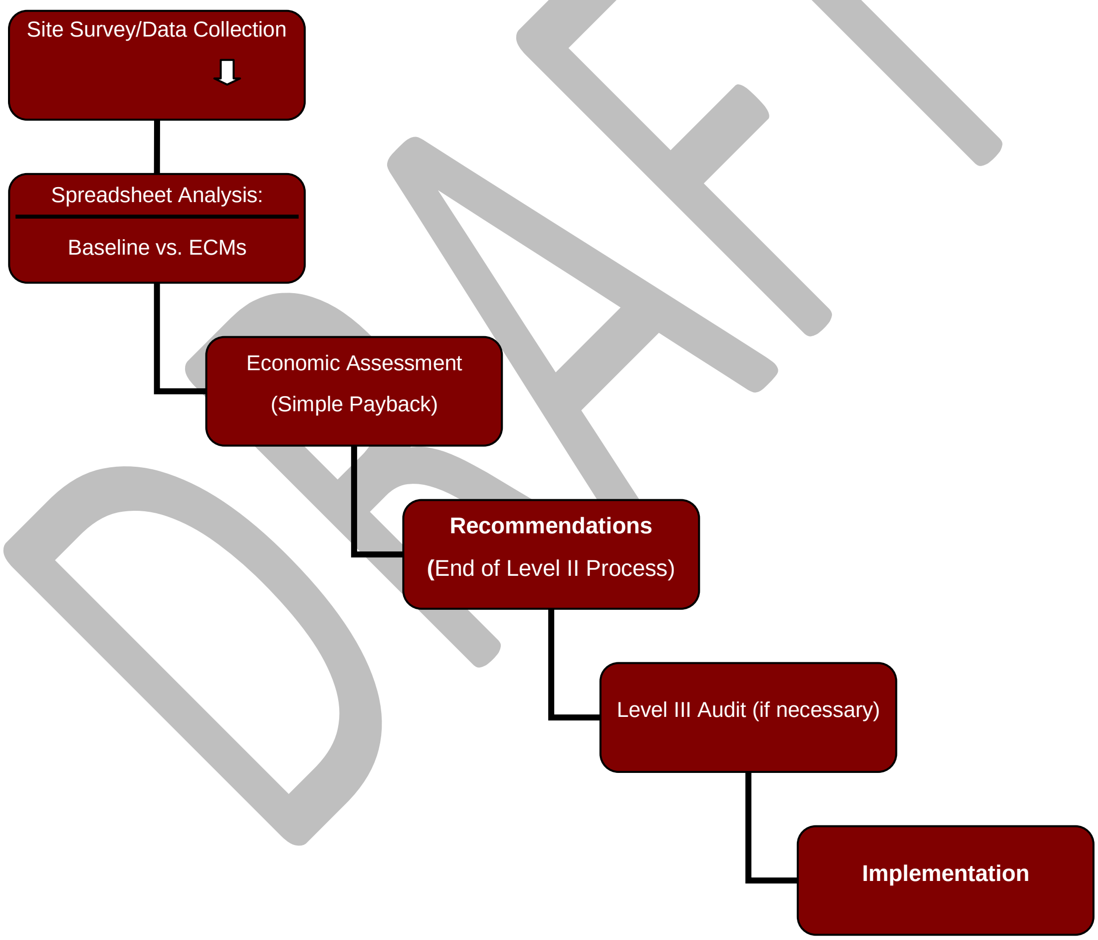
PROJECT RESULTS AND RECOMMENDATIONS

Overview

The Project Summary Sheet that follows the Executive Summary lists estimated costs and savings for each recommended ECM. Each ECM is discussed in detail in the following section with a brief recommendation on how to measure and verify the savings after implementation. These Measurement and Verification (M&V) methods are recommended in accordance with the International Performance for Measurement and Verification Protocol (IPMVP) guidelines. The recommended options (A, B, C or D) were determined based on a combination of cost, magnitude of savings, and reasonableness of methods. This process is described in more detail in Appendix E.

Methodology

Potential Energy Conservation Measures (ECMs) were evaluated after the site survey, operator interviews and collection of data necessary to perform the technical and economic analyses. This evaluation was completed to ASHRAE Level II standards through spreadsheet analysis. It is recommended that facility measures be further evaluated to Level III standards prior to implementation.



Methodology Flow Chart

To assess energy savings associated with each measure, the baseline for consumption was compared individually to consumption totals calculated for each measure. The baseline for equipment was obtained from monthly utility bills and steam and electric data and analyzed against daily weather data. Results were then calibrated as necessary.

Energy consumption associated with each measure was then assessed individually based on the technical performance of the recommended measure scope and then compared to the corresponding baseline in order to determine energy savings. Cost savings were determined using the projected energy savings and energy rates from energy bills.

All potential ECMs were analyzed. They are listed in this section of the report as *Recommended* or *Considered but Not Recommended* based on technical and/or economic feasibility. Prior to implementation, confirmation of projected savings and cost may be required for capital intensive measures.

The following assumptions were used in calculating the savings:

Building energy usage patterns remain relatively unchanged in the near future (no significant occupancy change and/or space conversion).

Energy costs remain relatively stable (although we believe electricity costs will escalate much more than natural gas).

Building systems operation remains relatively unchanged (unless change is related to a recommended ECM).

An economic analysis was performed for each measure using historical cost estimates from similar projects and pricing solicited from vendors. The cost savings were divided by implementation costs in order to determine simple payback for each measure.

Proposed Energy Conservation Measures (ECMs)

Each ECM is discussed in this section. Please see the Project Summary Sheet at the end of the Executive Summary for estimated costs and savings.

ECM #1: Lower Garage Nighttime Setback

Existing Conditions

While surveying the thermostatic controls of the garage portion of the facility, it was noted that the heating system was activated at a temperature below 50°F during unoccupied hours. This maintains the space at a temperature adequate to prevent any freezing issues but may result in wasted natural gas consumption as a lower temperature could be maintained while still preventing a freeze condition. This will reduce the natural gas consumption associated with the garage heaters and lower the total energy costs of the facility.

Measure Description

SWA recommends that the programed set point in the garage space thermostats be lower from 50°F to 40°F. By maintaining 40°F the garage heaters will consumed less energy while still preventing freezing in the space.

Repairs Required

No repairs are expected as a result of this measure.

Operations and Maintenance Impacts

Operations and maintenance will be unaffected by the implementation of this measure.

Equipment Life

The changes in equipment life should be expected as a result of this measure.

Savings

Savings is the result of reduced natural gas consumption during unoccupied hours. The savings values presented represent expected savings for an entire year while operating with natural gas. At the time of the analysis only 6 months of data was available and as such the total natural gas savings exceed the current natural gas consumption.

Measurement and Verification

Option C, *Utility Data Analysis*, would be the most accurate assessment tool to track the results of this ECM. Natural gas consumption data is available through Con Edison. Consumption data should be compared before and after measure implementation and normalized with weather data.

ECM #2: Insulate Hot Water Piping

Existing Conditions

While surveying the HW piping throughout the Public Works Garage, it was noted that the hot water piping was lacking insulation for portions of the piping in the boiler room and through office space. Missing insulation allows for hot water pipes to radiate heat into the surrounding which may not require heating. This unwanted heat transfer allows for system heat loss, which greatly reduces the amount of heat delivered to the baseboard radiators. These system losses are energy wasted, which also results in added natural gas costs.

Measure Description

SWA recommends that all non-insulated hot water piping be insulated to mitigate heat loss and reduce fuel oil consumption. The existing insulation appeared to be in good condition however any section found to be damaged should also be replaced. Included below is a table from ASHRAE 90.1 2007 documenting the recommended pipe insulation thickness based on pipe size and operating temperatures. This should serve as the guideline for any new insulation installed as well as means of evaluation for the existing insulation. Savings for this measure will result from reduced natural gas consumption in producing hot water for use within the office space of the Public Works Garage.

TABLE 6.8.3 Minimum Pipe Insulation Thickness[a]

Fluid Design Operating Temp. Range (°F)	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity Btu·in./(h·ft²·°F)	Mean Rating Temp. °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Heating Systems (Steam, Steam Condensate, and Hot Water)[b,c]							
>350	0.32 – 0.34	250	2.5	3.0	3.0	4.0	4.0
251 – 350	0.29 – 0.32	200	1.5	2.5	3.0	3.0	3.0
201 – 250	0.27 – 0.30	150	1.5	1.5	2.0	2.0	2.0
141 – 200	0.25 – 0.29	125	1.0	1.0	1.0	1.5	1.5
105 – 140	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
Domestic and Service Hot-Water Systems							
105+	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
Cooling Systems (Chilled Water, Brine, and Refrigerant)[d]							
40 – 60	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
<40	0.22 – 0.28	100	0.5	1.0	1.0	1.0	1.5

[a] For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:
$T = r\{(1 + t/r)^{K/k} - 1\}$
where T = minimum insulation thickness (in.), r = actual outside radius of pipe (in.), t = insulation thickness listed in this table for applicable fluid temperature and pipe size, K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in.[h·ft²·°F]); and k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
[b] These thicknesses are based on energy efficiency considerations only. Additional insulation is sometimes required relative to safety issues/surface temperature.
[c] Piping insulation is not required between the control valve and coil on run-outs when the control valve is located within 4 ft of the coil and the pipe size is 1 in. or less.
[d] These thicknesses are based on energy efficiency considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.

Repairs Required

Any damaged insulation found should be replaced following the table above. Piping throughout the Public Works Garage appeared to be in good condition however any damaged or leaking piping will need to be replaced prior to the installation of the insulation.

Operations and Maintenance Impacts

Operations and maintenance will be slightly increased such that periodic inspection of the insulation should be completed to ensure that it is good condition and complete.

Equipment Life

The new piping insulation can be expected to last 20 years with minimal disturbance.

Savings

Savings is the result of reduced heat loss and reduced natural gas consumption during the entire heating season. The savings values presented represent expected savings for an entire year while operating with natural gas. At the time of the analysis only 6 months of data was available and as such the total natural gas savings exceed the current natural gas consumption.

Measurement and Verification

Option C, *Utility Data Analysis*, would be the most accurate assessment tool to track the results of this ECM. Natural gas consumption data is available through Con Edison. Consumption data should be compared before and after measure implementation and normalized with weather data.

ECM #3: Weather-strip Exterior Door

Existing Conditions

The primary entrance door to the office space at the Public Works Garage was noted to have weather-stripping which left a gap between the door and the frame. The gaps allow for unwanted air infiltration and heat transfer, resulting in increased natural gas and electricity usage required to heat and cool the building, as well as the infiltration of air that is unfiltered and that contains dust and particulates that impact cleanliness and indoor environmental quality (IEQ).

Measure Description

SWA recommends installing weather-stripping on the primary entrance door such that it provides an adequate barrier against outside air infiltration and conditioned air loss.

Repairs Required

Doors and frames should be inspected such that any damage or misalignment can be repaired prior to the installation of this measure.

Operations and Maintenance Impacts

Operations will be positively impacted as a result of limiting the infiltration of unconditioned air from the exterior, improving energy efficiency, occupant comfort, building cleanliness and indoor air quality.

Equipment Life

Weather-stripping can be expected to last a year with regular use but should be inspected periodically for early failure.

Savings

Energy savings are realized due to reduced heating and cooling loads required to condition spaces into which outside air leaks. The natural gas savings values presented represent expected savings for an entire year while operating with natural gas. At the time of the analysis only 6 months of data was available and as such the total natural gas savings exceed the current natural gas consumption.

Measurement and Verification

Option C, Utility Data Analysis, would be the most accurate assessment tool to look at the results of this ECM. Natural gas consumption and electric usage data is available through Con Edison and NYSEG. Monthly usage should be compared before and after measure implementation and normalized with weather data.

APPENDICES

- APPENDIX A: EPA Portfolio Manager Statement Of Energy Performance
- APPENDIX A-3: Participant Information
- APPENDIX B: Energy Conservation Measure Calculations
- APPENDIX B-3: Project Summary Sheet
- APPENDIX C: BIN Data Calculation Spreadsheet Printouts
- APPENDIX D: Glossary and Method of Calculations
- APPENDIX E: IPMVP Protocols
- APPENDIX F: Method of Analysis

APPENDIX A: EPA Portfolio Manager Statement of Energy Performance

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
Town of Bedford - Public Works Garage

ENERGY STAR

Building ID: 3415751
For 12-month Period Ending: October 31, 2012[1]
Date SEP becomes ineligible: N/A

Date SEP Generated: January 23, 2013

Facility
Town of Bedford - Public Works Garage
301 Adams Street
Bedford Hills, NY 10507

Facility Owner
N/A

Primary Contact for this Facility
N/A

Year Built: 1980
Gross Floor Area (ft²): 9,000

Energy Performance Rating[2] (1-100) N/A

Site Energy Use Summary[3]	
Electricity - Grid Purchase(kBtu)	177,288
Natural Gas (kBtu)[4]	39,571
Propane (kBtu)	533,978
Total Energy (kBtu)	750,837
Energy Intensity[4]	
Site (kBtu/ft²/yr)	83
Source (kBtu/ft²/yr)	130
Emissions (based on site energy use)	
Greenhouse Gas Emissions ($MtCO_2e$/year)	52

Electric Distribution Utility
New York State Electric & Gas Corp [Iberdrola SA]

National Median Comparison	
National Median Site EUI	45
National Median Source EUI	96
% Difference from National Median Source EUI	36%
Building Type	Service (Vehicle Repair/Service, Postal Service)

Stamp of Certifying Professional

Based on the conditions observed at the time of my visit to this building, I certify that the information contained within this statement is accurate.

Meets Industry Standards[5] for Indoor Environmental Conditions:

Ventilation for Acceptable Indoor Air Quality	**N/A**
Acceptable Thermal Environmental Conditions	**N/A**
Adequate Illumination	**N/A**

Certifying Professional
N/A

Notes:
1. Application for the ENERGY STAR must be submitted to EPA within 4 months of the Period Ending date. Award of the ENERGY STAR is not final until approval is received from EPA.
2. The EPA Energy Performance Rating is based on total source energy. A rating of 75 is the minimum to be eligible for the ENERGY STAR.
3. Values represent energy consumption, annualized to a 12-month period.
4. Values represent energy intensity, annualized to a 12-month period.
5. Based on Meeting ASHRAE Standard 62 for ventilation for acceptable indoor air quality, ASHRAE Standard 55 for thermal comfort, and IESNA Lighting Handbook for lighting quality.

The government estimates the average time needed to fill out this form is 6 hours (includes the time for entering energy data, Licensed Professional facility inspection, and notarizing the SEP) and welcomes suggestions for reducing this level of effort. Send comments (referencing OMB control number) to the Director, Collection Strategies Division, U.S., EPA (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460.

EPA Form 5900-16

ENERGY STAR® Data Checklist for Commercial Buildings

In order for a building to qualify for the ENERGY STAR, a Professional Engineer (PE) or a Registered Architect (RA) must validate the accuracy of the data underlying the building's energy performance rating. This checklist is designed to provide an at-a-glance summary of a property's physical and operating characteristics, as well as its total energy consumption, to assist the PE or RA in double-checking the information that the building owner or operator has entered into Portfolio Manager.

Please complete and sign this checklist and include it with the stamped, signed Statement of Energy Performance.
NOTE: You must check each box to indicate that each value is correct, OR include a note.

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	☑
Building Name	Town of Bedford - Public Works Garage	Is this the official building name to be displayed in the ENERGY STAR Registry of Labeled Buildings?		☐
Type	Service (Vehicle Repair/Service, Postal Service)	Is this an accurate description of the space in question?		☐
Location	301 Adams Street, Bedford Hills, NY 10507	Is this address accurate and complete? Correct weather normalization requires an accurate zip code.		☐
Single Structure	Single Facility	Does this SEP represent a single structure? SEPs cannot be submitted for multiple-building campuses (with the exception of a hospital, k-12 school, hotel and senior care facility) nor can they be submitted as representing only a portion of a building.		☐
Office Space (Office)				
CRITERION	**VALUE AS ENTERED IN PORTFOLIO MANAGER**	**VERIFICATION QUESTIONS**	**NOTES**	☑
Gross Floor Area	2,000 Sq. Ft.	Does this square footage include all supporting functions such as kitchens and break rooms used by staff, storage areas, administrative areas, elevators, stairwells, atria, vent shafts, etc. Also note that existing atriums should only include the base floor area that it occupies. Interstitial (plenum) space between floors should not be included in the total. Finally gross floor area is not the same as leasable space. Leasable space is a subset of gross floor area.		☐
Weekly operating hours	45 Hours	Is this the total number of hours per week that the Office space is 75% occupied? This number should exclude hours when the facility is occupied only by maintenance, security, or other support personnel. For facilities with a schedule that varies during the year, "operating hours/week" refers to the total weekly hours for the schedule most often followed.		☐
Workers on Main Shift	3	Is this the number of employees present during the main shift? Note this is not the total number of employees or visitors who are in a building during an entire 24 hour period. For example, if there are two daily 8 hour shifts of 100 workers each, the Workers on Main Shift value is 100. The normal worker density ranges between 0.3 and 5.3 workers per 1000 square feet (92.8 square meters)		☐
Number of PCs	3	Is this the number of personal computers in the Office?		☐
Percent Cooled	50% or more	Is this the percentage of the total floor space within the facility that is served by mechanical cooling equipment?		☐
Percent Heated	50% or more	Is this the percentage of the total floor space within the facility that is served by mechanical heating equipment?		☐
Garage (Other)				
CRITERION	**VALUE AS ENTERED IN PORTFOLIO MANAGER**	**VERIFICATION QUESTIONS**	**NOTES**	☑

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Gross Floor Area	7,000 Sq. Ft.	Does this square footage include all supporting functions such as kitchens and break rooms used by staff, storage areas, administrative areas, elevators, stairwells, atria, vent shafts, etc. Also note that existing atriums should only include the base floor area that it occupies. Interstitial (plenum) space between floors should not be included in the total. Finally gross floor area is not the same as leasable space. Leasable space is a subset of gross floor area.		☐
Number of PCs	0(Optional)	Is this the number of personal computers in the space?		☐
Weekly operating hours	45Hours(Optional)	Is this the total number of hours per week that the space is 75% occupied? This number should exclude hours when the facility is occupied only by maintenance, security, or other support personnel. For facilities with a schedule that varies during the year, "operating hours/week" refers to the total weekly hours for the schedule most often followed.		☐
Workers on Main Shift	3(Optional)	Is this the number of employees present during the main shift? Note this is not the total number of employees or visitors who are in a building during an entire 24 hour period. For example, if there are two daily 8 hour shifts of 100 workers each, the Workers on Main Shift value is 100.		☐

ENERGY STAR® Data Checklist
for Commercial Buildings

Energy Consumption

Power Generation Plant or Distribution Utility: New York State Electric & Gas Corp [Iberdrola SA]

Fuel Type: Electricity		
Meter: ELEC - 10017450932 (kWh (thousand Watt-hours)) Space(s): Entire Facility Generation Method: Grid Purchase		
Start Date	**End Date**	**Energy Use (kWh (thousand Watt-hours))**
07/14/2012	09/15/2012	11,580.00
05/17/2012	07/14/2012	7,632.00
03/13/2012	05/17/2012	7,884.00
01/12/2012	03/13/2012	10,032.00
11/14/2011	01/12/2012	8,244.00
ELEC - 10017450932 Consumption (kWh (thousand Watt-hours))		**45,372.00**
ELEC - 10017450932 Consumption (kBtu (thousand Btu))		**154,809.26**
Total Electricity (Grid Purchase) Consumption (kBtu (thousand Btu))		**154,809.26**
Is this the total Electricity (Grid Purchase) consumption at this building including all Electricity meters?		☐

Fuel Type: Natural Gas		
Meter: GAS - 590912129320000 (therms) Space(s): Entire Facility		
Start Date	**End Date**	**Energy Use (therms)**
09/17/2012	10/16/2012	114.00
08/16/2012	09/17/2012	1.00
06/08/2012	08/16/2012	2.00
05/18/2012	06/08/2012	0.00
04/09/2012	05/18/2012	0.00
03/13/2012	04/09/2012	0.00
03/03/2012	03/13/2012	0.00
02/21/2012	03/03/2012	0.00
02/17/2012	02/21/2012	0.00
02/10/2012	02/17/2012	0.00
02/02/2012	02/10/2012	0.00
01/24/2012	02/02/2012	0.00
01/16/2012	01/24/2012	0.00
01/16/2012	01/16/2012	0.00
12/27/2011	01/16/2012	0.00
12/13/2011	12/27/2011	0.00
11/18/2011	12/13/2011	0.00

GAS - 590912129320000 Consumption (therms)	117.00
GAS - 590912129320000 Consumption (kBtu (thousand Btu))	11,700.00
Total Natural Gas Consumption (kBtu (thousand Btu))	11,700.00
Is this the total Natural Gas consumption at this building including all Natural Gas meters?	☐

Fuel Type: Propane

Meter: PROPANE - N/A (Gallons)
Space(s): Entire Facility

Start Date	End Date	Energy Use (Gallons)
09/17/2012	10/16/2012	0.00
08/16/2012	09/17/2012	0.00
06/08/2012	08/16/2012	0.00
05/18/2012	06/08/2012	152.00
04/09/2012	05/18/2012	434.00
03/13/2012	04/09/2012	351.00
03/03/2012	03/13/2012	348.00
02/21/2012	03/03/2012	149.00
02/17/2012	02/21/2012	303.00
02/10/2012	02/17/2012	406.00
02/02/2012	02/10/2012	308.00
01/24/2012	02/02/2012	453.00
01/16/2012	01/24/2012	720.00
01/16/2012	01/16/2012	139.00
12/27/2011	01/16/2012	516.00
12/13/2011	12/27/2011	668.00
11/18/2011	12/13/2011	516.00
PROPANE - N/A Consumption (Gallons)		**5,463.00**
PROPANE - N/A Consumption (kBtu (thousand Btu))		**500,670.84**
Total Propane Consumption (kBtu (thousand Btu))		**500,670.84**
Is this the total Propane consumption at this building including all Propane meters?		☐

Additional Fuels	
Do the fuel consumption totals shown above represent the total energy use of this building? Please confirm there are no additional fuels (district energy, generator fuel oil) used in this facility.	☐

On-Site Solar and Wind Energy	
Do the fuel consumption totals shown above include all on-site solar and/or wind power located at your facility? Please confirm that no on-site solar or wind installations have been omitted from this list. All on-site systems must be reported.	☐

Certifying Professional

(When applying for the ENERGY STAR, the Certifying Professional must be the same PE or RA that signed and stamped the SEP.)

Name: ____ Date: ____________

Signature: ______________________________________

Signature is required when applying for the ENERGY STAR.

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FOR YOUR RECORDS ONLY. DO NOT SUBMIT TO EPA.

Please keep this Facility Summary for your own records; do not submit it to EPA. Only the Statement of Energy Performance (SEP), Data Checklist and Letter of Agreement need to be submitted to EPA when applying for the ENERGY STAR.

Facility
Town of Bedford - Public Works Garage
301 Adams Street
Bedford Hills, NY 10507

Facility Owner
N/A

Primary Contact for this Facility
N/A

General Information

Town of Bedford - Public Works Garage	
Gross Floor Area Excluding Parking: (ft^2)	9,000
Year Built	1980
For 12-month Evaluation Period Ending Date:	October 31, 2012

Facility Space Use Summary

Office Space	
Space Type	Office
Gross Floor Area (ft^2)	2,000
Weekly operating hours	45
Workers on Main Shift	3
Number of PCs	3
Percent Cooled	50% or more
Percent Heated	50% or more

Garage	
Space Type	Other - Service (Vehicle Repair/Service, Postal Service)
Gross Floor Area (ft^2)	7,000
Number of PCs o	0
Weekly operating hours o	45
Workers on Main Shift o	3

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	**Current** (Ending Date 10/31/2012)	**Baseline** (Ending Date 07/31/2011)	**Rating of 75**	**Target**	**National Median**
Energy Performance Rating	N/A	N/A	75	N/A	N/A
Energy Intensity					
Site (kBtu/ft2)	83	24	41	N/A	45
Source (kBtu/ft2)	130	81	64	N/A	96
Energy Cost					
\$/year	\$ 19,461.69	\$ 7,083.45	\$ 9,589.72	N/A	\$ 10,497.14
\$/ft2/year	\$ 2.16	\$ 0.79	\$ 1.06	N/A	\$ 1.17
Greenhouse Gas Emissions					
$MtCO_2e$/year	52	20	26	N/A	28
$kgCO_2e/ft^2$/year	6	2	3	N/A	3

More than 50% of your building is defined as Service (Vehicle Repair/Service, Postal Service). This building is currently ineligible for a rating. Please note the National Median column represents the CBECS national median data for Service (Vehicle Repair/Service, Postal Service). This building uses 36% more energy per square foot than the CBECS national median for Service (Vehicle Repair/Service, Postal Service).

Notes:
o - This attribute is optional.
d - A default value has been supplied by Portfolio Manager.

APPENDIX B: Energy Conservation Measure Calculations

ECM #1: Lower Garage Nighttime Setback

ECM Description	Energy Saved in kWh	Energy Saved in kW	Energy Saved in MMBtu	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback in Years
Lower Garage Nighttime Setback	-	-	62.4	$805	$0	0.0

Inputs		
Baseline Garage Setback	50	°F
Proposed Garage Setback	40	°F
Baseline Hours of Operation	3283	Hours
Proposed Hours of Operation	2035	Hours
# of Garage Heaters	4	#
Heater Capacity	125,000	Btu/HR
Total Heater Capacity	500,000	Btu/HR
Heater Fire Rate	10%	%
Cost of Natural Gas	$1.29	$/Therm
Total Implementation Cost	$0	$

Equations

Natural Gas Consumption (MMBtu) = [(Heater Energy) x (Hours) x (Heater Fire Rate)] / 1000000

Natural Gas Consumption (Therm) = [(Natural Gas Cons MMBtu) x (1000000)] / 100000

Natural Gas Cost ($) = [(Natural Gas Cons Therm) x (Cost of Natural Gas)]

Bin Data				Baseline						Proposed						Savings	
Temp Boundaries		Hours Dry Bulb															
Low Temp (°F)	High Temp (°F)	Weekday Unocc	Weekend	Garage Heater	Heater Energy (Btu/HR)	Heater Fire Rate (%)	Natural Gas Consumption (MMBtu)	Natural Gas Consumption (Therm)	Cost ($)	Garage Heater	Heater Energy (Btu/HR)	Heater Fire Rate (%)	Natural Gas Consumption (MMBtu)	Natural Gas Consumption (Therm)	Cost ($)	Natural Gas Consumption (Therm)	Cost ($)
94	96	0	3	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
92	94	0	5	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
90	92	1	2	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
88	90	3	5	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
86	88	3	1	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
84	86	9	13	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
82	84	10	15	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
80	82	16	31	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
78	80	32	36	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
76	78	22	37	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
74	76	38	62	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
72	74	71	60	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
70	72	105	85	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
68	70	140	108	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
66	68	190	142	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
64	66	179	104	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
62	64	194	100	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
60	62	183	118	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
58	60	103	84	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
56	58	131	115	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
54	56	127	90	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
52	54	108	59	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
50	52	119	56	N	0	0%	0	0	$0	N	0	0%	0	0	$0	0.0	$0
48	50	289	119	Y	500,000	10%	20	204	$263	N	0	0%	0	0	$0	204.0	$263
46	48	161	60	Y	500,000	10%	11	111	$143	N	0	0%	0	0	$0	110.5	$143
44	46	131	77	Y	500,000	10%	10	104	$134	N	0	0%	0	0	$0	104.0	$134
42	44	146	81	Y	500,000	10%	11	114	$146	N	0	0%	0	0	$0	113.5	$146
40	42	108	76	Y	500,000	10%	9	92	$119	N	0	0%	0	0	$0	92.0	$119
38	40	123	57	Y	500,000	10%	9	90	$116	Y	500,000	10%	9	90	$116	0.0	$0
36	38	123	68	Y	500,000	10%	10	96	$123	Y	500,000	10%	10	96	$123	0.0	$0
34	36	133	44	Y	500,000	10%	9	89	$114	Y	500,000	10%	9	89	$114	0.0	$0
32	34	116	51	Y	500,000	10%	8	84	$108	Y	500,000	10%	8	84	$108	0.0	$0
30	32	171	117	Y	500,000	10%	14	144	$186	Y	500,000	10%	14	144	$186	0.0	$0
28	30	82	68	Y	500,000	10%	8	75	$97	Y	500,000	10%	8	75	$97	0.0	$0
26	28	110	71	Y	500,000	10%	9	91	$117	Y	500,000	10%	9	91	$117	0.0	$0
24	26	120	72	Y	500,000	10%	10	96	$124	Y	500,000	10%	10	96	$124	0.0	$0
22	24	58	36	Y	500,000	10%	5	47	$61	Y	500,000	10%	5	47	$61	0.0	$0
20	22	73	45	Y	500,000	10%	6	59	$76	Y	500,000	10%	6	59	$76	0.0	$0
18	20	56	23	Y	500,000	10%	4	40	$51	Y	500,000	10%	4	40	$51	0.0	$0
16	18	38	16	Y	500,000	10%	3	27	$35	Y	500,000	10%	3	27	$35	0.0	$0
14	16	21	12	Y	500,000	10%	2	17	$21	Y	500,000	10%	2	17	$21	0.0	$0
12	14	26	28	Y	500,000	10%	3	27	$35	Y	500,000	10%	3	27	$35	0.0	$0
10	12	61	16	Y	500,000	10%	4	39	$50	Y	500,000	10%	4	39	$50	0.0	$0
Totals		3930	2468				164.2	1641.5	$2,118				101.8	1017.5	$1,313	624.0	$805

ECM #2: Insulate Hot Water Piping

ECM Description	Energy Saved in kWh	Energy Saved in kW	Energy Saved in MMBtu	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback in Years
Insulated Hot Water Piping	-	-	24.1	$311	$500	1.6

Inputs		
Length of Piping Run	50	Feet
Pipe Size	1.25	Inches
Operating Temperature	150	°F
Heat Loss w/o Insulation*	5193	Btu/HR
Heat Loss w/ 1" Insulation*	670	Btu/HR
Natural Gas Conversion	100,000	Btu/Therm
Operating Hours per Year	5,061	Hours
Insulation Type	Fiberglass	N/A
Ambient Temperature	70	°F
Cost per Foot to Insulate	$10.00	$
Cost of Natural Gas	$1.29	$/Gallon
Boiler Efficiency	95%	%

Equations

Fuel Savings =	[((Heat Loss per Hour x Operating Hours) / Boiler Efficiency) / Fuel Oil Conversion]
Annual Savings =	[Fuel Savings] x [Fuel Rate]
Total Energy Savings =	[Fuel Savings] x 138.6905
Simple Payback =	[Annual Savings] / [Est. Costs for Implementation]

* Based on Whole Building Design Guide's Energy Calculator for Horizontal Piping

Case	Heat Loss (Btu/HR)	Operating Hours	Total Heat Loss (Btu)	Equivalent Fuel (Therml)	Fuel Savings (Therml)	Cost Savings ($)
Baseline (w/o Insulation)	5,193	5,061	26,281,773	277	-	-
Proposed (w/ 1" Insulation)	670	5,061	3,390,870	36	241	$311

ECM #3: Weather-strip Exterior Door

ECM Description	Energy Saved in kWh	Energy Saved in kW	Energy Saved in MMBtu	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback in Years
Weather-strip Exterior Doors	162	-	3.3	$59	$200	3.4

Inputs		
# of Doors Req. Weatherstripping	1	Doors
Gap Area per Door	14	in^2
Pressure Difference	0.02	in. wc
Air Infiltration per Door	35	CFM
Space Heating Set point	68	°F
Space Cooling Set point	72	°F
Heating Hours	5,061	Hours
Cooling Hours	848	Hours
Annual Heating Load/Door	3,311	kBtuh/Yr
Annual Cooling Load/Door	554	kBtuh/Yr
Electric Rate	$0.10	$/kWh
Natural Gas Rate	$1.29	$/Therm
Cost to Weather-strip	$200	$/Door

Equations

Airflow Through Leakage Area =	2610 x [Gap Area] x [Pressure Difference] ^ (0.5)
Annual Heating Load =	{1.08 x [Airflow Through Leakage Area] x [72 - (Temperature of Unconditioned Air)] x [Annual Heating Hours]} / 1000
Annual Cooling Load =	{4.5 x [Airflow Through Leakage Area] x [(Outside Air Enthalpy - Room Enthalpy)] x [Annual Cooling Hours]} / 1000
Annual kWh Savings =	[Annual Cooling Load] / 3.412
Electric Cost Savings =	[Annual kWh Savings] x [Estimated Electric Rate]

* *Please refer to Appendix C for the Weather BIN data calculation spreadsheet used to calculate heating/cooling hours and load*

APPENDIX B-3: Project Summary Sheet

STRATEGY OF ENERGY SAVINGS								
Measure Description	Measure Status (See Notes)	Fuel Type Saved (See Notes)	Energy Saved in kWh	Energy Saved in kW	Energy Saved in MMBtu	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback in Years
ECM #1: Lower Garage Nighttime Setback	R	NGas	-	-	62	$805	$0	0.0
ECM #2: Insulate Heating Hot Water Piping	R	NGas	-	-	24	$311	$500	1.6
ECM #3: Weather-strip Exterior Doors	R	Elec, NGas	162	-	3	$59	$200	3.4
Total			162	0	90	$1,175	$700	0.6

Notes:

1. Measure Status: Implemented (I); Recommended (R); Further Study Recommended (RS); Not Recommended (NR)
2. Fuel Type Saved: Elec, NGas, Oil2, Oil4, Oil6, Coal, LPG. MMBtu = 1,000,000 Btu

APPENDIX C: BIN Data Calculation Spreadsheet Printouts

Weekdays (Occupied Days)

Hour	Yes/No	Weekday	Yes/No	Month	Yes/No
1	No	1	No	1	Yes
2	No	2	Yes	2	Yes
3	No	3	Yes	3	Yes
4	No	4	Yes	4	Yes
5	No	5	Yes	5	Yes
6	No	6	Yes	6	Yes
7	No	7	No	7	Yes
8	Yes			8	Yes
9	Yes			9	Yes
10	Yes			10	Yes
11	Yes			11	Yes
12	Yes			12	Yes
13	Yes				
14	Yes				
15	Yes				
16	Yes				
17	Yes				
18	No				
19	No				
20	No				
21	No				
22	No				
23	No				
0	No				

Inputs			
Heating STPT	Day	68	
Cooling SPT	72		
Drybulb T	72	F	
Wetbulb T	60.2	F	
Room Enthalpy	26.47	h	
Gap Area	13.5	Sq in	
Pressure Diff	0.02	in wc	
Est. Infiltration	34.60	CFM	

Temp Boundaries									Heating		Cooling	
Low	High											
F	F	DB (F)	Mid-pts	DP (F)	WB (F)	h (BTU/lb)	HR(gr/lb)	Hrs Dry Bulb	btu/hr	btu/year	btu/hr	btu/year
94.0	96.0	94 to 96	95	66.3	74.7	38.1	96.9	4	-	-	1,806	7,225
92.0	94.0	92 to 94	93	66.0	74.0	37.4	95.9	7	-	-	1,706	11,941
90.0	92.0	90 to 92	91	67.4	74.3	37.7	100.6	8	-	-	1,743	13,948
88.0	90.0	88 to 90	89	67.1	73.6	37.0	99.7	21	-	-	1,644	34,526
86.0	88.0	86 to 88	87	67.3	73.1	36.6	100.3	18	-	-	1,584	28,518
84.0	86.0	84 to 86	85	61.3	69.1	33.1	81.0	55	-	-	1,035	56,900
82.0	84.0	82 to 84	83	63.1	69.5	33.5	86.4	42	-	-	1,089	45,756
80.0	82.0	80 to 82	81	61.6	68.0	32.3	81.8	48	-	-	901	43,269
78.0	80.0	78 to 80	79	65.0	69.4	33.4	92.5	49	-	-	1,087	53,242
76.0	78.0	76 to 78	77	61.8	66.9	31.4	82.4	40	-	-	763	30,529
74.0	76.0	74 to 76	75	61.4	66.0	30.7	81.2	77	-	-	659	50,722
72.0	74.0	72 to 74	73	62.4	65.9	30.7	84.2	118	-	-	654	77,177
70.0	72.0	70 to 72	71	60.4	64.1	29.3	78.5	105	-	-	439	46,048
68.0	70.0	68 to 70	69	60.1	63.2	28.6	77.4	105	-	-	338	35,439
66.0	68.0	66 to 68	67	58.0	61.3	27.3	71.8	151	37	5,643	125	18,872
64.0	66.0	64 to 66	65	56.7	59.8	26.3	68.5	88	112	9,866	-	-
62.0	64.0	62 to 64	63	54.3	57.7	24.9	62.7	80	187	14,949	-	-
60.0	62.0	60 to 62	61	53.1	56.3	24.0	60.0	87	262	22,760	-	-
58.0	60.0	58 to 60	59	48.3	53.0	22.0	50.2	71	336	23,881	-	-
56.0	58.0	56 to 58	57	48.2	52.1	21.4	50.0	98	411	40,287	-	-
54.0	56.0	54 to 56	55	46.4	50.3	20.4	46.6	70	486	34,009	-	-
52.0	54.0	52 to 54	53	40.8	46.8	18.5	37.5	95	561	53,256	-	-
50.0	52.0	50 to 52	51	40.3	45.6	17.9	36.8	101	635	64,168	-	-
48.0	50.0	48 to 50	49	38.6	44.0	17.1	34.5	169	710	120,003	-	-
46.0	48.0	46 to 48	47	36.6	42.1	16.2	31.8	78	785	61,216	-	-
44.0	46.0	44 to 46	45	33.4	39.8	15.1	28.0	79	860	67,906	-	-
42.0	44.0	42 to 44	43	31.8	38.2	14.4	26.2	61	934	56,993	-	-
40.0	42.0	40 to 42	41	30.5	36.5	13.6	24.7	33	1,009	33,299	-	-
38.0	40.0	38 to 40	39	27.9	34.4	12.7	21.9	75	1,084	81,285	-	-
36.0	38.0	36 to 38	37	27.6	33.1	12.2	21.5	57	1,159	66,037	-	-
34.0	36.0	34 to 36	35	26.3	31.5	11.5	20.2	57	1,233	70,297	-	-
32.0	34.0	32 to 34	33	21.7	28.8	10.4	16.3	60	1,308	78,482	-	-
30.0	32.0	30 to 32	31	20.0	27.1	9.7	15.0	119	1,383	164,551	-	-
28.0	30.0	28 to 30	29	16.6	25.0	8.9	12.7	53	1,458	77,249	-	-
26.0	28.0	26 to 28	27	14.7	23.2	8.3	11.6	65	1,532	99,597	-	-
24.0	26.0	24 to 26	25	11.9	21.2	7.5	10.1	52	1,607	83,565	-	-
22.0	24.0	22 to 24	23	10.6	19.6	7.0	9.4	20	1,682	33,635	-	-
20.0	22.0	20 to 22	21	8.7	17.8	6.4	8.6	19	1,757	33,374	-	-
18.0	20.0	18 to 20	19	6.1	15.9	5.7	7.5	22	1,831	40,287	-	-
16.0	18.0	16 to 18	17	3.6	14.0	5.1	6.6	25	1,906	47,650	-	-
14.0	16.0	14 to 16	15	2.1	12.3	4.5	6.1	9	1,981	17,827	-	-
12.0	14.0	12 to 14	13	-0.1	10.5	4.0	5.5	12	2,055	24,666	-	-
10.0	12.0	10 to 12	11	-5.0	8.3	3.3	4.2	14	2,130	29,823	-	-
								2617	31,393	1,550,916	15,573	554,111
										1,551	kBtu/yr	554

Weekday (Unoccupied Nights)

Hour	Yes/No	Weekday	Yes/No	Month	Yes/No
1	Yes	1	No	1	Yes
2	Yes	2	Yes	2	Yes
3	Yes	3	Yes	3	Yes
4	Yes	4	Yes	4	Yes
5	Yes	5	Yes	5	Yes
6	Yes	6	Yes	6	Yes
7	Yes	7	No	7	Yes
8	No			8	Yes
9	No			9	Yes
10	No			10	Yes
11	No			11	Yes
12	No			12	Yes
13	No				
14	No				
15	No				
16	No				
17	No				
18	Yes				
19	Yes				
20	Yes				
21	Yes				
22	Yes				
23	Yes				
0	Yes				

Inputs			
Heating STPT	Day	50	
Cooling SPT	72		
Drybulb T	72	F	
Wetbulb T	60.2	F	
Room Enthalpy	26.47	h	
Gap Area	13.5	Sq in	
Pressure Diff	0.02	in wc	
Est. Infiltration	34.60	CFM	

Temp Boundaries									Heating		Cooling	
Low	High											
F	F	DB (F)	Mid-pts	DP (F)	WB (F)	h (BTU/lb)	HR(gr/lb)	Hrs Dry Bulb	btu/hr	btu/year	btu/hr	btu/year
94.0	96.0	94 to 96	95	66.3	74.7	38.1	96.9	0	-	-	1,806	-
92.0	94.0	92 to 94	93	66.0	74.0	37.4	95.9	0	-	-	1,706	-
90.0	92.0	90 to 92	91	67.4	74.3	37.7	100.6	1	-	-	1,743	1,743
88.0	90.0	88 to 90	89	67.1	73.6	37.0	99.7	3	-	-	1,644	4,932
86.0	88.0	86 to 88	87	67.3	73.1	36.6	100.3	3	-	-	1,584	4,753
84.0	86.0	84 to 86	85	61.3	69.1	33.1	81.0	9	-	-	1,035	9,311
82.0	84.0	82 to 84	83	63.1	69.5	33.5	86.4	8	-	-	1,089	8,715
80.0	82.0	80 to 82	81	61.6	68.0	32.3	81.8	14	-	-	901	12,620
78.0	80.0	78 to 80	79	65.0	69.4	33.4	92.5	27	-	-	1,087	29,338
76.0	78.0	76 to 78	77	61.8	66.9	31.4	82.4	16	-	-	763	12,211
74.0	76.0	74 to 76	75	61.4	66.0	30.7	81.2	36	-	-	659	23,714
72.0	74.0	72 to 74	73	62.4	65.9	30.7	84.2	63	-	-	654	41,205
70.0	72.0	70 to 72	71	60.4	64.1	29.3	78.5	99	-	-	439	43,417
68.0	70.0	68 to 70	69	60.1	63.2	28.6	77.4	132	-	-	338	44,551
66.0	68.0	66 to 68	67	58.0	61.3	27.3	71.8	172	-	-	125	21,497
64.0	66.0	64 to 66	65	56.7	59.8	26.3	68.5	168	-	-	-	-
62.0	64.0	62 to 64	63	54.3	57.7	24.9	62.7	183	-	-	-	-
60.0	62.0	60 to 62	61	53.1	56.3	24.0	60.0	174	-	-	-	-
58.0	60.0	58 to 60	59	48.3	53.0	22.0	50.2	98	-	-	-	-
56.0	58.0	56 to 58	57	48.2	52.1	21.4	50.0	123	-	-	-	-
54.0	56.0	54 to 56	55	46.4	50.3	20.4	46.6	118	-	-	-	-
52.0	54.0	52 to 54	53	40.8	46.8	18.5	37.5	106	-	-	-	-
50.0	52.0	50 to 52	51	40.3	45.6	17.9	36.8	111	-	-	-	-
48.0	50.0	48 to 50	49	38.6	44.0	17.1	34.5	265	37	9,904	-	-
46.0	48.0	46 to 48	47	36.6	42.1	16.2	31.8	154	112	17,266	-	-
44.0	46.0	44 to 46	45	33.4	39.8	15.1	28.0	123	187	22,984	-	-
42.0	44.0	42 to 44	43	31.8	38.2	14.4	26.2	135	262	35,317	-	-
40.0	42.0	40 to 42	41	30.5	36.5	13.6	24.7	103	336	34,644	-	-
38.0	40.0	38 to 40	39	27.9	34.4	12.7	21.9	116	411	47,687	-	-
36.0	38.0	36 to 38	37	27.6	33.1	12.2	21.5	111	486	53,928	-	-
34.0	36.0	34 to 36	35	26.3	31.5	11.5	20.2	129	561	72,316	-	-
32.0	34.0	32 to 34	33	21.7	28.8	10.4	16.3	109	635	69,251	-	-
30.0	32.0	30 to 32	31	20.0	27.1	9.7	15.0	162	710	115,032	-	-
28.0	30.0	28 to 30	29	16.6	25.0	8.9	12.7	77	785	60,431	-	-
26.0	28.0	26 to 28	27	14.7	23.2	8.3	11.6	99	860	85,097	-	-
24.0	26.0	24 to 26	25	11.9	21.2	7.5	10.1	114	934	106,511	-	-
22.0	24.0	22 to 24	23	10.6	19.6	7.0	9.4	54	1,009	54,489	-	-
20.0	22.0	20 to 22	21	8.7	17.8	6.4	8.6	67	1,084	72,614	-	-
18.0	20.0	18 to 20	19	6.1	15.9	5.7	7.5	55	1,159	63,720	-	-
16.0	18.0	16 to 18	17	3.6	14.0	5.1	6.6	32	1,233	39,465	-	-
14.0	16.0	14 to 16	15	2.1	12.3	4.5	6.1	19	1,308	24,853	-	-
12.0	14.0	12 to 14	13	-0.1	10.5	4.0	5.5	24	1,383	33,187	-	-
10.0	12.0	10 to 12	11	-5.0	8.3	3.3	4.2	56	1,458	81,621	-	-
								3668	14,949	1,100,317	15,573	258,008
										1,100	kBtu/yr	258

Weekend (Unoccupied)

Hour	Yes/No	Weekday	Yes/No	Month	Yes/No
1	Yes	1	Yes	1	Yes
2	Yes	2	No	2	Yes
3	Yes	3	No	3	Yes
4	Yes	4	No	4	Yes
5	Yes	5	No	5	Yes
6	Yes	6	No	6	Yes
7	Yes	7	Yes	7	Yes
8	Yes			8	Yes
9	Yes			9	Yes
10	Yes			10	Yes
11	Yes			11	Yes
12	Yes			12	Yes
13	Yes				
14	Yes				
15	Yes				
16	Yes				
17	Yes				
18	Yes				
19	Yes				
20	Yes				
21	Yes				
22	Yes				
23	Yes				
0	Yes				

Inputs		
Heating STPT	Day	50
Cooling SPT	72	
Drybulb T	72	F
Wetbulb T	60.2	F
Room Enthalpy	26.47	h
Gap Area	13.5	Sq in
Pressure Diff	0.02	in wc
Est. Infiltration	34.60	CFM

Temp Boundaries									Heating		Cooling	
Low	High											
F	F	DB (F)	Mid-pts	DP (F)	WB (F)	h (BTU/lb)	HR(gr/lb)	Hrs Dry Bulb	btu/hr	btu/year	btu/hr	btu/year
94.0	96.0	94 to 96	95	66.3	74.7	38.1	96.9	3	-	-	1,806	5,419
92.0	94.0	92 to 94	93	66.0	74.0	37.4	95.9	5	-	-	1,706	8,529
90.0	92.0	90 to 92	91	67.4	74.3	37.7	100.6	2	-	-	1,743	3,487
88.0	90.0	88 to 90	89	67.1	73.6	37.0	99.7	5	-	-	1,644	8,220
86.0	88.0	86 to 88	87	67.3	73.1	36.6	100.3	1	-	-	1,584	1,584
84.0	86.0	84 to 86	85	61.3	69.1	33.1	81.0	13	-	-	1,035	13,449
82.0	84.0	82 to 84	83	63.1	69.5	33.5	86.4	15	-	-	1,089	16,341
80.0	82.0	80 to 82	81	61.6	68.0	32.3	81.8	31	-	-	901	27,944
78.0	80.0	78 to 80	79	65.0	69.4	33.4	92.5	36	-	-	1,087	39,117
76.0	78.0	76 to 78	77	61.8	66.9	31.4	82.4	37	-	-	763	28,239
74.0	76.0	74 to 76	75	61.4	66.0	30.7	81.2	62	-	-	659	40,841
72.0	74.0	72 to 74	73	62.4	65.9	30.7	84.2	60	-	-	654	39,242
70.0	72.0	70 to 72	71	60.4	64.1	29.3	78.5	85	-	-	439	37,277
68.0	70.0	68 to 70	69	60.1	63.2	28.6	77.4	108	-	-	338	36,451
66.0	68.0	66 to 68	67	58.0	61.3	27.3	71.8	142	-	-	125	17,747
64.0	66.0	64 to 66	65	56.7	59.8	26.3	68.5	104	-	-	-	-
62.0	64.0	62 to 64	63	54.3	57.7	24.9	62.7	100	-	-	-	-
60.0	62.0	60 to 62	61	53.1	56.3	24.0	60.0	118	-	-	-	-
58.0	60.0	58 to 60	59	48.3	53.0	22.0	50.2	84	-	-	-	-
56.0	58.0	56 to 58	57	48.2	52.1	21.4	50.0	115	-	-	-	-
54.0	56.0	54 to 56	55	46.4	50.3	20.4	46.6	90	-	-	-	-
52.0	54.0	52 to 54	53	40.8	46.8	18.5	37.5	59	-	-	-	-
50.0	52.0	50 to 52	51	40.3	45.6	17.9	36.8	56	-	-	-	-
48.0	50.0	48 to 50	49	38.6	44.0	17.1	34.5	119	37	4,447	-	-
46.0	48.0	46 to 48	47	36.6	42.1	16.2	31.8	60	112	6,727	-	-
44.0	46.0	44 to 46	45	33.4	39.8	15.1	28.0	77	187	14,388	-	-
42.0	44.0	42 to 44	43	31.8	38.2	14.4	26.2	81	262	21,190	-	-
40.0	42.0	40 to 42	41	30.5	36.5	13.6	24.7	76	336	25,563	-	-
38.0	40.0	38 to 40	39	27.9	34.4	12.7	21.9	57	411	23,432	-	-
36.0	38.0	36 to 38	37	27.6	33.1	12.2	21.5	68	486	33,037	-	-
34.0	36.0	34 to 36	35	26.3	31.5	11.5	20.2	44	561	24,666	-	-
32.0	34.0	32 to 34	33	21.7	28.8	10.4	16.3	51	635	32,402	-	-
30.0	32.0	30 to 32	31	20.0	27.1	9.7	15.0	117	710	83,079	-	-
28.0	30.0	28 to 30	29	16.6	25.0	8.9	12.7	68	785	53,368	-	-
26.0	28.0	26 to 28	27	14.7	23.2	8.3	11.6	71	860	61,029	-	-
24.0	26.0	24 to 26	25	11.9	21.2	7.5	10.1	72	934	67,270	-	-
22.0	24.0	22 to 24	23	10.6	19.6	7.0	9.4	36	1,009	36,326	-	-
20.0	22.0	20 to 22	21	8.7	17.8	6.4	8.6	45	1,084	48,771	-	-
18.0	20.0	18 to 20	19	6.1	15.9	5.7	7.5	23	1,159	26,646	-	-
16.0	18.0	16 to 18	17	3.6	14.0	5.1	6.6	16	1,233	19,733	-	-
14.0	16.0	14 to 16	15	2.1	12.3	4.5	6.1	12	1,308	15,696	-	-
12.0	14.0	12 to 14	13	-0.1	10.5	4.0	5.5	28	1,383	38,718	-	-
10.0	12.0	10 to 12	11	-5.0	8.3	3.3	4.2	16	1,458	23,320	-	-
								2468	14,949	659,809	15,573	323,889
										660	kBtu/yr	324

APPENDIX D: Glossary and Method of Calculations

Net ECM Cost: The net ECM cost is the cost experienced by the customer, which is typically the total cost (materials + labor) of installing the measure. The total cost is expressed in the summary for each ECM.

Simple Payback: This is a simple measure that displays how long the ECM will take to break-even based on the annual energy and maintenance savings of the measure.

ECM Lifetime: This is included with each ECM so that the owner can see how long the ECM will be in place and whether or not it will exceed the simple payback period. Additional guidance for calculating ECM lifetimes can be found below. This value can come from manufacturer's rated lifetime or warranty, the ASHRAE rated lifetime, or any other valid source.

Operating Cost Savings (OCS): This calculation is an annual operating savings for the ECM. It is the difference in the operating, maintenance, and / or equipment replacement costs of the existing case versus the ECM. In the case where an ECM lifetime will be longer than the existing measure (such as LED lighting versus fluorescent) the operating savings will factor in the cost of replacing the units to match the lifetime of the ECM. In this case or in one where one-time repairs are made, the total replacement / repair sum is averaged over the lifetime of the ECM.

Return on Investment (ROI): The ROI is expresses the percentage return of the investment based on the lifetime cost savings of the ECM. This value can be included as an annual or lifetime value, or both.

Fuel Oil Rate and Electric Rate ($/gallon and $/kWh): The fuel oil rate and electric rate used in the financial analysis is the total annual energy cost divided by the total annual energy usage for the 12 month billing period studied. The graphs of the electric rates reflect the total monthly energy costs divided by the monthly usage, and display how the average rate fluctuates throughout the year. The average annual rate is the only rate used in energy savings calculations.

APPENDIX E: IPMVP Protocols

IPMVP provides four Options for determining savings (A, B, C and D). The choice among the Options involves many considerations. The selection of an IPMVP Option is the decision of the designer of the M&V program for each project. These options are summarized below:

Option (A) Retrofit Isolation: Key Parameter Measurement

Savings are determined by field measurement of the key performance parameter(s) which define the energy use of the energy conservation measure's (ECM) affected system(s) and/or the success of the project. Parameters not selected for field measurement are estimated. Estimates can be based on historical data, manufacturer's specifications, or engineering judgment. Documentation of the source or justification of the estimated parameter is required.
Typical applications may include a lighting retrofit, where the power drawn can be monitored and hours of operation can be estimated.

Option (B) Retrofit Isolation: All Parameter Measurement

Savings are determined by field measurement of all key performance parameters which define the energy use of the ECM-affected system.
Typical applications may include a lighting retrofit where both power drawn and hours of operation are recorded.

Option (C) Whole Facility

Savings are determined by measuring energy use at the whole facility or sub-facility level. This approach is likely to require a regression analysis or similar to account for independent variables such as outdoor air temperature, for example.
Typical examples may include measurement of a facility where several ECMs have been implemented, or where the ECM is expected to affect all equipment in a facility.

Option (D) Calibrated Simulation

Savings are determined through simulation of the energy use of the whole facility, or of a sub-facility. Simulation routines are demonstrated to adequately model actual energy performance measured in the facility. This Option usually requires considerable skill in calibrated simulation.
Typical applications may include measurement of a facility where several ECMs have been implemented, but no historical energy data is available.

APPENDIX F: Method of Analysis

Assumptions and Tools

Savings Estimates:	Established/standard industry spreadsheets
Cost Estimates:	RS Means 2012 (Facilities Maintenance & Repair Cost Data)
	RS Means 2012 (Building Construction Cost Data)
	RS Means 2012 (Mechanical Cost Data)
	Published and established specialized equipment material and labor costs
	Cost estimates also based on utility bill analysis and prior experience with similar projects

DISCLAIMER

Steven Winter Associates, Inc. (SWA) prepared this engineering assessment and was using the most current and accurate fuel consumption data available for the site. The estimated savings that are projected are intended to help guide the owner toward the best energy choices. The costs and savings are subject to fluctuations in weather, variations in quality of maintenance, changes in prices of fuel, materials, and labor, and other factors. Although we cannot guarantee savings or costs estimates, we suggest that you use this report for economic analysis of the building and as a means to estimate future cash flow.

* * *

PLEASE NOTE:

THE RECOMMENDATIONS PRESENTED IN THIS REPORT ARE BASED ON THE RESULTS OF ANALYSIS, INSPECTION, AND PERFORMANCE TESTING OF A SAMPLE OF COMPONENTS OF THE BUILDING SITE. ALTHOUGH CODE-RELATED ISSUES MAY BE NOTED, SWA STAFF HAVE NOT COMPLETED A COMPREHENSIVE EVALUATION FOR CODE-COMPLIANCE. THE OWNER(S) AND MANAGER(S) OF THE BUILDING(S) CONTAINED IN THIS REPORT ARE REMINDED THAT ANY IMPROVEMENTS SUGGESTED IN THIS SCOPE OF WORK MUST BE PERFORMED IN ACCORDANCE WITH ALL LOCAL, STATE, AND FEDERAL LAWS AND REGULATIONS THAT APPLY TO SAID WORK. PARTICULAR ATTENTION MUST BE PAID TO ANY WORK WHICH INVOLVES HEATING AND AIR MOVEMENT SYSTEMS AND ANY WORK WHICH WILL INVOLVE THE DISTURBANCE OF PRODUCTS CONTAINING MOLD, ASBESTOS, OR LEAD.