BALES ENERGY ASSOCIATES

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ENERGY STUDY
For the
Ashby Town Office Building

Energy Analysis of Measures
Through the
Massachusetts Clean Energy Center
Green Communities Program

Completed By:

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Table of Contents

Introduction

Bales Energy Associates, an energy efficiency engineering firm, was contracted to provide an energy study for selected Town-owned buildings in Ashby, Massachusetts. The study was funded through grant funds provided by Green Communities Program of the Massachusetts Clean Energy Center. The building evaluated in this report is the Town Office Building.

Bart Bales, PE, MSME, senior engineer at Bales Energy Associates, visited the site, reviewed energy usage & billing information, examined relevant equipment and systems, and developed energy analyses and recommendations with regard to each building's energy related systems.

Given the nature of the funding process for the Green Communities Program, a preliminary site visit identified specific measures for inclusion in the current report. Other potential measures indentified in the course of this study have been noted and may be considered for evaluation for future Green Communities grant applications.

The town office building serves as an office space for town personnel and as a meeting space for various town boards and committees. The town office building is a three-story wood frame building located in front of the police station and adjacent to the elementary school. . One end section of basement of the building has been finished as a space for audio-visual functions. The remainder of the basement comprises the boiler mechanical room and unfinished storage spaces. The unused area is large and has the potential to be finished for other uses.

Note: Through the course of this study, BEA has evaluated specific system improvement opportunities including building enclosure, HVAC, controls, domestic hot water and other mechanical and electrical systems. This analysis was completed to a level sufficient for recommending and calculating potential energy and dollar savings and for estimating costs for recommended energy system improvements to aid the client in making an informed decision on implementation of the recommendations provided.

Disclaimer: An added design phase for development of final design documents for construction implementation is assumed and recommended to follow this report. This study may be used as a starting point with supporting information for development of final system design and specification documents.

Verification of all field measurements and recalculation of all heat load and final system sizing calculations are the responsibility of the final designer of record. Design implementation may be accomplished by either of the following methods: plan-specification-bid process or performance specification-design-build process.

Note: Subsequent to the completion of the report, the Town of Ashby requested the inclusion of a replacement window measure. The Town also elected to employ a modified insulation approach for the basement windows. This information has been added to the appendix where updated executive summary, fuel energy reduction and greenhouse gas impact charts can also be found.

Executive Summary

Energy Conservation Opportunities Evaluated

During the proposal and contracting process, specific energy conservation measures needing evaluation were identified at each facility. ASHRAE Level II calculations were completed for all measures evaluated.

BEA has approached the Ashby Town Office Building using a "whole systems thinking" approach. Improvements in various systems have interactive impacts with other systems. Key conclusions are the following:

1. **Controls Systems Recommendation**
   - **To improve temperature control during occupied periods and to provide temperature setback for areas during unoccupied periods, install networked, microprocessor-based, programmable thermostats to control the operation of existing circulator pumps, air handlers, and heat pumps in the building.**
   - **In the offices indicated in the table in the appendix, install programmable thermostats to control fin-tube radiation.**
   - **In the remainder of the spaces listed, install new thermostatically controlled radiator valves with remote temperature sensors.**
   - **Use networkable capability to allow systems to be scheduled locally and remotely using via internet connection.**
2. **Building Enclosure Improvements:**
   - **Insulate 1st and 2nd Floor Exterior Walls**
   - **Insulate & Air Seal the 3rd Floor**
   - **Insulate & Air Seal the Basement**
   - **Install Exterior Storm Windows on the 2nd Floor**
3. **Heating & Domestic Hot Water System Recommendation**
   - **Replace the existing boilers with premium efficiency, modulating, condensing boilers capable of meeting 100% of the building's total design load.**
   - **Design the piping system from the new boilers to allow for entire building to be heated by both boilers (as opposed to boilers dedicated to specific spaces/floor(s) as they are now).**
   - **Provide for separate scheduling of circulators serving various zones.**
   - **Include new controls and control strategies including outdoor temperature reset and parallel cascading boiler control**
   - **Remove the electric hot water heater and install mini-tank water heaters at the points of use.**

The costs, savings, and economic payback for these energy conservation measures are presented in the following Executive Summary Chart. The values shown in the Executive Summary Table represent the savings calculated for the measures taken in the order shown. Savings interactions between measures have been included. The most important metric is the performance as shown in the totals for all measures combined.

The calculations supporting each measure are included in the appendices.

Executive Summary Chart *(see appendix for updated chart, as of 2/4/15)*

Executive Summary Chart

Green Communities Study

Natural Gas	Propane	Oil	Electricity
$1.62 per therm	per gal	per gal	$0.20 per kWh

Measure #	Measure Description (RTM = Renewable Thermal Measure) (ECM = Energy Conservation Measure)	Available Incentive ($)	Fuel Energy Savings (% of base)	Annual Savings ($ / yr)	Full Cost				Incremental Cost Difference *			
							After Incentive				After Incentive	
					Cost ($)	Payback (yrs)	Cost ($)	Payback (yrs)	Cost ($)	Payback (yrs)	Cost ($)	Payback (yrs)
ECM 1	Energy Management System Controls	$ -	11%	$ 2,373	$ 19,382	8.2	$ 19,382	8.2	$ 19,382	8.2	$ 19,382	8.2
ECM 2	Space Heating With Condensing Boilers	$ 2,000	15%	$ 3,027	$ 33,986	11.2	$ 31,986	10.6	$ 19,354	6.4	$ 17,354	5.7
ECM 3.1	1st & 2nd Floor Wall Insulation	$ -	22%	$ 4,449	$ 21,334	4.8	$ 21,334	4.8	$ 21,334	4.8	$ 21,334	4.8
ECM 3.2	3rd Floor Ceiling/Wall Insulation & Air Sealing	$ -	14%	$ 2,883	$ 8,092	2.8	$ 8,092	2.8	$ 8,092	2.8	$ 8,092	2.8
ECM 3.3	Basement Insulation & Air Sealing	$ -	3%	$ 679	$ 4,061	6.0	$ 4,061	6.0	$ 4,061	6.0	$ 4,061	6.0
ECM 4	Storm Window Installation	$ -	3%	$ 606	$ 12,553	20.7	$ 12,553	20.7	$ 12,553	20.7	$ 12,553	20.7
	Totals:	*$ 2,000*	*68%*	*$ 14,018*	*$ 99,408*	*7.1*	*$ 97,408*	*6.9*	*$ 84,775*	*6.0*	*$ 82,775*	*5.9*

*Incremental = (Full Cost) - (Replacement-In-Kind of Existing)

Fuel Energy Reduction Chart *(see appendix for updated chart, as of 2/4/15)*

		Fuel Energy Impact						
		Natural Gas	Propane	Oil	Electricity			
		100.0 kBtu / therm	92.5 kBtu / gal	138.7 kBtu / gal	3.413 kBtu / kWh			
Baseline Energy Use		Natural Gas	Propane	Oil	Electricity	Fuel Energy		
Space Heating		12,754				1,275,406		
Measure #	Measure Description (RTM = Renewable Thermal Measure) (ECM = Energy Conservation Measure)	Fuel Usage After Measures: Natural Gas (therms / yr)	Propane (gal / yr)	Oil (gal / yr)	Electricity (kWh / yr)	Fuel Energy Use (kBtu / yr)	Fuel Energy Savings (kBtu / yr)	Savings As % of Baseline
ECM 1	Energy Management System Controls	11,288				1,128,792	146,614	11%
ECM 2	Space Heating With Condensing Boilers	9,418				941,781	187,011	15%
ECM 3.1	1st & 2nd Floor Wall Insulation	6,669				666,892	274,889	22%
ECM 3.2	3rd Floor Ceiling/Wall Insulation & Air Sealing	4,888				488,791	178,101	14%
ECM 3.3	Basement Insulation & Air Sealing	4,468				446,814	41,977	3%
ECM 4	Storm Window Installation	4,093				409,348	37,466	3%
						Totals:	*866,058*	*68%*

Existing Conditions

Facility Description

The Ashby Town Office Building facility is a three story structure with a partly finished basement. The entire building has a heated square footage of approximately 16,000 ft^2 (this includes all heated spaces inside the thermal area, not just those currently "occupied").

The building is used as office and meeting space for town officers, personnel and the several boards and committees that exist in the town. Consideration of consolidation of functions into smaller spaces or utilizing existing spaces for added functions currently housed in other facilities could result in energy savings for overall town operations.

(For example, the consultant noted constraints and physical and mechanical systems limitations in the building currently housing the adjacent Police Department. Consideration of departmental relocation is beyond the scope of the current study. If useful, Bales Energy Associates can provide added services to aid the town in considerations with regard to adaptive re-use of under-utilized portions of the Town Hall Building.)

Utility Energy Use

Utility data for a multi-year period was collected and reviewed. Data for the (May 2013 - April 2014) reference year used for heat balance purposes is tabulated and reported in the appendices. For that period, the annual electrical usage was 48,224 kWh; the annual natural gas consumption was 12,754.1 Energy usage expressed in common energy units resulted in annual totals of 1,439,946 kBtu per year. Per heated square foot of floor area, energy usage is a relatively high value of 89.9 $kBtu/ft^2$.

Building Enclosure

This facility is of wood framed construction throughout (with the exception of the new elevator and associated components) on a stone foundation. It has a moderately pitched, asphalt-shingled roof over wood framing.

The attic/ceilings are insulated to different levels. The thermal barrier for part of the building is the second floor ceiling, except for the portions of the building in which the attic has been remodeled for use as occupied spaces for the council on aging, the veterans office and the cafe.

The exterior walls are not insulated.

The basement is approximately 20% occupied and the remaining space is used for storage and mechanicals.

The windows are large, wood construction, single-pane units and many are not operational and do not seal tightly. The 1st floor units have had exterior storm windows applied so they function better as air and thermal barriers than ones without. There are triple-track, exterior storm windows in place on the first floor that, when secured during the heating season, would greatly improve the performance of the old window units. The windows on the second and third floors have no storms.

Exterior entry doors are wood framed with approximately 45% glazed area.

Below is a picture taken of the interior of one of the offices in the building.

1: Typical office space in the building

Building Enclosure Improvement Recommendations

- **Insulate 1st and 2nd Floor Exterior Walls -** This measure was developed based on insulating the wall cavities on the 1st and 2nd floors with blown in cellulose through a 'drill & plug' process. This will improve the R-value of those wall components to approximately R-14 (as compared to R-3 in the existing baseline)
- **Insulate & Air Seal the 3rd Floor -** This portion of the enclosure improvement targets the roof, ceiling & walls of the third floor (mainly surrounding the center section) and the top sections of the two main stairwells. The improvement is to air-seal the accessible ceiling above the 'cafe' and small 'offices' and insulate those areas to R-60. The wall section between those occupied spaces and the attic storage space would also be insulated to R-11 and have sheetrock installed on the back side in an effort to limit future damage to the insulation. Ensuring an continuous air and thermal barrier at the top of the stairwells is also included here. When performing the roof insulating, venting the underside of the roof deck should be considered.
- **Insulate & Air Seal the Basement -** Use spray foam to insulate the rim joist section connecting the wood exterior walls to the stone foundation. This measures includes air sealing and installing rigid foam where the existing windows are currently boarded.

- **Install Exterior Storm Windows on the 2nd Floor -** A measure was developed to install exterior storm windows on the 2nd floor windows.

Heating, Ventilation & Air Conditioning Systems

Boiler

The Town Office Building is heated by two natural gas-fired hydronic units boilers: a Weil-McLain 778 boiler (778) equipped with a Powerflame model JR30A burner and a Weil-McLain boiler Model 676. The combined net output of the two is 1,019 MBH (664 and 355 respectively). The boilers are cast-iron, atmospheric units located in the basement of the building. Boiler room and basement distribution piping is insulated. Rated combustion efficiency of this boiler is approximately 83%.

One boiler is approximately eight years old, and provides heat for the basement, second floor and third floor. The second boiler is twenty years old, and heats the first floor only.

On the third floor, there is a split system air source heat pump (ASHP) that serves council on aging (COA) space. The unit is a Sanyo model CMH1822 (outdoor unit) heat pump capable of providing either heating or cooling, depending upon space conditioning needs.. There are two wall mounted indoor "heads" connected to the main heat pump.

As currently configured, the heat pumps condenser unit is located in the unfinished portion of the attic adjacent to the conditioned space it serves. This attic area is not well isolated from the conditioned spaces in the attic. The wall separating the two areas is not insulated. The roof above the conditioned space is not well insulated. In addition, the air handler serving the "café" area in the finished portion of the third floor also delivers heated air into the same attic storage area in which the heat pump's condenser is located. The duct which delivers this air to the attic storage area is not insulated. There are very large gaps around the ductwork where it penetrates the wall between the two spaces.

In short, the thermal boundary between the finished, conditioned spaces of the attic and the unfinished spaces in the attic is not clearly defined. The air handler treats the attic as a tempered space and delivers heat to it. The heat pump utilizes the space as an "outside" area from which to extract or dump thermal energy.

The current configuration results in large energy losses from the conditioned attic area of the attic by conduction and large energy losses from the building as a whole because such a breach in the thermal barrier at the attic level sets up condition for large air infiltration from the building (due to the "stack" effect causing warm air to rise out of the top of the building which causes cold outside air to leak into the lower sections of the building.)

Energy improvement recommendations with regard to insulation and air sealing at the attic level, serve to reduce conduction and infiltration heat losses from the attic and to address the interrelated effects described here.

The modeled design heat load for the building as currently configured and designed is approximately 544,000 Btu/hr.

After the completion of the recommended Energy Conservation Measures (ECM), the design heat load of the building was calculated to be 280,000 Btu/hr. Sizing of the replacement heating system in this report assumes the lower design heat load required after implementation of the recommended enclosure improvement measures. All estimates and quotes were based on this value.

Note: Any future quotations and heat load calculations should take into account any design heat load reductions due to implementation of the measures recommended in this report.

Recommendation: **Install Condensing Boilers**

Replace the existing boilers with natural-gas-fired premium efficiency condensing boilers with sufficient total capacity to meet the building's total design load after all recommended enclosure measures are completed.

Condensing boilers are designed and constructed to safely capture the latent energy in boiler exhaust by condensing the water vapor. This condensate contains sulfuric acid. For this reason condensing boilers must be constructed of materials designed to withstand such corrosive condensate. Quality condensing boilers are constructed with a stainless steel heat exchanger and with condensate neutralization to allow for environmentally acceptable disposal of condensate to drain.

The boiler system should also be installed with sealed combustion. In such a system configuration, combustion air is brought from outdoors via a plastic intake pipe to directly provide air to the burner. The low-temperature exhaust may be vented from the building typically via plastic pipe as well.

Locate the new boilers in the same area as the existing boilers. Remove existing boilers.

Other system improvements included in this measure are:

- The new boilers will be interconnected with the microprocessor-based scheduling and temperature control system addressed a separate measure to provide scheduling of occupied and unoccupied periods.
- The new boilers will reset boiler operating temperatures based upon outdoor air temperature information provided by an outdoor air temperature sensor. This sensor will also provide information to the building temperature control system to determine when boilers and circulators shall run for occupied and unoccupied periods.

System costs and energy and dollar savings for this measure are reported in the appendix of this report.

Heating Distribution System

In the basement, there are unit heaters spaced throughout the storage section of the basement There also an air handling unit dedicated to the office space in the basement.

On the first and second floors, the heating distribution system consists of hydronic piping carrying heated boiler water through wall-mounted, fin-tube convectors. The radiators on the first floor are old (possibly 20+ years old); the radiators on the second floor are newer (approximately twelve years old). See photos below.

2: Fin-tube heating elements in the Town Office Building (left- first floor, right - second floor)

On the third floor, there is another air handler serving the café and the veterans' office. This unit also currently sends approximately 50% of its heated air to the attic storage space.

As already noted, on the third floor, there are also two split system heat pump indoor units serving the Council on Aging.

Temperature & Ventilating Control System

On the first floor, the thermostatic radiator valves installed on individual panel radiators are very old; many are reported to not be operating properly. The newer fin-tube radiators on the second floor have working thermostatic radiator valves. These devices may be manually set by turning to a setting of 1 to 5.

Based upon temperature in the room these devices open or close the piping orifice to provide local temperature control.

Operation of the building's four circulation pumps is controlled by zone thermostats. There is a digital programmable thermostat on the first floor and manual thermostat on the second floor. The building occupants indicate that thermostat settings are left unchanged and temperatures are not scheduled for manual or setback at night or on weekends.

Temperature Controls Improvement Recommendation:

Install networked programmable thermostats to control the operation of existing circulator pumps, air handlers, and heat pumps in the building. In the offices indicated in the table in the appendix, install programmable thermostats to control fin-tube radiation. In the remainder of the spaces listed, install new thermostatically controlled radiator valves with remote temperature sensors.

Domestic Hot Water System

Domestic hot water is provided by a 12 gallon electric water heater. The copper, hot water pipes that feed to the upper floor sinks and located in the basement are not insulated. There is also a smaller electric water heater located on the third floor to serve the 'cafe' demand.

Bales Energy Associates recommends discontinuing the use of the existing electric water heater in the basement and installation of two point-of-use mini-tank water heaters to serve the first floor lavatories. This will provide hot water to these spaces more promptly and eliminate the heat losses from the un-insulated hot water pipes.

Cooling System

The building's occupants currently use several portable window air conditioners as needed for cooling. They are removed from the windows and stored in the basement prior to heating season. The third floor council on aging space is cooled by the air-source heat pump system.

Lighting

Neither interior nor exterior lighting were addressed in this report. (It is the consultant's understanding that lighting improvements are not eligible for funding through the Green Communities program.

APPENDICES

UTILITY INFORMATION

May 2013 - Apr 2014	Billed Energy Use Table for Electricity & Fuel									
Building Name	**Town Office Building**									
Owner	**Town of Ashby**									
Month	Electricity KWH	Demand KW	Delivery Charged $	Supplier Charged $	Electricity Total $	Natural Gas therms	Natural Gas Delivery $	Natural Gas Supplier $	Natural Gas Total $	**Energy $ Totals**
May 2013	3,195	15.0	$396	$204	$600	605.14	$540	$355	$895	**$1,495**
Jun	3,668	19.0	$457	$258	$716				$0	**$716**
Jul	4,272	18.5	$487	$324	$810				$0	**$810**
Aug	3,555	15.5	$407	$271	$678				$0	**$678**
Sept	3,679	22.0	$473	$258	$731				$0	**$731**
Oct	3,479	24.0	$479	$235	$715	304.65	$293	$174	$467	**$1,182**
Nov	3,634	18.5	$430	$256	$686	1,504.70	$1,140	$1,054	$2,194	**$2,881**
Dec	4,407	22.0	$515	$405	$920	2,001.32	$1,454	$1,488	$2,942	**$3,861**
Jan 2014	4,872	23.0	$560	$545	$1,105	2,439.60	$1,756	$1,902	$3,658	**$4,764**
Feb	5,063	20.5	$548	$590	$1,138	2,557.13	$1,837	$2,130	$3,967	**$5,106**
Mar	4,663	22.0	$538	$402	$940	2,179.78	$1,577	$2,612	$4,189	**$5,129**
Apr 2014	3,737	20.5	$463	$270	$733	1,161.74	$874	$1,458	$2,332	**$3,065**
Annual (Units)	48,224		$5,755	$4,019	$9,774	12,754.1	$9,472	$11,172	$20,644	**$30,418**
Heating Season (Units)	29,855				$6,238	12,148.9			$19,749	**$19,202**
Annual ($/Unit)			$0.12	$0.08	$0.20		$0.74	$0.88	$1.62	
Heating Season ($/Unit)					$0.21				$1.63	
	Electricity kBtu					**Natural Gas kBtu**	**Energy Use Total (kBtu)**			
Annual (kBtu)	164,540					1,275,406	1,439,946			**Energy $ Totals**
Heating Season (kBtu)	101,865					1,214,892	1,316,757			
							Total (kBtu/sf)			**($/sf)**
Annual (kBtu/sf)	10.3					79.7	**89.9**			**$1.90**
Heating Season (kBtu/sf)	6.4					75.9	**82.2**			**$1.20**
Building Name	**Town Office Building**							**Heated Square Footage**		**16,011**

HEAT BALANCE & PEAK DESIGN LOAD INFORMATION

BASELINE: Temperature & Schedule Information

Building Name: Town Office Building

Total Heating Days	212	Floor SF	
Outdoor Winter Temperature	35	16,011	

	Wing name	Occupied Temp.	Unoccupied Temp. Night	Unoccupied Temp. Off days	Htg System Occ. Hrs per day *	Schedule	Occ Level Heating Days
1	Basement - Occupied	68	68	68	24	5 days per week	151
2	First floor	68	68	68	24	5 days per week	151
3	Second floor	68	68	68	24	5 days per week	151
4	Third floor - Occupied	70	70	70	24	5 days per week	151
5	Basement - Unoccupied	60	60	60	24	5 days per week	151
6	Third floor - Unoccupied	55	55	55	24	5 days per week	151

BASELINE: HEAT BALANCE

GAINS AND LOSSES	BTU/HEATING SEASON*1E6
CONDUCTION LOSSES	-860.3
INFILTRATION LOSSES	-311.7
VENTILATION LOSSES	0.0
SOLAR GAIN	94.7
OCCUPANT GAIN	1.5
ELECTRICAL GAIN	96.8
NET HEATING DEMAND	-979.0

Net Heating Demand (MMbtu)	/Energy Required (MMbtu)	Seasonal Efficiency %
979.0	1,275.4	77%

Peak Design Heat Load *(AFTER ALL ECMs)*

Design CFM	1,634	cfm
* *(Constant)*	1.08	
=	1,765.1	
+ *Design UA*	2,232.3	
= *Total*	3,997.4	
* *design Delta T*	70	degrees
/	1,000	
= *Equipment Sizing*	**280**	**kBtu/hr**

BASELINE:		HEAT LOSS COEFFICIENTS				
Zone #	Building Zone		U-Value (BTU/hr-sf-F)	Area (sf)		UA-Value (BTU/hr-F)
1	**Basement - Occupied**					
		Occupied Basement Walls	0.072	846		61
		Below Grade Slab	0.033	94	per l.f.	3
				Wing UA Total	**64.2**	
2	**First floor**					
		Wall 1	0.346	2,976		1,028
		Doors 1	0.690	105		72
		Windows 1 - w/ storm	0.570	642		366
				Wing UA Total	**1466.9**	
3	**Second floor**					
		Wall 1	0.346	2,990		1,033
		Doors 1	0.690	21		14
		Windows 2 - NO storm	0.900	713		642
				Wing UA Total	**1689.1**	
4	**Third floor - Occupied**	3rd floor ceiling, café & veterans	0.228	875		200
		COA Roof 2	0.054	1,366		74
		COA Walls	0.050	358		18
		Wall 1	0.346	275		95
		Windows 2 - NO storm	0.900	75		68
		COA Skylight	0.870	14		12
				Wing UA Total	**466.4**	
5	**Basement - Unoccupied**					0
		Basement Wall Above Grade	0.346	811		280
		Basement Wall Below Grade	1.271	230	per l.f.	292
		Boarded Windows - Basement	1.471	224		329
		Below Grade Slab	0.033	230	per l.f.	8
				Wing UA Total	**909.6**	
6	**Third floor - Unoccupied**	3rd floor storage Roof 3	0.484	2,065		1,000
		Wall 1	0.574	328		188
						0
				Wing UA Total	**1188.1**	
				Building Total UA:	**5784.2**	

BASELINE: CONDUCTION LOSSES

#	Zone	UA	HOURS/ DAY	DAYS/ -	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement - Occupied	64	24	151	33	8	
		64	0	151	33	0	
		64	24	61	33	3	10.8
2	First floor	1,467	24	151	33	175	
		1,467	0	151	33	0	
		1,467	24	61	33	71	246.3
3	Second floor	1,689	24	151	33	202	
		1,689	0	151	33	0	
		1,689	24	61	33	82	283.6
4	Third floor - Occupied	466	24	151	35	59	
		466	0	151	35	0	
		466	24	61	35	24	83.0
5	Basement - Unoccupied	910	24	151	25	82	
		910	0	151	25	0	
		910	24	61	25	33	115.7
6	Third floor - Unoccupied	1,188	24	151	20	86	
		1,188	0	151	20	0	
		1,188	24	61	20	35	120.9
	Total UA	**5,784**			**Conduction Total**		**860.3**

BASELINE: INFILTRATION LOSSES

0.8

#	Zone	VOLUME	ACH	HRS/ DAY	DAYS/ YR	0.018	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement - Occupied	8,019	0.80	0	151	0.018	33	0.0	
		8,019	0.80	24	61	0.018	33	5.6	
	Occ.	8,019	0.80	24	151	0.018	33	13.8	19.4
2	First floor	43,002	0.80	0	151	0.018	33	0.0	
		43,002	0.80	24	61	0.018	33	29.9	
	Occ.	43,002	0.80	24	151	0.018	33	74.1	104.0
3	Second floor	43,002	0.80	0	151	0.018	33	0.0	
		43,002	0.80	24	61	0.018	33	29.9	
	Occ.	43,002	0.80	24	151	0.018	33	74.1	104.0
4	Third floor - Occupied	9,789	0.80	0	151	0.018	35	0.0	
		9,789	0.80	24	61	0.018	35	7.2	
	Occ.	9,789	0.80	24	151	0.018	35	17.9	25.1
5	Basement - Unoccupied	24,754	0.80	0	151	0.018	25	0.0	
		24,754	0.80	24	61	0.018	25	13.0	
	Occ.	24,754	0.80	24	151	0.018	25	32.3	45.3
6	Third floor - Unoccupied	9,483	0.80	0	151	0.018	20	0.0	
		9,483	0.80	24	61	0.018	20	4.0	
	Occ.	9,483	0.80	24	151	0.018	20	9.9	13.9
								Infiltration Total	**311.7**

Controls ECM 1 Heat Balance

CONTROLS ECM:	HEAT BALANCE
GAINS AND LOSSES	BTU/HEATING SEASON*1E6
CONDUCTION LOSSES	-780.2
INFILTRATION LOSSES	-279.3
VENTILATION LOSSES	0.0
SOLAR GAIN	94.7
OCCUPANT GAIN	1.5
ELECTRICAL GAIN	96.8
NET HEATING DEMAND	-866.4

CONTROLS ECM: Temperature & Schedule Information

Building Name: Town Office Building

Total Heating Days	212		Floor SF
Outdoor Winter Temperature	35		16,011

	Wing name	Occupied Temp.	Unoccupied Temp. Night	Unoccupied Temp. Off days	Htg System Occ. Hrs per day *	Schedule	Occ Level Heating Days
1	Basement - Occupied	68	64	60	8	5 days per week	151
2	First floor	68	64	60	8	5 days per week	151
3	Second floor	68	64	60	8	5 days per week	151
4	Third floor - Occupied	70	66	60	8	5 days per week	151
5	Basement - Unoccupied	60	60	60	24	5 days per week	151
6	Third floor - Unoccupied	55	55	55	24	5 days per week	151

CONTROLS ECM: CONDUCTION LOSSES

#	Zone	UA	HOURS/ DAY	DAYS/ -	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement - Occupied	64	8	151	33	3	
		64	16	151	29	5	
		64	24	61	25	2	9.4
2	First floor	1,467	8	151	33	58	
		1,467	16	151	29	103	
		1,467	24	61	25	54	214.9
3	Second floor	1,689	8	151	33	67	
		1,689	16	151	29	118	
		1,689	24	61	25	62	247.5
4	Third floor - Occupied	466	8	151	35	20	
		466	16	151	31	35	
		466	24	61	25	17	71.7
5	Basement - Unoccupied	910	24	151	25	82	
		910	0	151	25	0	
		910	24	61	25	33	115.7
6	Third floor - Unoccupied	1,188	24	151	20	86	
		1,188	0	151	20	0	
		1,188	24	61	20	35	120.9
	Total UA	5,784			Conduction Total		780.2

CONTROLS ECM: INFILTRATION LOSSES

0.8

#	Zone	VOLUME	ACH	HRS/ DAY	DAYS/ YR	0.018	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement - Occupied	8,019	0.80	16	151	0.018	29	8.1	
		8,019	0.80	24	61	0.018	25	4.2	
	Occ.	8,019	0.80	8	151	0.018	33	4.6	16.9
2	First floor	43,002	0.80	16	151	0.018	29	43.4	
		43,002	0.80	24	61	0.018	25	22.7	
	Occ.	43,002	0.80	8	151	0.018	33	24.7	90.7
3	Second floor	43,002	0.80	16	151	0.018	29	43.4	
		43,002	0.80	24	61	0.018	25	22.7	
	Occ.	43,002	0.80	8	151	0.018	33	24.7	90.7
4	Third floor - Occupied	9,789	0.80	16	151	0.018	31	10.6	
		9,789	0.80	24	61	0.018	25	5.2	
	Occ.	9,789	0.80	8	151	0.018	35	6.0	21.7
5	Basement - Unoccupied	24,754	0.80	0	151	0.018	25	0.0	
		24,754	0.80	24	61	0.018	25	13.0	
	Occ.	24,754	0.80	24	151	0.018	25	32.3	45.3
6	Third floor - Unoccupied	9,483	0.80	0	151	0.018	20	0.0	
		9,483	0.80	24	61	0.018	20	4.0	
	Occ.	9,483	0.80	24	151	0.018	20	9.9	13.9
							Infiltration Total		279.3

Enclosure ECM 3.1 Heat Balance

ENCLOSURE ECM 3.1 (1st/2nd Flr.Wall):	HEAT BALANCE
GAINS AND LOSSES	BTU/HEATING SEASON*1E6
CONDUCTION LOSSES	-538.6
INFILTRATION LOSSES	-268.0
VENTILATION LOSSES	0.0
SOLAR GAIN	94.7
OCCUPANT GAIN	1.5
ELECTRICAL GAIN	96.8
NET HEATING DEMAND	-613.5

ENCLOSURE ECM 3.1 (1st/2nd Flr.Wall): INFILTRATION LOSSES

0.8

#	Zone	VOLUME	ACH	HRS/ DAY	DAYS/ YR	0.018	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement - Occupied	8,019	0.80	16	151	0.018	29	8.1	
		8,019	0.80	24	61	0.018	25	4.2	
	Occ.	8,019	0.80	8	151	0.018	33	4.6	16.9
2	First floor	43,002	0.75	16	151	0.018	29	40.7	
		43,002	0.75	24	61	0.018	25	21.2	
	Occ.	43,002	0.75	8	151	0.018	33	23.1	85.1
3	Second floor	43,002	0.75	16	151	0.018	29	40.7	
		43,002	0.75	24	61	0.018	25	21.2	
	Occ.	43,002	0.75	8	151	0.018	33	23.1	85.1
4	Third floor - Occupied	9,789	0.80	16	151	0.018	31	10.6	
		9,789	0.80	24	61	0.018	25	5.2	
	Occ.	9,789	0.80	8	151	0.018	35	6.0	21.7
5	Basement - Unoccupied	24,754	0.80	0	151	0.018	25	0.0	
		24,754	0.80	24	61	0.018	25	13.0	
	Occ.	24,754	0.80	24	151	0.018	25	32.3	45.3
6	Third floor - Unoccupied	9,483	0.80	0	151	0.018	20	0.0	
		9,483	0.80	24	61	0.018	20	4.0	
	Occ.	9,483	0.80	24	151	0.018	20	9.9	13.9
							Infiltration Total		268.0

ENCLOSURE ECM 3.1 (1st/2nd Flr.Wall):			HEAT LOSS COEFFICIENTS			
Zone #	Building Zone		U-Value (BTU/hr-sf-F)	Area (sf)		UA-Value (BTU/hr-F)
1	**Basement - Occupied**					
		Occupied Basement Walls	0.072	846		61
		Below Grade Slab	0.033	94	per l.f.	3
				Wing UA Total	**64.2**	
2	**First floor**					
		Improved Wall 1	0.069	2,976		206
		Doors 1	0.690	105		72
		Windows 1 - w/ storm	0.570	642		366
				Wing UA Total	**644.5**	
3	**Second floor**					
		Improved Wall 1	0.069	2,990		207
		Doors 1	0.690	21		14
		Windows 2 - NO storm	0.900	713		642
				Wing UA Total	**863.0**	
4	**Third floor - Occupied**	3rd floor ceiling, café & veterans	0.228	875		200
		COA Roof 2	0.054	1,366		74
		COA Walls	0.050	358		18
		Wall 1	0.346	275		95
		Windows 2 - NO storm	0.900	75		68
		COA Skylight	0.870	14		12
				Wing UA Total	**466.4**	
5	**Basement - Unoccupied**					0
		Basement Wall Above Grade	0.346	811		280
		Basement Wall Below Grade	1.271	230	per l.f.	292
		Boarded Windows - Basement	1.471	224		329
		Below Grade Slab	0.033	230	per l.f.	8
				Wing UA Total	**909.6**	
6	**Third floor - Unoccupied**	3rd floor storage Roof 3	0.484	2,065		1,000
		Wall 1	0.574	328		188
						0
				Wing UA Total	**1188.1**	
				Building Total UA:	**4135.7**	

ENCLOSURE ECM 3.1 (1st/2nd Flr.Wall): CONDUCTION LOSSES

#	Zone	UA	HOURS/ DAY	DAYS/ -	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement - Occupied	64	8	151	33	3	
		64	16	151	29	5	
		64	24	61	25	2	9.4
2	First floor	644	8	151	33	26	
		644	16	151	29	45	
		644	24	61	25	24	94.4
3	Second floor	863	8	151	33	34	
		863	16	151	29	60	
		863	24	61	25	32	126.4
4	Third floor - Occupied	466	8	151	35	20	
		466	16	151	31	35	
		466	24	61	25	17	71.7
5	Basement - Unoccupied	910	24	151	25	82	
		910	0	151	25	0	
		910	24	61	25	33	115.7
6	Third floor - Unoccupied	1,188	24	151	20	86	
		1,188	0	151	20	0	
		1,188	24	61	20	35	120.9
	Total UA	**4,136**			**Conduction Total**		**538.6**

Enclosure ECM 3.2 Heat Balance

ENCLOSURE ECM 3.2 (3rd floor):	HEAT BALANCE
GAINS AND LOSSES	BTU/HEATING SEASON*1E6
CONDUCTION LOSSES	-390.0
INFILTRATION LOSSES	-252.7
VENTILATION LOSSES	0.0
SOLAR GAIN	94.7
OCCUPANT GAIN	1.5
ELECTRICAL GAIN	96.8
NET HEATING DEMAND	-449.7

ENCLOSURE ECM 3.2 (3rd floor): CONDUCTION LOSSES

#	Zone	UA	HOURS/ DAY	DAYS/ -	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement - Occupied	64	8	151	33	3	
		64	16	151	29	5	
		64	24	61	25	2	9.4
2	First floor	644	8	151	33	26	
		644	16	151	29	45	
		644	24	61	25	24	94.4
3	Second floor	941	8	151	33	38	
		941	16	151	29	66	
		941	24	61	25	34	137.9
4	Third floor - Occupied	212	8	151	35	9	
		212	16	151	31	16	
		212	24	61	25	8	32.6
5	Basement - Unoccupied	910	24	151	25	82	
		910	0	151	25	0	
		910	24	61	25	33	115.7
6	Third floor - Unoccupied	0	24	151	20	0	
		0	0	151	20	0	
		0	24	61	20	0	0.0
	Total UA	2,771			Conduction Total		390.0

ENCLOSURE ECM 3.2 (3rd floor):			HEAT LOSS COEFFICIENTS			
Zone #	Building Zone		U-Value (BTU/hr-sf-F)	Area (sf)		UA-Value (BTU/hr-F)
1	**Basement - Occupied**					
		Occupied Basement Walls	0.072	846		61
		Below Grade Slab	0.033	94	per l.f.	3
				Wing UA Total	**64.2**	
2	**First floor**					
		Improved Wall 1	0.069	2,976		206
		Doors 1	0.690	105		72
		Windows 1 - w/ storm	0.570	642		366
				Wing UA Total	**644.5**	
3	**Second floor**					
		Improved Wall 1	0.069	2,990		207
		Doors 1	0.690	21		14
		Windows 2 - NO storm	0.900	713		642
		Existing Ceiling 6" of cellulose	0.051	1,543	ADDED	78
				Wing UA Total	**940.9**	
4	**Third floor - Occupied**	Improved 3rd floor Ceiling	0.024	875		21
		COA Roof 2	0.054	1,366		74
		COA Walls	0.050	358		18
		Improved Wall 1	0.069	275		19
		Windows 2 - NO storm	0.900	75		68
		COA Skylight	0.870	14		12
				Wing UA Total	**212.0**	
5	**Basement - Unoccupied**					0
		Basement Wall Above Grade	0.346	811		280
		Basement Wall Below Grade	1.271	230	per l.f.	292
		Boarded Windows - Basement	1.471	224		329
		Below Grade Slab	0.033	230	per l.f.	8
				Wing UA Total	**909.6**	
6	**Third floor - Unoccupied**	3rd floor storage Roof 3	0.484		Removed	0
		Wall 1	0.574		Removed	0
						0
				Wing UA Total	**0.0**	
				Building Total UA:	**2771.1**	

ENCLOSURE ECM 3.2 (3rd floor): INFILTRATION LOSSES

0.8

#	Zone	VOLUME	ACH	HRS/ DAY	DAYS/ YR	0.018	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement - Occupied	8,019	0.80	16	151	0.018	29	8.1	
		8,019	0.80	24	61	0.018	25	4.2	
	Occ.	8,019	0.80	8	151	0.018	33	4.6	16.9
2	First floor	43,002	0.75	16	151	0.018	29	40.7	
		43,002	0.75	24	61	0.018	25	21.2	
	Occ.	43,002	0.75	8	151	0.018	33	23.1	85.1
3	Second floor	43,002	0.75	16	151	0.018	29	40.7	
		43,002	0.75	24	61	0.018	25	21.2	
	Occ.	43,002	0.75	8	151	0.018	33	23.1	85.1
4	Third floor - Occupied	9,789	0.75	16	151	0.018	31	9.9	
		9,789	0.75	24	61	0.018	25	4.8	
	Occ.	9,789	0.75	8	151	0.018	35	5.6	20.3
5	Basement - Unoccupied	24,754	0.80	0	151	0.018	25	0.0	
		24,754	0.80	24	61	0.018	25	13.0	
	Occ.	24,754	0.80	24	151	0.018	25	32.3	45.3
6	Third floor - Unoccupied	0	0.80	0	151	0.018	20	0.0	
		0	0.80	24	61	0.018	20	0.0	
	Occ.	0	0.80	24	151	0.018	20	0.0	0.0
								Infiltration Total	**252.7**

Enclosure ECM 3.3 Heat Balance

(see appendix for updated measure, as of 2/4/15)

ENCLOSURE ECM 3.3 (Basement): HEAT BALANCE	
GAINS AND LOSSES	BTU/HEATING SEASON*1E6
CONDUCTION LOSSES	-351.4
INFILTRATION LOSSES	-252.7
VENTILATION LOSSES	0.0
SOLAR GAIN	94.7
OCCUPANT GAIN	1.5
ELECTRICAL GAIN	96.8
NET HEATING DEMAND	-411.1

ENCLOSURE ECM 3.3 (Basement): CONDUCTION LOSSES

#	Zone	UA	HOURS/ DAY	DAYS/ -	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement - Occupied	64	8	151	33	3	
		64	16	151	29	5	
		64	24	61	25	2	9.4
2	First floor	644	8	151	33	26	
		644	16	151	29	45	
		644	24	61	25	24	94.4
3	Second floor	941	8	151	33	38	
		941	16	151	29	66	
		941	24	61	25	34	137.9
4	Third floor - Occupied	212	8	151	35	9	
		212	16	151	31	16	
		212	24	61	25	8	32.6
5	Basement - Unoccupied	606	24	151	25	55	
		606	0	151	25	0	
		606	24	61	25	22	77.1
6	Third floor - Unoccupied	0	24	151	20	0	
		0	0	151	20	0	
		0	24	61	20	0	0.0
	Total UA	2,467			Conduction Total		351.4

ENCLOSURE ECM 3.3 (Basement): HEAT LOSS COEFFICIENTS

Zone #	Building Zone		U-Value (BTU/hr-sf-F)	Area (sf)		UA-Value (BTU/hr-F)
1	**Basement - Occupied**					
		Occupied Basement Walls	0.072	846		61
		Below Grade Slab	0.033	94	per l.f.	3
				Wing UA Total	**64.2**	
2	**First floor**					
		Improved Wall 1	0.069	2,976		206
		Doors 1	0.690	105		72
		Windows 1 - w/ storm	0.570	642		366
				Wing UA Total	**644.5**	
3	**Second floor**					
		Improved Wall 1	0.069	2,990		207
		Doors 1	0.690	21		14
		Windows 2 - NO storm	0.900	713		642
		Existing 6" of cellulose	0.051	1,543		78
				Wing UA Total	**940.9**	
4	**Third floor - Occupied**	Improved 3rd floor Ceiling	0.024	875		21
		COA Roof 2	0.054	1,366		74
		COA Walls	0.050	358		18
		Improved Wall 1	0.069	275		19
		Windows 2 - NO storm	0.900	75		68
		COA Skylight	0.870	14		12
				Wing UA Total	**212.0**	
5	**Basement - Unoccupied**					0
		Basement Wall Above Grade	0.346	811		280
		Basement Wall Below Grade	1.271	230	per l.f.	292
		Insulated/Boarded Windows - Basement	0.115	224		26
		Below Grade Slab	0.033	230	per l.f.	8
				Wing UA Total	**605.9**	
6	**Third floor - Unoccupied**	3rd floor storage Roof 3	0.484			0
		Wall 1	0.574			0
						0
				Wing UA Total	**0.0**	
				Building Total UA:	**2467.5**	

Storm Window ECM 4 Heat Balance

STORM WINDOW ECM:	HEAT BALANCE
GAINS AND LOSSES	BTU/HEATING SEASON*1E6
CONDUCTION LOSSES	-316.9
INFILTRATION LOSSES	-252.7
VENTILATION LOSSES	0.0
SOLAR GAIN	94.7
OCCUPANT GAIN	1.5
ELECTRICAL GAIN	96.8
NET HEATING DEMAND	-376.6

STORM WINDOW ECM: CONDUCTION LOSSES

#	Zone	UA	HOURS/ DAY	DAYS/ -	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement - Occupied	64	8	151	33	3	
		64	16	151	29	5	
		64	24	61	25	2	9.4
2	First floor	644	8	151	33	26	
		644	16	151	29	45	
		644	24	61	25	24	94.4
3	Second floor	706	8	151	33	28	
		706	16	151	29	49	
		706	24	61	25	26	103.4
4	Third floor - Occupied	212	8	151	35	9	
		212	16	151	31	16	
		212	24	61	25	8	32.6
5	Basement - Unoccupied	606	24	151	25	55	
		606	0	151	25	0	
		606	24	61	25	22	77.1
6	Third floor - Unoccupied	0	24	151	20	0	
		0	0	151	20	0	
		0	24	61	20	0	0.0
	Total UA	2,232			Conduction Total		316.9

STORM WINDOW ECM: HEAT LOSS COEFFICIENTS

Zone #	Building Zone		U-Value (BTU/hr-sf-F)	Area (sf)		UA-Value (BTU/hr-F)
1	**Basement - Occupied**					
		Occupied Basement Walls	0.072	846		61
		Below Grade Slab	0.033	94	per l.f.	3
				Wing UA Total	**64.2**	
2	**First floor**					
		Improved Wall 1	0.069	2,976		206
		Doors 1	0.690	105		72
		Windows 1 - w/ storm	0.570	642		366
				Wing UA Total	**644.5**	
3	**Second floor**					
		Improved Wall 1	0.069	2,990		207
		Doors 1	0.690	21		14
		Windows 1 - w/ storm	0.570	713		406
		Existing 6" of cellulose	0.051	1,543		78
				Wing UA Total	**705.6**	
4	**Third floor - Occupied**	Improved 3rd floor Ceiling	0.024	875		21
		COA Roof 2	0.054	1,366		74
		COA Walls	0.050	358		18
		Improved Wall 1	0.069	275		19
		Windows 2 - NO storm	0.900	75		68
		COA Skylight	0.870	14		12
				Wing UA Total	**212.0**	
5	**Basement - Unoccupied**					0
		Basement Wall Above Grade	0.346	811		280
		Basement Wall Below Grade	1.271	230	per l.f.	292
		Insulated/Boarded Windows - Basement	0.115	224		26
		Below Grade Slab	0.033	230	per l.f.	8
				Wing UA Total	**605.9**	
6	**Third floor - Unoccupied**	3rd floor storage Roof 3	0.484			0
		Wall 1	0.574			0
						0
				Wing UA Total	**0.0**	
				Building Total UA:	**2232.3**	

ENERGY MANAGEMENT CONTROLS MEASURE INFORMATION

Summary of Energy Savings					
ECM 1	**Energy Management System Controls**				
	Baseline	**After ECM 1**	**Savings**	**Reduction**	
Net Building Demand (MMBtu/yr)	979.0	866.4	112.54	11.5%	
Marginal System Efficiency	76%	76%			
Fuel Energy Usage (MMBtu/yr)	1,288.1	1,140.1			
Energy Savings	**% Reduction**	**Fuel Use**	**Therms Saved**	**$/Unit**	**$ Saved**
	11.5%	12,754	1,466	$1.62	$2,373
				Total Savings	**$2,373**

Cost	Savings	Payback (yr)
$19,382	**$2,373**	**8.2**

Note:
Cost estimates were developed by BEA based in part upon figures from Honeywell and TCS Basys Controls

Floor	Room Name	Equipment Controlled	Recommended Control	# Thermostatic Radiator Valves	# Motorized Valves	$/ MTRV	# Programmable Thermostats	$/ Thermostat or TRV	Based on Product #
Basement:	AV Room	Air Handler	Programmable Thermostat				1	$713	SZ1051
	Remainder of Basement	Unit Heaters	Programmable Zone Thermostat				1	$656	SZ1041
First Floor:	Assessor's Office	Radiation	Thermostatic Radiator Valve w/ Remote Sensor	1				$200	T104F1512
	Collector's Office	Radiation	Thermostatic Radiator Valve w/ Remote Sensor	1				$200	T104F1512
	Town Clerk's Office	Radiation	Motorized Valve & Programmable Thermostat		1	$400	1	$392	SZ1009
	Building Department	Radiation	Thermostatic Radiator Valve w/ Remote Sensor	1				$200	T104F1512
	Board of Health	Radiation	Thermostatic Radiator Valve w/ Remote Sensor	1				$200	T104F1512
	Land Use Departments	Radiation	Thermostatic Radiator Valve w/ Remote Sensor	1				$200	T104F1512
	Stair	Radiation	Thermostatic Radiator Valve w/ Remote Sensor	1				$200	T104F1512
	Restroom - Men	Radiation	Thermostatic Radiator Valve w/ Remote Sensor	1				$200	T104F1512
	Restroom - Women	Radiation	Thermostatic Radiator Valve w/ Remote Sensor	1				$200	T104F1512
	Stair	Radiation	Thermostatic Radiator Valve w/ Remote Sensor	1				$200	T104F1512
Second Floor:	Accountant's Office	Radiation & Circulator	Motorized Valve & Programmable Thermostat		1	$400	1	$656	SZ1041
	Treasurer's Office	Radiation & Circulator	Motorized Valve & Programmable Thermostat		1	$400	1	$656	SZ1041
	Hallway	Circulator	Programmable Thermostat				1	$656	SZ1041
	Finance Meeting Room	Radiation	Thermostatic Radiator Valve w/ Remote Sensor	1				$200	T104F1512
	Town Admin Assistant	Radiation & Circulator	Motorized Valve & Programmable Thermostat		1	$400	1	$656	SZ1041
	Selectmen's Room	Radiation	Thermostatic Radiator Valve w/ Remote Sensor	1				$200	T104F1512
	Historic Classroom	Radiation	Thermostatic Radiator Valve w/ Remote Sensor	1				$200	T104F1512
	Town Admin's Office	Mini-Split							
	Town Admin's Office	Radiation & Circulator	Motorized Valve & Programmable Thermostat		1	$400	1	$656	SZ1041
Third Floor:	Lone Perk Café	Air Handler& Circulator	Programmable Thermostat				1	$713	SZ1051
	Senior Center Larger Rm	Mini-Split	Programmable Thermostat				1	$392	SZ1009
	Senior Center Smaller Rm	Mini-Split	Programmable Thermostat				1	$392	SZ1009
			Totals	**12**	**5**	**$2,000**	**11**	**$8,938**	

Terminal Controls Subtotal	$ 10,938
Field Controller	$ 4,000
Graphics programming	$ 1,080
Subtotal	**$ 16,018**
Contingency	$ 1,602
Totals	***$ 17,620***
Advisory & Contractor Oversight	$ 1,762
Measure Total	***$ 19,382***

SZ product number are TCS Basys Controls.; T product numbers are Honeywell product Numbers

Programmable 365-Day Modulating Thermostat

SZ1041

· 2 stages each of heating and cooling plus a 4-20 mA analog output for economizing
· Discharge air sensor input for economizer functions
· Outdoor air sensor input with heating & cooling lockouts

Instructions Submittal Data

Technical Data

Wiring

· 365-day time clock with two holiday schedules with automatic leap year and daylight savings correction
· Stand-alone or network operation
· Adjustable delay on power-up and start-up for soft starts
· P+I control option on digital stages
· Smart Recovery
· No backup battery required
· Minimum on/off times for HVAC equipment protection
· 32 character LCD display
· 6 status LEDs
· Remote room sensing capability
· User setpoint adjustment limits
· Local and remote override capability
· System and fan switching with access lockouts
· Fan interlock safety option
· Filter service input and indication
· Equipment monitoring inputs and indication
· External time clock input
· Energy management input for setpoint shift

High Capacity Thermostatic Actuator

By HONEYWELL

Product Description

High Capacity Thermostatic Actuator, Temp. Range 43 to 79 Degrees F, Capillary Length 80 In., Max. Pressure Water 150 psi, Steam 15 psi

Technical Specifications

Standards: Meets ASHRAE 102-1989	**Function**: Provide Precise and Automatic Control of Room Temperature in Two-pipe Systems, Modulate the Flow of Hot Water or Steam through Free-standing Radiators, Convectors and other Heating Units with High Capacity Requirements, Continually Monitor and Adjust Room Temperature for Consistent Comfort and Relief from Underheating and Overheating
Item: High Capacity Thermostatic Actuator	**Temp. Range (F)**: 43 to 79
Capillary Length (In.): 80	**Includes**: Remote Sensor, Integral Setpoint
Zoro Number: G1878746	**Mfr Number**: T104F1512

HEATING SYSTEM MEASURE INFORMATION

ECM # 2 — **Space Heating With Condensing Boilers** — **Town Office Building**

Fuel Rate ($ / therm)						
$1.62	**Existing Condition:**			**New Condition:**		
Equipment Type	**Space Heating Boiler**	**Space Heating Boiler**		**Space Heating Boiler**	**Space Heating Boiler**	
Boiler #	1	2		1	2	
Make	Weil McLain	Weil McLain		Lochinvar	Lochinvar	
Model	778	676		KBN 211	KBN 151	
Type	Atmospheric	Atmospheric		Condensing	Condensing	
Heating Medium	Water	Water		Water	Water	
Control Mode				Modulating	Modulating	
Output kBtu/Hr	764	408		196	139	
Steady State Eff	82%	78%		95%	95%	
Input kBtu/Hr	937	520		135	150	
Seasonal Eff	77%	77%		92%	92%	
Percentage of Load	273%	146%		70%	50%	

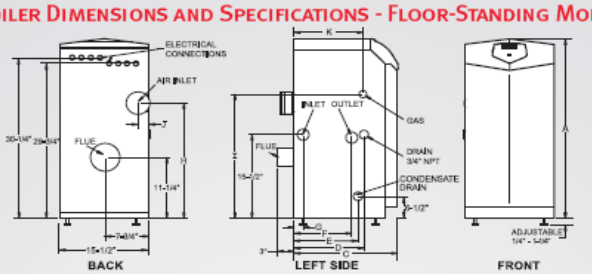
	Replacement-In-Kind Costs		**Installed System Costs**	
Boiler	$14,633	**Condensing Boilers**	$24,388	
		Reconfigure Hydronic Piping in Boiler Room	$1,600	
		Three (3) Mini-Tank Domestic Hot Water Heaters	$2,100	
			$28,088	*Subtotal*
		Contingency	$2,809	
			$30,897	*Subtotal*
		Contractor Oversight	$3,090	
Totals	**$14,633**	***Total:***	**$33,986**	

Summary of Existing Building-Related Heat Loads	**Annual Building Operating Load (kBtu/year)**	**Existing Fuel Usage Therms**	**New Fuel Usage Therms**	**Fuel Cost**	**Peak Space Heating Load (kBtu/hr)**	**Provide (#) 2 Boiler @ 120% of design Load**
Space Heating Load	**866,439**	**11,288**		**$18,271**	**280**	**335**
	866,439		**9,418**	**$15,244**		
			Savings $	**$3,027**		

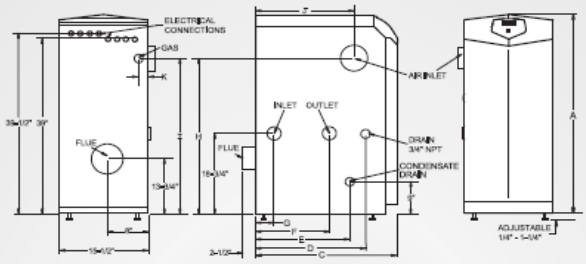
	Cost	**Savings**	**Payback**
Full Equipment Cost Basis:	**$33,986**	**$3,027**	**11.2**
Incremental Equipment Cost Difference:	**$19,354**	**$3,027**	**6.4**

KNIGHT® BOILER DIMENSIONS AND SPECIFICATIONS - FLOOR-STANDING MODELS

Models:
KBN 081-211



Model:
KBN286



KNIGHT HEATING BOILER

DIMENSIONS AND SPECIFICATIONS

Model Number	Input Min. MBH	Input Max. MBH	AFUE %	Heating Capacity MBH	NET AHRI MBH	A	C	D	E	F	G	H	I	J	K	Gas Conn.	Water Conn.	Air Inlet	Vent Size	Shipping Wt. (lbs.)
KBN081	16	80	95.0	74	64	33-1/4"	14"	7"	5-3/4"	5"	3"	20-1/2"	22"	1-3/4"	6-1/2"	1/2"	1"	3"	3"	125
KBN106	21	105	95.0	97	84	33-1/4"	14"	6-1/2"	5-3/4"	4-1/2"	1-1/2"	20-1/2"	22"	1-3/4"	6-1/2"	1/2"	1"	3"	3"	129
KBN151	30	150	95.0	139	121	33-1/4"	18"	12-1/4"	11-1/2"	10"	1-1/2"	21-1/4"	23"	1-3/4"	12"	1/2"	1"	3"	3"	157
KBN211	42	210	95.0	196	170	33-1/4"	22-1/4"	16-1/2"	15-3/4"	14-1/4"	5-1/4"	21-1/4"	23"	1-3/4"	16-1/4"	1/2"	1"	3"	3"	172
KBN286	57	285	95.0	267	232	42-1/4"	19-3/4"	12-3/4"	13-1/2"	6"	2"	34"	31"	11-3/4"	4-1/4"	3/4"	1-1/4"	4"	4"	224

Notes: Indoor installation only. All information subject to change. Change "N" to "L" for LP gas models.
Net ratings based on piping and pick-up allowance of 1.15

SMART SYSTEM™ FEATURES

- **SMART SYSTEM Digital Operating Control**
  - Multi-Color Graphic LCD Display with Navigation Dial and Soft Keys
- **Three Setpoint Temperature Inputs**
- **Built-in Cascading Sequencer for up to 8 Boilers**
  - Cascade Multiple Sized Boilers
  - Lead Lag
  - Efficiency Optimization
  - Front End Loading Capability with Copper Fin II
- **Outdoor Reset Control with Outdoor Air Sensor**
  - Programmable for Three Reset Temperature Inputs
- **Programmable System Efficiency Optimizers**
  - Night Setback w/Overide Function
  - DHW Night Setback w/Overide Function
  - Anti-Cycling
  - Outdoor Air Reset Curve
  - Ramp Delay
  - Boost Temperature & Time
- **Three Pump Control**
  - System Pump with Parameter for Continuous Operation
  - Boiler Pump with Variable Speed Pump Control*
  - Domestic Hot Water Pump
- **Domestic Hot Water Prioritization**
  - DHW tank piped with priority in the boiler loop
  - DHW tank piped as a zone in the system with the pumps controlled by the Smart System
  - DHW Modulation Limiting
  - Separately Adjustable SH/DHW Switching Times*
- **Building Management System Integration**
  - 0-10 VDC Input to Control Modulation or Set Point
  - 0-10 VDC Modulation Rate Output
  - 0-10 VDC Input Signal from Variable Speed System Pump*
  - 0-10 VDC Input to Enable/Disable call for heat
- **High-Voltage Terminal Strip**
  - 120 VAC / 60 Hertz / 1 Phase Power Supply
  - Three Sets of Pump Contacts
- **Low Voltage Terminal Strip**
  - 24 VAC Device Relay
  - Proving Switch Contacts
  - Flow Switch Contacts
  - Alarm on Any Failure Contacts
  - Runtime Contacts
  - DHW Thermostat Contacts
  - 3 Space Heat Thermostat Contacts
  - System Sensor Contacts
  - DHW Tank Sensor Contacts
  - Outdoor Air Sensor Contacts
  - Cascade Contacts
  - 0-10 VDC BMS External Control Contact
  - 0-10 VDC Boiler Rate Output Contacts
  - 0-10 VDC Variable Speed System Pump Signal Input
  - 0-10 VDC Signal to Control Variable Speed Boiler Pump
  - Modbus Contacts
- **Time Clock**
- **Data Logging**
  - Hours Running, Space Heating
  - Hours Running, Domestic Hot Water
  - Ignition Attempts
  - Last 10 Lockouts
- **Access to BMS Settings through Graphic LCD Display**
- **Maintenance Reminder**
  - Custom Maintenance Reminder with Contractor Info
  - Installer Ability to De-activate Service Reminder
- **Low-Water Flow Safety Control & Indication**
- **Dual Level Password Security**
- **Customizable Freeze Protection Parameters**

*Exclusive feature, available only from Lochinvar

STANDARD FEATURES

- **ENERGY STAR Most Efficient Recognition**
- **95% DOE AFUE Efficiency**
- **Modulating Burner with 5:1 Turndown**
  - Direct-Spark Ignition
  - Low-NOx Operation
  - Field Convertible from Natural to LP Gas
- **ASME Stainless Steel Heat Exchanger**
  - 30 psi ASME Relief Valve
- **Vertical & Horizontal Direct-Vent**
  - PVC, CPVC, Polypropylene or SS Venting up to 100 feet
- **Smart System Control**
- **Condensate Trap**
- **Other Features**
  - Automatic Reset High Limit
  - Adjustable High Limit w/Manual Reset
  - Boiler Circulating Pump
  - Adjustable Leveling Legs
  - Zero Clearances to Combustible Materials
  - 12-Year Limited Warranty (See Warranty for Details)
  - 2-Year Parts Warranty

OPTIONAL EQUIPMENT

- Modbus Communication
- Condensate Neutralization Kit
- Multi Temperature Loop Control
- Flow Switch
- Low-Water Cutoff w/Manual Reset & Test
- Alarm Bell
- Concentric Vent Kit
- SMART SYSTEM PC Software
- Stack Frame
- BMS Gateway to LON or BacNet
- Sidewall Vent Termination

FIRING CODES

- M9 Standard Construction
- M7 California Code

Lochinvar®
HIGH EFFICIENCY BOILERS & WATER HEATERS

Lochinvar, LLC
300 Maddox Simpson Parkway
Lebanon, Tennessee 37090
P: 615-889-8900 / F: 615-547-1000
www.lochinvar.com

Patent Pending

ENCLOSURE MEASURE INFORMATION

Summary of Energy Savings					
ECM 3.1	**1st & 2nd Floor Wall Insulation**				
	Baseline (after ECM1)	**After ECM 2**	**Savings**	**Reduction**	
Net Building Demand (MMBtu/yr)	866.4	613.5	252.90	29.2%	
Projected Seasonal System Efficiency	92%	92%			
Fuel Energy Usage (MMBtu/yr)	941.8	666.9			
Energy Savings	**% Reduction**	**Natural Gas Use**	**Therms Saved**	**$/Unit**	**$ Saved**
	29.2%	9,418	2,749	$1.62	$4,449
				Total Savings	**$4,449**

Cost	Savings	Payback (yr)
$21,334	**$4,449**	**4.8**

Note:
Cost estimates were developed by BEA based upon figures from Energia, LLC.

	Depth (in.)	R-value	$ / sq.ft.	$ / in.
Drill & Plug 4"	5	17	$ 3.01	$ 0.60
			$ 3.01	per s.f.

1st & 2nd floor walls	5,966	sq.ft.
Blow in 5" of cellulose	5.0	"

	Depth (in.)	R-value	Cost ($)
Drill & Plug 4" wall w/ cellulose	5	17	$ 17,958
			$ -
		Subtotal	**$ 17,958**
		Contingency	$ 1,796
		Totals	***$ 19,754***
		Advisory & Contractor Oversight	$ 1,580
		Measure Total	***$ 21,334***

Enclosure Measure Continued

Summary of Energy Savings					
ECM 3.2	**3rd Floor Ceiling/Wall Insulation & Air Sealing**				
	Baseline	**After ECM**	**Savings**	**Reduction**	
Net Building Demand (MMBtu/yr)	613.5	449.7	163.85	26.7%	
Projected Seasonal System Efficiency	92%	92%			
Fuel Energy Usage (MMBtu/yr)	666.9	488.8			
Energy Savings	**% Reduction**	**Natural Gas Use**	**Therms Saved**	**$/Unit**	**$ Saved**
	26.7%	6,669	1,781	$1.62	$2,883
				Total Savings	**$2,883**

Cost	Savings	Payback (yr)
$8,092	**$2,883**	**2.8**

Note:
Cost estimates were developed by BEA based upon figures from Energia, LLC.

	Depth (in.)	R-value	$ / sq.ft.	$ / in.
Open Blow	9	33	$ 2.03	$ 0.23
O.B. to R60	6	22	$ 0.40	$ 0.07
Cellulose net & blow	5	17	$ 2.80	-

Portion of 3rd Floor Ceiling	875 sq.ft.
Improved 3rd floor Ceiling	11 "
Stairwells Wall/Roof Area	924 sq. ft.

	Depth (in.)	R-value	Cost ($)
Open Blow	9	33	$ 1,776
O.B. to R60	1.7	6	$ 100
Insulate Peaks of 2 Stairwells	-	-	$ 2,987
Wall Insulate & Air Seal	4	11	$ 828
Sheetrock	-	-	$ 360
Air Sealing	-	-	$ 760
		Subtotal	**$ 6,811**
		Contingency	$ 681
		Totals	***$ 7,492***
		Advisory & Contractor Oversight	$ 599
		Measure Total	***$ 8,092***

Enclosure Measure Continued

Summary of Energy Savings					
ECM 3.3	**Basement Insulation & Air Sealing**				
	Baseline	**After ECM**	**Savings**	**Reduction**	
Net Building Demand (MMBtu/yr)	449.7	411.1	38.62	8.6%	
Projected Seasonal System Efficiency	92%	92%			
Fuel Energy Usage (MMBtu/yr)	488.8	446.8			
Energy Savings	**% Reduction**	**Natural Gas Use**	**Therms Saved**	**$/Unit**	**$ Saved**
	8.6%	4,888	420	$1.62	$679
				Total Savings	**$679**

Cost	Savings	Payback (yr)
$4,061	**$679**	**6.0**

Note:
Cost estimates were developed by BEA based upon figures from Energia, LLC.

Basement Rim Joist	230 ft.			
2" Closed Cell Spray Foam	4.55 $ / ft.			
	Depth (in.)	**R-value**	**Cost ($)**	
Foam Rim Joist	2	14	$	1,047
Window area (sf): **224**	2		$	392
Install 2" XPS Rigid Foam in Windows	2.0	10	$	1,600
Air Sealing	-	-	$	380
		Subtotal	**$**	**3,419**
		Contingency	$	342
		Totals	***$***	***3,760***
		Advisory & Contractor Oversight	$	301
	Measure Total		***$***	***4,061***

STORM WINDOW MEASURE INFORMATION

Summary of Energy Savings					
ECM 3	**Storm Window Installation**				
	Baseline	**After ECM 2**	**Savings**	**Reduction**	
Net Building Demand (MMBtu/yr)	411.1	376.6	34.47	8.4%	
Projected Seasonal System Efficiency	92%	92%			
Fuel Energy Usage (MMBtu/yr)	446.8	409.3			
Energy Savings	**% Reduction**	**Natural Gas Use**	**Therms Saved**	**$/Unit**	**$ Saved**
Natural Gas	8.4%	4,468	375	$1.62	$606
				Total Savings	**$606**

Cost	Savings	Payback (yr)
$12,553	$606	20.7

Note:
Cost estimates were developed by BEA based upon window estimate from Harvey Building Products

Storm Window Installation

	Qty.	Cost ($)
Storm Windows	27	$ 4,573
Installation	27	$ 6,480
Equipment Rental		$ 1,500
Totals		***$ 12,553***

GREENHOUSE GAS INFORMATION

(see appendix for updated chart, as of 2/4/15)

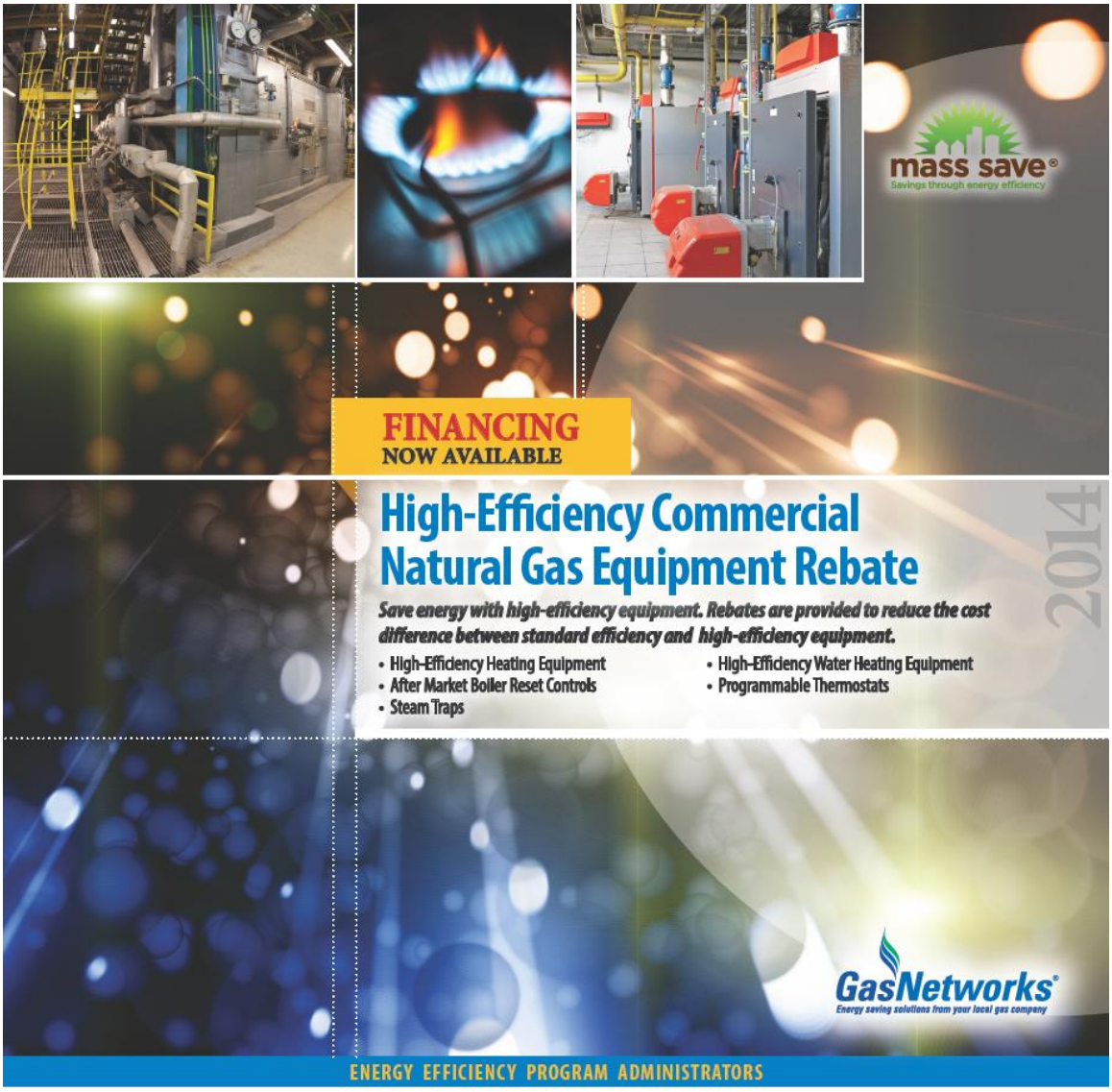
Greenhouse Gas (GHG) Impact

Baseline Fuel Usage	Natural Gas	Propane	Oil	Electricity	MT eCO2
Space Heating	1,275				68

Measure #	Measure Description (RTM = Renewable Thermal Measure) (ECM = Energy Conservation Measure)	Fuel Usage After Measures				GHG Emmissions	GHG Savings	Savings As % of Baseline
		Natural Gas (MMBtu / yr)	Propane (gal / yr)	Oil (gal / yr)	Electricity (kWh / yr)	(MT eCO2)	(MT eCO2)	
ECM 1	Energy Management System Controls	1,129				60	8	11%
ECM 2	Space Heating With Condensing Boilers	942				50	10	15%
ECM 3.1	1st & 2nd Floor Wall Insulation	667				35	15	22%
ECM 3.2	3rd Floor Ceiling/Wall Insulation & Air Sealing	489				26	9	14%
ECM 3.3	Basement Insulation & Air Sealing	447				24	2	3%
ECM 4	Storm Window Installation	409				22	2	3%
						Totals:	***46***	***68%***

GHG Emmissions		
10.3	MT eCO2 / 1,000	gallons of #2 Fuel Oil
5.3	MT eCO2 / 1,000	gallons of Propane (LPG)
53.2	MT eCO2 / 1,000	MMBtu's of Natural Gas
14.1	MT eCO2 / 100	short ton of wood pellets (2,000 lbs.)
333.7	MT eCO2 / 1,000,000	kWh of electricity
per Clean Air Cool Planet Campus Carbon Calculator (2013 value)		

MASS SAVE INCENTIVE INFORMATION



FINANCING
NOW AVAILABLE

APPLICATION INSTRUCTIONS

1. If you are interested in financing your project, please contact your energy efficiency program administrator to discuss terms and eligibility prior to purchasing your qualifying equipment. Further information can be found on masssave.com/financing.
2. Purchase and install the qualifying equipment. *Must be installed between 1/1/2014 and 12/31/2014.*
3. Go to www.smartenergy-zone.com/masssave/, to submit your online rebate application. Customers who do not have online access can call 1-877-883-1759.
4. Upload or return the completed application along with the following items:
   - Completed and Signed Application
   - A copy of the pre-approval rebate letter (if applicable)
   - Manufacturer's technical specification sheets ("cut sheets") for each type of eligible equipment purchased
   - Copy of a dated work order / invoice / receipt that identifies:
     - Equipment or measure installed
     - Manufacturer
     - Model Number
     - Contractor
     - Contractor Address
     - Equipment & Installation Costs
     - AFUE/EF/Thermal Efficiency Rating

   All are required to process application.
5. To view an example of an invoice, please visit https://www.smartenergy-zone.com/masssave/.
6. Mail the signed rebate form with attached receipt to:
   Commercial High-Efficiency Gas Equipment Rebate
   Offer#: H946556
   P.O. Box 540064
   El Paso, TX 88554-0064

Program Details: This rebate program applies to equipment purchased and installed between January 1, 2014 and December 31, 2014. Applications must be postmarked within 60 days from installation date. Please allow 6-8 weeks processing time.

Reminder: Retain a copy of the completed rebate form for your records.

2014 High-Efficiency Natural Gas Equipment Rebates

HEATING EQUIPMENT

FURNACE	RATING	REBATE
Up to 150 MBH	95% AFUE* or greater & ECM motor	$300
Up to 150 MBH	97% AFUE* or greater & ECM motor	$600

CONDENSING UNIT HEATER	RATING	REBATE
Up to 300 MBH	90% Thermal Efficiency or greater	$750

INFRARED HEATERS	RATING	REBATE
All Sizes	Low Intensity	$750

CONDENSING BOILERS	RATING	REBATE
Up to 300 MBH	90% AFUE* or greater	$1,000
Up to 300 MBH	95% AFUE* or greater	$1,500
301 to 499 MBH	90% Thermal Efficiency or greater	$2,000
500 to 999 MBH	90% Thermal Efficiency or greater	$4,000
1000 to 1700 MBH	90% Thermal Efficiency or greater	$7,500
1701 to 2000 MBH	90% Thermal Efficiency or greater	$10,000

CONTROLS EQUIPMENT

AFTER MARKET BOILER RESET CONTROLS	$225
STEAM TRAPS	$ 50
PROGRAMMABLE THERMOSTATS	up to $ 25

WATER HEATING EQUIPMENT

ON-DEMAND TANKLESS	RATING	REBATE
with Electronic Ignition	Energy Factor of .82 or greater	$500
	Energy Factor of .94 or greater	$800

HIGH-EFFICIENCY INDIRECT WATER HEATER	REBATE
	$400

CONDENSING STAND ALONE	RATING	REBATE
75 to 300 MBH	95% Thermal Efficiency or greater	$500

ENERGY STAR®	RATING	REBATE
Freestanding	Energy Factor of .67 or greater	$100

COMBINED HIGH-EFFICIENCY BOILER AND WATER HEATING UNIT

CONDENSING BOILER	RATING	REBATE
with On-Demand Hot Water	Minimum AFUE Rating of 90%	$1,200
	Minimum AFUE Rating of 95%	$1,600

Must be considered one unit by manufacturer.

NOTES

* AFUE = Annual Fuel Utilization Efficiency, MBH levels are based on the unit's input.
Equipment must meet program guidelines, rebates are given on a per-unit basis not to exceed purchase price

Some restrictions may apply. Rebate offers are subject to change without notice.

A LIST OF QUALIFYING HEATING EQUIPMENT IS AVAILABLE AT **www.ahridirectory.org** | **1-877-883-1759**

NATURAL GAS COMMERCIAL APPLICATION

ACCOUNT HOLDER INFORMATION (Account Number must match Installation Address)

Form must be completed in its entirety.

BERKSHIRE GAS # ☐☐☐☐☐☐☐☐☐☐☐☐

COLUMBIA GAS OF MASSACHUSETTS # ☐☐☐☐☐☐☐☐☐☐

LIBERTY UTILITIES (MA only) # ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

NATIONAL GRID GAS (MA only) # ☐☐☐☐☐ - ☐☐☐☐☐ UTILITY REPRESENTATIVE NAME _____

NSTAR GAS # ☐☐☐☐☐☐☐☐☐☐ UNITIL GAS (MA only) # ☐☐☐☐☐☐☐ - ☐☐☐☐☐☐☐

ACCOUNT HOLDER'S/COMPANY NAME _____

ACCOUNT HOLDER'S TAX ID# _____ COMPANY TYPE: ❑ INCORPORATED ❑ NOT INCORPORATED ❑ EXEMPT

INSTALLED STREET ADDRESS _____ CITY _____ STATE _____ ZIP _____

CONTACT PERSON _____ EMAIL _____ TELEPHONE _____

BUILDING TYPE *(SELECT ONE)*

❑ Assembly	❑ Fast Food	❑ Hotel	❑ Multi Story Retail	❑ Religious	❑ Small Retail
❑ Automobile	❑ Full Service Restaurant	❑ Large Refrigerated Space	❑ Multifamily High Rise	❑ K-12 Schools	❑ University
❑ Big Box	❑ Grocery	❑ Large Office	❑ Multifamily Low Rise	❑ Small Office	❑ Warehouse
❑ Community College	❑ Heavy Industrial	❑ Light Industrial	❑ Other _____		
❑ Dormitory	❑ Hospital	❑ Motel			

PROJECT TYPE *(SELECT ONE)*

❑ Change in the use or Function of the Building Space	❑ New Building	❑ Expansion of an Existing Building	❑ Planned Replacement of Equipment
❑ New Equipment for New Process or Expanded Operation	❑ Renovation of Existing Building	❑ New Controls for Improved Operations	❑ Replacement of Failed Equipment
❑ Fuel Conversion			

ELECTRIC UTILITY INFORMATION (Required for an ECM Furnace Rebate Only)

NATIONAL GRID ELECTRIC (MA only) # ☐☐☐☐☐ - ☐☐☐☐☐ NSTAR ELECTRIC # ☐☐☐☐☐☐☐☐☐☐

UNITIL ELECTRIC # ☐☐☐☐☐☐☐ - ☐☐☐☐☐☐☐

WESTERN MA ELECTRIC # ☐☐☐☐☐☐☐☐☐☐

❑ Municipal Electric Company

PAYEE INFORMATION

Choose One ☐ Account Holder ☐ Lender ☐ Vendor/Installer ☐ Landlord

If payee information is different from account holder information and the gas utility provider is National Grid, additional processing time will be needed for payee verification.

PAYEE/COMPANY NAME _____

ADDRESS _____ CITY _____ STATE _____ ZIP _____

CONTACT PERSON _____ EMAIL _____ TELEPHONE _____

CONTRACTOR INFORMATION

Contractor Information is also required to be on the installation invoice.

CONTRACTOR NAME _____

ADDRESS _____ CITY _____ STATE _____ ZIP _____

CONTACT PERSON _____ EMAIL _____ TELEPHONE _____

ACCEPTANCE OF TERMS

I hereby request a rebate for the equipment listed. Attached are copies of all receipts or invoices. I have read and agree to the Terms and Conditions on the reverse of this form. I certify that a licensed contractor has installed the listed equipment (when applicable) in accordance with Program Guidelines and Terms and Conditions. I certify that I have seen the Energy Efficient Measures that have been installed and I am satisfied with their installation.

DATE _____ SIGNATURE X _____

GLE

The Customer must send a complete, signed rebate form along with copy of dated receipts and any other required information or documentation to the Program Administrator within sixty (60) days from installation date.

040109

NATURAL GAS COMMERCIAL APPLICATION

To check on the status of your rebate please visit https://www.smartenergy-zone.com/masssave/TrackYourRebate.aspx

THE SAME INFORMATION MUST ALSO BE INCLUDED ON YOUR INVOICE.

MEASURE INFORMATION - HEATING EQUIPMENT

Type of Equipment	Date Installed	Manufacturer	Model Number	Rating (THERMAL EFFICIENCY, AFUE OR ENERGY FACTOR)	MBH Input Size	Installed Cost	*Qty Installed	*Rebate Amount
ECM Furnace **Must fill out electric information on account holder page.**	/ /							
Condensing Unit Heater	/ /							
Infrared Heater	/ /							
Condensing Boiler	/ /							
Integrated Condensing Boiler/ Water Heater	/ /							
On-Demand Tankless Water Heater	/ /							
Indirect Water Heater	/ /							
Condensing Stand Alone Water Heater	/ /							
ENERGY STAR® Storage Water Heater	/ /							

** PROJECTS THAT ARE EXPECTED TO EXCEED 100 OF THE SAME UNITS AND / OR $25,000 IN REBATES WILL REQUIRE PRE-APPROVAL FROM YOUR GAS COMPANY.*

ANTICIPATED TOTAL REBATE: $

MEASURE INFORMATION - CONTROLS

Type of Equipment	Date Installed	Manufacturer	Model Number	Size of Unit Controlled (BTU)	Installed Cost	*Qty Installed	Rebate Amount
After Market Boiler Reset Controls	/ /						
Steam Traps	/ /						

** PROJECTS THAT ARE EXPECTED TO EXCEED 50 STEAM TRAPS WILL REQUIRE PRE-APPROVAL FROM YOUR GAS COMPANY.*

ANTICIPATED TOTAL REBATE: $

FOR THERMOSTAT REBATES, PLEASE ANSWER THE FOLLOWING QUESTIONS:

MEASURE INFORMATION -THERMOSTAT REBATES

Type of Equipment	Installed Date	Manufacturer	Model Number	Does the Thermostat Control Air Conditioning?	Purchase/ Installed Cost	Qty Installed	Rebate Amount
Programmable Thermostat	/ /			☐ Yes ☐ No			
Programmable Thermostat	/ /			☐ Yes ☐ No			
Programmable Thermostat	/ /			☐ Yes ☐ No			

ANTICIPATED TOTAL REBATE: $

GLE 040109

TERMS AND CONDITIONS

1. Definitions

(a) "Program Administrator" means Berkshire Gas, Columbia Gas of Massachusetts, Liberty Utilities (MA only), National Grid Gas (MA only), NSTAR Gas, or Unitil (MA only), as applicable.
(b) "Customers" are commercial natural gas customers in Massachusetts on a qualifying rate code.
(c) "Rebate" means those payment(s) made by the Program Administrator to Customers pursuant to the Program and these Terms and Conditions.
(d) "Program" means the energy efficiency program offered by the Program Administrator to Customers.
(e) "EEMs" are those energy efficiency measures described in the Program Materials or other custom measures that may be approved, in writing, by the Program Administrator.
(f) "Program Materials" means the documents and information provided by the Program Administrator specifying the qualifying EEMs, technology requirements, costs and other Program requirements.

2. Customer Eligibility

(a) You must be an eligible Natural Gas Customer of a Program Administrator to participate and qualify for a Rebate.
(b) Equipment purchases and installations made between January 1, 2014 and December 31, 2014 are eligible for Rebates.
(c) Equipment must be installed by a licensed heating or plumbing contractor at the Customer's address listed on the rebate form.
(d) The Customer must send a complete, signed rebate form along with original dated receipts and any other required information or documentation to the Program Administrator within sixty (60) days from installation date.

3. Installation Verification

The Program Administrator is not obligated to pay any Rebate until the Program Administrator has performed a satisfactory pre-installation inspection (unless the Program Materials state such pre-inspection is not required) and post-installation verification of the installation. The Program Administrators or its representatives, reserve the right to perform pre – and post - installation monitoring and inspection of the installed equipment for a three year period following the completion of the installation in order to determine the energy savings. If the Program Administrator determines that any EEMs were not installed in accordance with program requirements, the Program Administrator shall have the right to require modifications before having the obligation to make any Rebate payments. To the extent applicable, the Program Administrator may, at its sole discretion, withhold payment of any Rebate until Program Administrator verifies that the Customer has received, as appropriate, final drawings, operation and maintenance manuals, operator training, and the Program Administrator has received documentation detailing the installation of the EEMs in accordance with these Terms and Conditions and the Program Materials. The Customer shall provide access and information to the Program Administrator and reasonably cooperate in good faith with the Program Administrator regarding such activity. The Customer understands that the scope of the review by the Program Administrator does not include any kind of safety, code, or other compliance review or inspection. Maximum rebate amount cannot exceed purchase price.

4. No Warranties or Representations

(a) TO THE FULLEST EXTENT ALLOWED BY LAW, THE PROGRAM ADMINISTRATOR DOES NOT ENDORSE, GUARANTEE, OR WARRANT ANY CONTRACTOR, MANUFACTURER OR PRODUCT, AND THE PROGRAM ADMINISTRATOR MAKES NO WARRANTIES OR GUARANTEES IN CONNECTION WITH ANY PROJECT, OR ANY SERVICES PERFORMED IN CONNECTION HEREWITH OR THEREWITH, WHETHER STATUTORY, ORAL, WRITTEN, EXPRESS, OR IMPLIED, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THIS DISCLAIMER SHALL SURVIVE ANY CANCELLATION, COMPLETION, TERMINATION OR EXPIRATION OF THE CUSTOMER'S PARTICIPATION IN THE PROGRAM. CUSTOMER ACKNOWLEDGES AND AGREES THAT ANY WARRANTIES PROVIDED BY ORIGINAL MANUFACTURERS', LICENSORS', OR PROVIDERS' OF MATERIAL, EQUIPMENT, OR OTHER ITEMS PROVIDED OR USED IN CONNECTION WITH THE PROGRAM UNDER THESE TERMS AND CONDITIONS, INCLUDING ITEMS INCORPORATED IN THE PROGRAM, ("THIRD PARTY WARRANTIES") ARE NOT TO BE CONSIDERED WARRANTIES OF THE PROGRAM ADMINISTRATOR AND THE PROGRAM ADMINISTRATOR MAKES NO REPRESENTATIONS, GUARANTEES, OR WARRANTIES AS TO THE APPLICABILITY OR ENFORCEABILITY OF ANY SUCH THIRD PARTY WARRANTIES. THE TERMS OF THIS SECTION SHALL GOVERN OVER ANY CONTRARY VERBAL STATEMENTS OR LANGUAGE APPEARING IN ANY PROGRAM ADMINISTRATOR'S OTHER DOCUMENTS.

(b) Neither the Program Administrator nor any of its employees or contractors is responsible for determining that the design, engineering or installation of the EEMs is proper or complies with any particular laws, codes, or industry standards. The Program Administrator does not make any representations of any kind regarding the benefits or energy savings to be achieved by the EEMs or the adequacy or safety of the EEMs.

(c) Customer acknowledges and agrees that it is solely responsible (directly-based on its own judgment or indirectly-based on the advice of its independent expert, not the Program Administrator) for all aspects of the EEMs and related work including, but not limited to: selecting the equipment; selecting contractors to perform the work; inspecting the work and the equipment; ensuring that the equipment is in good working order and condition; ensuring that the equipment is of the manufacture, design specifications, size and capacity selected by the Customer and that the same is properly installed and suitable for Customer's purposes; and determining if work was properly performed and meets Program requirements and applicable laws, regulations and codes.

(d) Customer agrees and acknowledges that Program Administrator is not a manufacturer of, or regularly engaged in the sale or distribution of, or an expert with regard to, any equipment or work.

(e) The provisions of this Section 4 shall survive the termination, cancellation or completion of the Customer's participation in the Program.

5. Changes to High-Efficiency Equipment Rebate Program

The Customer understands that the Program is subject to change by the Program Administrator, at its sole discretion, without prior notice to the Customer. The Customer further understands that Rebate offers may increase or decrease at any time.

6. Tax Liability

Participants in the Program may be subject to tax liability for the value of goods and services received through the Program pursuant to state or federal income tax codes. The Program Administrator and the rebate administrator are not responsible for any tax liability which may be imposed as a result of receipt of the Rebates provided by the Program Administrator to the Customer.

TERMS AND CONDITIONS - *continued*

7. Indemnification

The Customer shall indemnify, defend and hold harmless Program Administrator, its affiliates and their respective contractors, officers, directors, employees, agents, representatives from and against any and all claims, damages, losses and expenses, including reasonable attorneys' fees and costs incurred to enforce this indemnity, arising out of, resulting from, or related to the Program or the performance of any services or other work in connection with the Program ("Damages"), arising directly or indirectly out of or in connection with the installation or related services and material or caused or alleged to be caused in whole or in part by any actual or alleged act or omission of the Customer, any contractor, subcontractor, agent, third party, or anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable. The provisions of this Section 7 shall survive the termination, cancellation or completion of the Customer's participation in the Program.

8. Limitation of Liability

To the fullest extent allowed by law, the Program Administrator's liability shall be limited to paying approved Rebates in accordance with these Terms and Conditions and the Program Materials. The Program Administrator and its affiliates and their respective contractors, officers, directors, employees, agents, representatives shall have absolutely no liability to the Customer or any other party for any other obligation. In no event, whether as a result of breach of contract, tort (including negligence and strict liability), or any other theory of recovery shall the Program Administrator be liable in connection with this Agreement or the Program for any or all special, indirect, incidental, penal, punitive or consequential damages of any nature whether or not (i) such damages were reasonably foreseeable or (ii) the Program Administrator was advised or aware that such damages might be incurred. The provisions of this Section 8 shall survive the termination, cancellation or completion of the Customer's participation in the Program.

9. Release

To the fullest extent allowed by law and as part of the consideration for participation in the Program, the Customer waives and releases the Program Administrator and its affiliates from all obligations (other than payment of a Rebate(s)), and for any liability or claim associated with the EEMs, the performance of the EEMs, the Program and associated work or items, or these Terms and Conditions. The provisions of this Section 9 shall survive the termination, cancellation or completion of the Customer's participation in the Program.

10. Rebate Amounts

The Program Administrator shall provide Rebate(s) for approved equipment up to the rebate amount indicated in the Customer's application. Projects greater than ten (10) or more of the same units and/or $25,000 in Rebates require pre-approval from the Program Administrator for rebate funds to be reserved.

11. Monitoring and Inspection

The Program Administrators or its representatives, reserve the right to perform pre- and post- installation monitoring and inspection of the installed equipment for a three year period following the completion of the installation in order to determine the energy savings. The Customer shall provide access and information to the Program Administrator and cooperate with the Program Administrator regarding such activity. The scope of the review by the Program Administrator does not include any kind of safety, code, or other compliance review or inspection. The provisions of this Section 11 shall survive the termination, cancellation or completion of the Customer's participation in the Program.

12. Miscellaneous

(a) Paragraph headings are for the convenience of the parties only and are not to be construed as part of these Terms and Conditions.
(b) If any provision of these Terms and Conditions is deemed invalid by any court or administrative body having jurisdiction, such ruling shall not invalidate any other provision, and the remaining provisions shall remain in full force and effect in accordance with their terms.
(c) These Terms and Conditions shall be interpreted and enforced according to the laws of the Commonwealth of Massachusetts.
(d) In the event of any conflict or inconsistency between these Terms and Conditions and any Program Materials, these Terms and Conditions shall be controlling.
(e) Except as expressly provided herein, there shall be no modification or amendment to these Terms and Conditions or the Program Materials unless such modification or amendment is in writing and signed by a duly authorized officer of the Program Administrator.
(f) The provisions of Sections 4, 6, 7, 8, 9 and 11 and any other provision that specifies by its terms that it survives termination, shall survive the termination or expiration of the Customer's participation in the Program.
(g) Counterpart Execution; Scanned Copy. Any and all agreements and documents requiring signature related to the Program may be executed in several counterparts, each of which, when executed, shall be deemed to be an original, but all of which together shall constitute one and the same instrument. A scanned or electronically reproduced copy or image of such agreements and documents bearing the signatures of the parties shall be deemed an original and may be introduced or submitted in any action or proceeding as competent evidence of the execution, terms and existence of such agreements and documents notwithstanding the failure or inability to produce or tender an original, executed counterpart of the same and without the requirement that the unavailability of such original, executed counterpart of the same first be proven.

13. Rebate Payment

Pending approval, we will process and mail the rebate within 6-8 weeks of receipt of the properly completed and signed application.

14. Payments Assignable to a Third Party

(a) The Customer may request that the incentive be paid directly to a third party by so indicating in the Program Application. Notification of third party payment will be sent to the Customer ("Account Holder") upon submission of the Program Application for the purpose of customer confirmation.
(b) If no payment choice is made, the Company will send the incentive payment directly to the Customer ("Account Holder") at the address indicated in the Program Application. If payee information is different from account holder information and the gas utility provider is National Grid, additional processing time will be needed for payee verification.

15. Financing Option

Pre-approved custom and prescriptive projects are eligible for 3rd party financing by a 3rd Party Lender. 1. Lender to qualify customer. 2. Invoicing monthly loan payment will be administered by 3rd Party Lender. 3. Interest rate on 3rd party loans is set at prime plus 100 basis points with a 6.25% minimum rate. 4. Scheduled interest payments on the loan will be pre-paid by the local utility or energy efficiency provider in lieu of a portion of the Mass Save incentive or rebate. If rebate is not sufficient to pay the interest, customer must pay the additional amount indicated to the lender.

ENERGY STAR PARTNER Mass Save is a proud partner of ENERGY STAR®

GasNetworks

mass save®

ADDED ECM CALCULATIONS REQUESTED

(includes revised ECM calculations)

Provided as a courtesy by BEA

Revised Executive Summary Chart:

Natural Gas	Propane	Oil	Electricity
$1.62 per therm	per gal	per gal	$0.20 per kWh

Executive Summary Chart
Ashby Town Office Building
Green Communities Study

Measure #	Measure Description (RTM = Renewable Thermal Measure) (ECM = Energy Conservation Measure)	Available Incentive ($)	Fuel Energy Savings (% of base)	Annual Savings ($ / yr)	Full Cost				Incremental Cost Difference *			
							After Incentive				After Incentive	
					Cost ($)	Payback (yrs)	Cost ($)	Payback (yrs)	Cost ($)	Payback (yrs)	Cost ($)	Payback (yrs)
ECM 1	Energy Management System Controls	$ -	11%	$ 2,373	$ 19,382	8.2	$ 19,382	8.2	$ 19,382	8.2	$ 19,382	8.2
ECM 2	Space Heating With Condensing Boilers	$ 2,000	15%	$ 3,027	$ 33,986	11.2	$ 31,986	10.6	$ 19,354	6.4	$ 17,354	5.7
ECM 3.1	1st & 2nd Floor Wall Insulation	$ -	22%	$ 4,449	$ 21,334	4.8	$ 21,334	4.8	$ 21,334	4.8	$ 21,334	4.8
ECM 3.2	3rd Floor Ceiling/Wall Insulation & Air Sealing	$ -	14%	$ 2,883	$ 8,092	2.8	$ 8,092	2.8	$ 8,092	2.8	$ 8,092	2.8
ECM 3.3	Basement Insulation & Air Sealing	$ -	4%	$ 786	$ 22,247	28.3	$ 22,247	28.3	$ 22,247	28.3	$ 22,247	28.3
	*ECM 3.3: Cost, Savings & Payback adjusted; town elected more comprehensive improvement											
ECM 5	Window Replacement	$ -	14%	$ 1,982	$ 94,424	47.6	$ 94,424	47.6	$ -	0.0	$ -	0.0
	*ECM 5: Window replacement ECM added at the request of the Town; energy savings calculations included in appendix											
	Totals:	*$ 2,000*	*79%*	*$ 15,500*	*$ 199,465*	*12.9*	*$ 197,465*	*12.7*	*$ 90,409*	*5.8*	*$ 88,409*	*5.7*
ECM Alternate												
ECM 4	Storm Window Installation	$ -	3%	$ 606	$ 12,553	20.7	$ 12,553	20.7	$ 12,553	20.7	$ 12,553	20.7

*Incremental = (Full Cost) - (Replacement-In-Kind of Existing)

Revised Fuel Energy Impact Chart:

		Fuel Energy Impact						
		Natural Gas	Propane	Oil	Electricity			
		100.0 kBtu / therm	92.5 kBtu / gal	138.7 kBtu / gal	3.413 kBtu / kWh			
Baseline Energy Use		**Natural Gas**	**Propane**	**Oil**	**Electricity**	**Fuel Energy**		
Space Heating		12,754				1,275,406		
Measure #	**Measure Description** *(RTM = Renewable Thermal Measure) (ECM = Energy Conservation Measure)*	**Fuel Usage After Measures** **Natural Gas** (therms / yr)	**Propane** (gal / yr)	**Oil** (gal / yr)	**Electricity** (kWh / yr)	**Fuel Energy Use** (kBtu / yr)	**Fuel Energy Savings** (kBtu / yr)	**Savings As % of Baseline**
ECM 1	**Energy Management System Controls**	11,288				1,128,792	146,614	11%
ECM 2	**Space Heating With Condensing Boilers**	9,418				941,781	187,011	15%
ECM 3.1	**1st & 2nd Floor Wall Insulation**	6,669				666,892	274,889	22%
ECM 3.2	**3rd Floor Ceiling/Wall Insulation & Air Sealing**	4,888				488,791	178,101	14%
ECM 3.3	**Basement Insulation & Air Sealing**	4,402				440,222	48,568	4%
ECM 5	**Window Replacement**	3,178				317,787	122,435	10%
						Totals:	***957,619***	***75%***
ECM Alternate								
ECM 4	**Storm Window Installation**	4,028				402,756	37,466	3%

Revised Greenhouse Gas Chart:

		Greenhouse Gas (GHG) Impact						
Baseline Fuel Usage		**Natural Gas**	**Propane**	**Oil**	**Electricity**	**MT eCO2**		
Space Heating		1,275				68		
Measure #	**Measure Description** *(RTM = Renewable Thermal Measure) (ECM = Energy Conservation Measure)*	**Fuel Usage After Measures** **Natural Gas** (MMBtu / yr)	**Propane** (gal / yr)	**Oil** (gal / yr)	**Electricity** (kWh / yr)	**GHG Emmissions** (MT eCO2)	**GHG Savings** (MT eCO2)	**Savings As % of Baseline**
ECM 1	**Energy Management System Controls**	1,129				60	8	11%
ECM 2	**Space Heating With Condensing Boilers**	942				50	10	15%
ECM 3.1	**1st & 2nd Floor Wall Insulation**	667				35	15	22%
ECM 3.2	**3rd Floor Ceiling/Wall Insulation & Air Sealing**	489				26	9	14%
ECM 3.3	**Basement Insulation & Air Sealing**	440				23	3	4%
ECM 5	**Window Replacement**	318				17	7	10%
						Totals:	***51***	***75%***
ECM Alternate								
ECM 4	**Storm Window Installation**	403				21	2	3%

Modified Treatment of Basement Windows

(Enclosure ECM 3.3 Revised)

Through the course of soliciting contractor estimates for replacement windows in the Ashby Town Hall, the conceptual handling of the boarded basement windows, with respect to insulating and sealing off the openings, was modified. The tables below show the results of the changes.

Summary of Energy Savings					
ECM 3.3	**Basement Insulation & Air Sealing**				
	Baseline	**After ECM**	**Savings**	**Reduction**	
Net Building Demand (MMBtu/yr)	449.7	405.0	44.68	9.9%	
Projected Seasonal System Efficiency	92%	92%			
Fuel Energy Usage (MMBtu/yr)	488.8	440.2			
Energy Savings	**% Reduction**	**Natural Gas Use**	**Therms Saved**	**$/Unit**	**$ Saved**
	9.9%	4,888	486	$1.62	$786
				Total Savings	**$786**

Cost	Savings	Payback (yr)
$22,247	**$786**	**28.3**

Note:
Cost estimates were developed by BEA based upon figures from Energia, LLC. & Peg & Beam, Inc.

Basement Rim Joist	230 ft.			
2" Closed Cell Spray Foam	4.55 $ / ft.			
	Depth (in.)	**R-value**	**Cost ($)**	
Foam Rim Joist	2	14	$	1,047
Insulate Basement Window Openings	4	25	$	17,300
Air Sealing	-	-	$	380
		Subtotal	**$**	**18,727**
		Contingency	$	1,873
		Totals	***$***	***20,599***
		Advisory & Contractor Oversight	$	1,648
		Measure Total	***$ 22,247***	

ENCLOSURE ECM 3.3 (Basement): HEAT BALANCE

GAINS AND LOSSES	BTU/HEATING SEASON*1E6
CONDUCTION LOSSES	-349.2
INFILTRATION LOSSES	-248.8
VENTILATION LOSSES	0.0
SOLAR GAIN	94.7
OCCUPANT GAIN	1.5
ELECTRICAL GAIN	96.8
NET HEATING DEMAND	-405.0

ENCLOSURE ECM 3.3 (Basement): HEAT LOSS COEFFICIENTS

Zone #	Building Zone		U-Value (BTU/hr-sf-F)	Area (sf)		UA-Value (BTU/hr-F)
1	**Basement - Occupied**	Occupied Basement Walls	0.072	846		61
		Below Grade Slab	0.033	94	per l.f.	3
				Wing UA Total	**64.2**	
2	**First floor**	Improved Wall 1	0.069	2,976		206
		Doors 1	0.690	105		72
		Windows 1 - w/ storm	0.570	642		366
				Wing UA Total	**644.5**	
3	**Second floor**	Improved Wall 1	0.069	2,990		207
		Doors 1	0.690	21		14
		Windows 2 - NO storm	0.900	713		642
		Existing 6" of cellulose	0.051	1,543	ADDED	78
				Wing UA Total	**940.9**	
4	**Third floor - Occupied**	Improved 3rd floor Ceiling	0.024	875		21
		COA Roof 2	0.054	1,366		74
		COA Walls	0.050	358		18
		Improved Wall 1	0.069	275		19
		Windows 2 - NO storm	0.900	75		68
		COA Skylight	0.870	14		12
				Wing UA Total	**212.0**	
5	**Basement - Unoccupied**	Basement Wall Above Grade	0.346	811		280
		Basement Wall Below Grade	1.271	230	per l.f.	292
		Insulated/Boarded Windows - Basement	0.039	224		9
		Below Grade Slab	0.033	230	per l.f.	8
				Wing UA Total	**588.9**	
6	**Third floor - Unoccupied**	3rd floor storage Roof 3	0.484		Removed	0
		Wall 1	0.574		Removed	0
				Wing UA Total	**0.0**	
				Building Total UA:	**2450.4**	

ENCLOSURE ECM 3.3 (Basement): CONDUCTION LOSSES

#	Zone	UA	HOURS/ DAY	DAYS/ -	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement - Occupied	64	8	151	33	3	
		64	16	151	29	5	
		64	24	61	25	2	9.4
2	First floor	644	8	151	33	26	
		644	16	151	29	45	
		644	24	61	25	24	94.4
3	Second floor	941	8	151	33	38	
		941	16	151	29	66	
		941	24	61	25	34	137.9
4	Third floor - Occupied	212	8	151	35	9	
		212	16	151	31	16	
		212	24	61	25	8	32.6
5	Basement - Unoccupied	589	24	151	25	53	
		589	0	151	25	0	
		589	24	61	25	22	74.9
6	Third floor - Unoccupied	0	24	151	20	0	
		0	0	151	20	0	
		0	24	61	20	0	0.0
	Total UA	2,450			Conduction Total		349.2

ENCLOSURE ECM 3.3 (Basement): INFILTRATION LOSSES

0.8

#	Zone	VOLUME	ACH	HRS/ DAY	DAYS/ YR	0.018	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement - Occupied	8,019	0.75	16	151	0.018	29	7.6	
		8,019	0.75	24	61	0.018	25	4.0	
	Occ.	8,019	0.75	8	151	0.018	33	4.3	15.9
2	First floor	43,002	0.75	16	151	0.018	29	40.7	
		43,002	0.75	24	61	0.018	25	21.2	
	Occ.	43,002	0.75	8	151	0.018	33	23.1	85.1
3	Second floor	43,002	0.75	16	151	0.018	29	40.7	
		43,002	0.75	24	61	0.018	25	21.2	
	Occ.	43,002	0.75	8	151	0.018	33	23.1	85.1
4	Third floor - Occupied	9,789	0.75	16	151	0.018	31	9.9	
		9,789	0.75	24	61	0.018	25	4.8	
	Occ.	9,789	0.75	8	151	0.018	35	5.6	20.3
5	Basement - Unoccupied	24,754	0.75	0	151	0.018	25	0.0	
		24,754	0.75	24	61	0.018	25	12.2	
	Occ.	24,754	0.75	24	151	0.018	25	30.3	42.5
6	Third floor - Unoccupied	0	0.80	0	151	0.018	20	0.0	
		0	0.80	24	61	0.018	20	0.0	
	Occ.	0	0.80	24	151	0.018	20	0.0	0.0
							Infiltration Total		**248.8**

ECM 5: Replacement Window Evaluation

BEA was asked to evaluate the replacement of the buildings windows. This measure assumes replacing all of the windows with ones having a .3 U-value (R-3.3). Cost estimates and window performance values were provided by the town and the following tables indicate the results.

Summary of Energy Savings

ECM 5 Window Replacement

	Baseline	After ECM 5	Savings	Reduction	
Net Building Demand (MMBtu/yr)	405.0	292.4	112.64	27.8%	
Projected Seasonal System Efficiency	92%	92%			
Fuel Energy Usage (MMBtu/yr)	440.2	317.8			

Energy Savings	% Reduction	Natural Gas Use	Therms Saved	$/Unit	$ Saved
Natural Gas	27.8%	4,402	1,224	$1.62	$1,982
				Total Savings	$1,982

Cost	Savings	Payback (yr)
$94,424	$1,982	47.6

Note:
Cost estimates were provided to BEA by the Town of Ashby from Peg & Beam, Inc.

Window Replacement Estimates

	Qty.	$ / unit	Cost ($)
New Replacement Windows	63	$ 1,414	$ 89,064
New Replacement Doors	4	$ 1,340	$ 5,360
		Totals	*$ 94,424*

REPLACEMENT WINDOW ECM 5: HEAT BALANCE

GAINS AND LOSSES	BTU/HEATING SEASON*1E6
CONDUCTION LOSSES	-253.2
INFILTRATION LOSSES	-232.2
VENTILATION LOSSES	0.0
SOLAR GAIN	94.7
OCCUPANT GAIN	1.5
ELECTRICAL GAIN	96.8
NET HEATING DEMAND	-292.4

REPLACEMENT WINDOW ECM 5: HEAT LOSS COEFFICIENTS

Zone #	Building Zone		U-Value (BTU/hr-sf-F)	Area (sf)		UA-Value (BTU/hr-F)
1	**Basement - Occupied**	Occupied Basement Walls	0.072	846		61
		Below Grade Slab	0.033	94	per l.f.	3
				Wing UA Total	**64.2**	
2	**First floor**	Improved Wall 1	0.069	2,976		206
		Doors 1	0.690	105		72
		Replacement Windows (LG)	0.300	544		163
		Replacement Windows (SM)	0.300	74		22
		Windows 2 - NO storm	0.900			
				Wing UA Total	**463.9**	
3	**Second floor**	Improved Wall 1	0.069	2,990		207
		Doors 1	0.690	21		14
		Existing 6" of cellulose	0.051	1,543	ADDED	78
		Replacement Windows (LG)	0.300	544		163
		Replacement Windows (SM)	0.300	169		51
		Windows 2 - NO storm	0.900			
				Wing UA Total	**513.2**	
4	**Third floor - Occupied**	Improved 3rd floor Ceiling	0.024	875		21
		COA Roof 2	0.054	1,366		74
		COA Walls	0.050	358		18
		Improved Wall 1	0.069	275		19
		Replacement Windows (SM)	0.300	75		23
		COA Skylight	0.870	14		12
				Wing UA Total	**167.0**	
5	**Basement - Unoccupied**	Basement Wall Above Grade	0.346	811		280
		Basement Wall Below Grade	1.271	230	per l.f.	292
		Insulated/Boarded Windows - Basement	0.039	224		9
		Below Grade Slab	0.033	230	per l.f.	8
				Wing UA Total	**588.9**	
6	**Third floor - Unoccupied**	3rd floor storage Roof 3	0.484		Removed	0
		Wall 1	0.574		Removed	0
				Wing UA Total	**0.0**	
				Building Total UA:	**1797.1**	

REPLACEMENT WINDOW ECM 5: CONDUCTION LOSSES

#	Zone	UA	HOURS/ DAY	DAYS/ -	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement - Occupied	64	8	151	33	3	
		64	16	151	29	5	
		64	24	61	25	2	9.4
2	First floor	464	8	151	33	18	
		464	16	151	29	33	
		464	24	61	25	17	68.0
3	Second floor	513	8	151	33	20	
		513	16	151	29	36	
		513	24	61	25	19	75.2
4	Third floor - Occupied	167	8	151	35	7	
		167	16	151	31	13	
		167	24	61	25	6	25.7
5	Basement - Unoccupied	589	24	151	25	53	
		589	0	151	25	0	
		589	24	61	25	22	74.9
6	Third floor - Unoccupied	0	24	151	20	0	
		0	0	151	20	0	
		0	24	61	20	0	0.0
	Total UA	**1,797**	**Conduction Total**				**253.2**

REPLACEMENT WINDOW ECM 5: INFILTRATION LOSSES

0.8

#	Zone	VOLUME	ACH	HRS/ DAY	DAYS/ YR	0.018	TEMP DIFF	LOSSES (* 1E6)	Sub Totals
1	Basement - Occupied	8,019	0.70	16	151	0.018	29	7.1	
		8,019	0.70	24	61	0.018	25	3.7	
	Occ.	8,019	0.70	8	151	0.018	33	4.0	14.8
2	First floor	43,002	0.70	16	151	0.018	29	38.0	
		43,002	0.70	24	61	0.018	25	19.8	
	Occ.	43,002	0.70	8	151	0.018	33	21.6	79.4
3	Second floor	43,002	0.70	16	151	0.018	29	38.0	
		43,002	0.70	24	61	0.018	25	19.8	
	Occ.	43,002	0.70	8	151	0.018	33	21.6	79.4
4	Third floor - Occupied	9,789	0.70	16	151	0.018	31	9.2	
		9,789	0.70	24	61	0.018	25	4.5	
	Occ.	9,789	0.70	8	151	0.018	35	5.2	19.0
5	Basement - Unoccupied	24,754	0.70	0	151	0.018	25	0.0	
		24,754	0.70	24	61	0.018	25	11.4	
	Occ.	24,754	0.70	24	151	0.018	25	28.3	39.7
6	Third floor - Unoccupied	0	0.80	0	151	0.018	20	0.0	
		0	0.80	24	61	0.018	20	0.0	
	Occ.	0	0.80	24	151	0.018	20	0.0	0.0
							Infiltration Total		**232.2**